The Lives of Objects: Designing for Meaningful Things

Dimitrios Paris Darzentas, BSc, MSc

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

September 2017

Abstract

Today's Internet of Things (IoT) is often employed to connect material artefacts to digital identifiers and a digital record of their history and existence. This has been heralded as a coming together of our material existences and our increasingly-digital lives. Bringing each object that we create, use and cherish into the IoT, is an outwardly appealing prospect. Using material objects is an accepted part of connecting with narratives and our history, and such a technological boon already enables the storytelling opportunities that are supported by rich digital records.

However, in everyday life and in the practices that occupy them, people consider and share stories about the things that they feel to be meaningful to them in complex ways which do not necessarily conform to the expectations of the designers and developers who attempt to intervene and support such practices by focusing on the material objects at hand.

This thesis draws upon observations from a thorough engagement with the community of practice of the Tabletop Miniature Wargaming pastime, which involves the acknowledged craft and use of objects deemed as meaningful, to reveal that the practitioners, in reality, construct their shared records and narratives around intangible Identities, both singular and collective, which they find to be the actual 'meaningful things' of their activities. These findings contravene the conventional emphasis on the material objects, and pose technological and conceptual challenges. Considering these findings through a lens informed by philosophical grounding, the thesis examines the distinctions between ordinary objects and extraordinary things; how things become meaningful; and the interplay between material and abstract things.

The culmination of these efforts is the Meaningful Things Framework, which aims to help disambiguate the complex ways by which practitioners create, perceive and treat the meaningful things involved in their activities, and aid designers, developers and the communities themselves in understanding and supporting their practices.

Acknowledgements

I would like to express my deep gratitude to all those who helped and supported me throughout the course of my doctorate.

First and foremost, I wish to sincerely thank my supervisors: Steve Benford for his enthusiastic, inspiring and unfailing support, and the many opportunities he has given me; Martin Flintham for his unstinting counsel and guidance; and Michael Brown for his encouragement and for introducing me to the world of wargaming that truly characterised this research. Their patient mentoring gave me the confidence to see this work through.

Many thanks are due also to my thesis examiners, Professors Boriana Koleva and Alan Dix.

I also want to thank my study participants for sharing their thoughts, insights and revealing banter, and the National Videogame Arcade for hosting my Mixed Reality Storytelling project.

Sincere thanks also to my many colleagues and friends at the Mixed Reality Lab and the Horizon Programme for their advice and help, especially Emma Juggins, Sam Stapleford-Allen, Felicia Black, Sue Jones, Anthony Brown, Adrian Hazzard, Holger Schnädelbach, Nils Jaeger, Patrick Brundell, Paul Tennent and many, many others.

I am deeply grateful to my close friends with whom I could share this experience, particularly my erstwhile flatmates Lachlan Urquhart and Diana Miranda, and especially to my partner Hanne for her understanding, companionship and cooking.

And finally, I want to especially thank my family, whose unfaltering support got me where I am today.

Table of Contents

1 Introduction

1.1 Introducing the Problem Space & Motivating the Research

In keeping with the ever-increasing rapidity of technological advancement of the ongoing Information Age, the last two decades have appropriately seen an explosive expansion in the ways in which people record, create and share content about their lives and activities.

The Digital Revolution underpins Information Age, and the advent of the Internet forever changed the landscape of information sharing. And coupled with the previously unthought of popularity of Social Media, which has impacted our lives in ways we are still struggling to come to terms with, these phenomena are here to stay.

However, another phenomenon that has emerged is the Internet of Things (IoT) paradigm. Envisioned as a future where all 'Things' are connected, identifiable and interrogable, the IoT has been thought by many to suggest that the material world that we physically exist in will join us in the Information scape that cognitively live in. The marketing-driven vision of the future is one full of smart objects and environments that communicate with us and anticipate our needs.

The reality however is quite different. Like many similar paradigms, the Internet of Things has not yet been able to live up to expectations. While it has found a home in industry and logistics, it should be said that before being rebranded as the IoT, such technologies as tagged inventory tracking and distributed sensors – both mainstays of the current IoT, have been in use in such settings for years. One need look no further than automated factories or the ubiquitous product barcode. The IoT has been markedly less successful at making inroads in the same way as mobile technology and social media have in daily life, consumer applications and creative practices. Part of the reason for this is the fragmentation of the vision and the approaches to reaching it. The IoT is and means many different things to different people and interests. It has links to innumerable established spheres of research and commercial

endeavours, ranging from the aforementioned industrial logistics and manufacturing, to the still developing Smart/Connected Homes and Cities. However, the core concept of the vision, meaning the interconnectivity of all the material things around us has spurred the imagination of many beyond these applications.

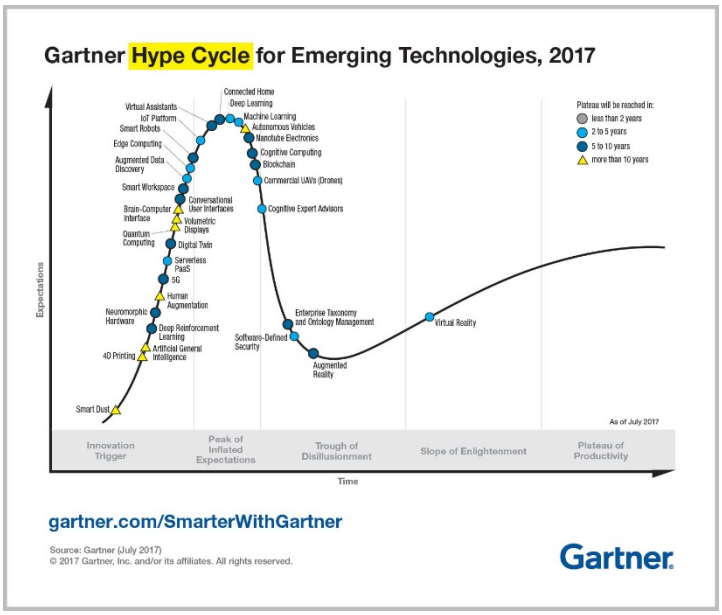


Figure 1.1. The speculative Gartner Hype Cycle Chart for 2017 shows various aspects of the IoT teetering towards the Trough of Disillusionment. There is hope of escape however. (Source: Gartner July 2017)

Bruce Sterling's vision of Spimes [130] is an emblematic example here. He envisioned an object, titled a Spime, that could be tracked through space and time over its entire lifetime, from cradle to grave. While Sterling's concept was a convergence of six aspects, including Virtual Design, Rapid Manufacturing, and Circular sustainability, the three aspects that fell under the purview of the IoT were the ability to: Uniquely identify each object, track its position, and be able to extract any information from it. Variations of these last three premises have been the cornerstones of several research and creative projects which have drawn a link between these capabilities and different real-world objects.

Essentially, the question that has been asked often and in many variations, is this: *If we could have access to a Record of the lifetime and existence of any*

given material object, what would this mean? How would it affect our relationship with the object, how we perceived and valued it, both objectively and subjectively?

These questions were by no means born from the advent of the IoT. Several disciplines exist with the sole purpose of discovering, maintaining and sharing the histories of material objects. Such objects have long been one of the best ways of connecting with a story, whether from one's history or from fiction. Archaeological artefacts, symbolic monuments, personal keepsakes and mementos, all have the power to evoke and elicit meaningful responses and create experiences for people. Coupled with the innate curiosity to 'know' about something and there is a powerful draw to explore the Lives of Objects.

Understandably then, the IoT has been seen as a primary candidate to providing this capability and satisfy our eternal curiosity. It appears a natural fit, a collection of technologies that have made it their business to singularise objects and track their every move.

Why then has it not lived up to expectations? Why are people not tagging their prized meaningful material possessions and embedding technology within? The answer, like most things, is manifold.

Firstly, there are the understandable limitations of the technology. Not just in the restrictions brought upon by cost and practicality, but also in the uncertainty the still developing standards around the bedrock architecture of the IoT. The challenge of creating an architecture that can handle the estimated billions of connected things, and worst, the indescribably large amounts of data they will create, requires concerted effort.

However, a more cogent reason is also subtle and challenging to clearly define. In short, it has to do with the 'Things' of the Internet of Things.

When tasked with capturing the 'Records' of the 'Things' of a context, setting, or practice, the current convention is to determine the 'common denominator' material object involved and technologically augmenting it for tracking. This

approach turns out to often be ill-suited for the task, and can be met with resistance by the community of a practice. The reasons why this is so are not immediately apparent, and can be especially intriguing when the practice in question seems to revolve around these material objects that are acknowledged as meaningful, and the practice already involves elaborate activities of Record documentation and sharing.

To begin exploring these possible reasons, an investigative approach was deemed necessary to gain a deeper understanding of such a practice. This began with an ethnographical approach, which has a recognised effectiveness in uncovering the nuances of a practice, and was followed by a concentrated deployment of Technology Probes [77] and workshops to further elucidate the findings and draw actionable conclusions, as detailed below.

1.2 Objectives and Approach

The stated long-term objective at the commencement of the research was to investigate the possible effects of using technological means to capture and share records about things. Partitioning this objective into several, more feasible, sub-goals, the focus was placed on the ways of a community of practice which inherently involves 'things'. This would allow investigation of questions about their existing record keeping practices, the use – if any – of technology, and the effects of possible technological support.

The first issue to resolve was the immense variety of possible contexts that can be chosen as the focus of the research. Each potential context varies immensely in nature and scope. Possibilities that were considered ranged from contexts involving personally cherished items such as keepsakes, mementos and gifts; to crafting-oriented practices of making; to culturally significant artefacts in museum and heritage settings; and to practices of creativity and storytelling. However very few of these contexts offered insights into a balanced array of aspects. For example, some practices focused entirely on material crafting, such as pottery and knitting, while missing out on aspects of heritage and

storytelling by not having a culture of Record documentations, and vice versa. Critically, many of the considered contexts had few examples of rich ‘usage’ of the ‘Things’ that were the purportedly the mainstay of the practice.

An opportunity was found in the practice of Tabletop Miniature Wargaming. As will be discussed in depth within this thesis, the practice of wargaming is seemingly focused on the collection of miniature models and their use in tabletop gameplay. However, upon further examination the practice actually contains a wealth and variety of interleaved activities including rich narrative storytelling, competitive performance driven gameplay, creative expression through modelling, painting and conversions, and more. Critically there is a pre-existing culture of documenting all of these activities and sharing them with the community. Examples of this range from detailed step by step crafting and painting guides to elaborate post-game ‘battle reports’ told from both narrative and gameplay performance viewpoints. The gameplay aspects of the pastime were particularly salient when compared to other practices, as it provided evidence of active and rich use. And due to the unpredictable nature of the competitive gameplay, it led to the occurrence of emergent and unexpected events that were afforded the miniatures a degree of agency and created storytelling opportunities.

Figure 1.2. A completed miniature army arranged on a thematic display board during a painting competition.

Therefore, Tabletop Miniature Wargaming was chosen as the context, as the objects involved – meaning the miniatures and the paraphernalia involved – simply led richer and more interesting 'lives'. Combined with the existing Record documentation culture, unprecedented access to the wargaming community, and eagerness of that community to explore integration technology into their practice, the choice of focusing on Wargaming was deemed as an appropriate choice for observing a wider variety of practice activities and richer environment for exploration and potential intervention.

The first step was to conduct an in-depth ethnographical investigation of the practice. With little-to-no prior experience of the wargaming practice, extensive fieldwork was conducted to become immersed in the setting and activities of the practice, including gaining proficiency in the work of the community and actively participating and observing training and events. The investigation revealed a wealth of insights, and provided the first clear indications that there was more to the 'meaningful things' of the practice than the evident miniature models. Specifically, a picture began to form where the things that were considered meaningful; captured the attention and imagination of most of the practitioners; and were more often the focus of their narratives, were not just the material objects. They were also the characters, groups and organisations that featured in several aspects of the activities. The factions; armies; units; and characters, that they created or appropriated from background settings, were the 'living' things that would have their 'lives' documented and shared with others. These phenomena offered the first clues about the challenges that the design interventions face due to the complexities of the activities and the preconceptions about the importance of the material elements over the intangible 'things' of the practice. These 'things' are those that the practitioners actually consider more meaningful to them, and thus wished to document and share.

Thus, the next step in the approach was to developa set of four Technology Probes that were designed to support aspects of the practice that were identified as critical, including the documentation of detailed crafting Records

and the presentation of those Records. These probes were deployed with a group of experienced wargaming hobbyists, who through a series of reflective workshops offered their insights and opinions of the interventions and more importantly used them as exemplars to give voice to the hard-to-describe innate ways by which they actually perceived and treated the things of the practice.

From this process three telling vignettes were derived. These served to illustrate the different ways by which practitioners perceive, consider, treat and value the tangible and intangible things of their practice.

The next part of the approach was the development of an interactive exhibit in a national museum consisting of refined and expanded versions of the probes. These were designed to demonstrate possible future ways of capturing rich Records Footprint, such as 3D scans of objects, and presenting Record-supported narratives in engaging ways by highlighting the identity-centric storytelling. These were experience by a wider audience of tabletop wargamers and the general public and offered further reflections on the work and insights into its wider application.

The garnered insights were reflected on, informed by grounding in congruent concepts from domains of philosophy, and the approach culminated in the formulation of the *Meaningful Things Framework*. Comprised of interconnected Material Objects and Abstract Identities, the framework aims to help disambiguate the complex innate activities of communities of practice and help identify the 'things' in practice, whether material or intangible, which the practitioners consider to be meaningful and attempt to document and share a record for. By doing so it can guide design interventions which aim to support and expand the activities of practice. In particular it can guide the technologically supported capture of Records, by directing design and development efforts towards toward those things that practitioners actually value for themselves and their community. And thus, it can instead help avoid being misdirected by the technology trends into interventions that are ultimately unsuitable to the task

1.3 Thesis Structure

This chapter offered a short orientation of the problem space and context of the thesis, outlining the motivation and general approach, followed by an introduction to the concepts that are key to the research.

Following this, the thesis is comprised of 3 main parts. The first part elaborates on the current state and directions of the Internet of Things paradigm that coloured much of the work. It also presents several research and creative projects which have used Internet of Things inspired approaches for purposes diverging from the conventional IoT uses. Finally, it briefly discusses the theoretical framing that guides the more nuanced and complex aspects of the problem space through a lens composed of philosophical debates on the nature of Objects and Things, Abstract Things and Meaningful Things (**Chapter 2**). The second part describes the work that took place to gain a deep familiarity with the chosen context of tabletop wargaming. This was accomplished through extensive ethnographic fieldwork, interventions through technology probes and workshops, and a culminating public exhibit. Critically this part provides a series of vignettes, which illustrate the complexities of the chosen practice and serve as exemplars of the findings (**Chapters 3,4,5**). The third part, starting at chapter 6, introduces the Meaningful Things Framework, detailing each set of components and the rationale behind them. Next the framework is applied to the context of tabletop wargaming and the previously discussed vignettes are revisited as illustrative examples. This is followed by discussion and examples of the application of the framework to other contexts, such as some of the earlier discussed projects. Finally, the potential use, contributions and beneficiaries of the outcomes are discussed, followed by considerations of further work and research that could be done (**Chapters 6,7**).

Specifically:

Chapter 2 reviews the current state of the Internet of Things, describes several congruent projects that use or incorporate aspects of the IoT, and discusses the theoretical underpinnings and considerations of the work.

Chapter 3 details the ethnographic fieldwork, providing insights into the multitude of interleaved activities of the tabletop wargaming practice. The work focuses on what parts of their activities practitioners try to document into Records, what these Records are focused on, and how they use them to create and share narratives with the rest of the community.

Chapter 4 describes the development and deployment of four Technology Probes whose design was informed by the ethnographic findings and aimed to gain a much deeper and focused understanding of the challenges of technologically supporting the Record documentation activities of the practice. The three vignettes that were derived from the probe and workshops are first introduced and described in detail.

Chapter 5 details the Mixed Reality Storytelling project which was a public exhibit that was created as an opportunity to publicly demonstrate refined and expanded versions of the earlier technology probes.

Chapter 6 brings together the finds of the work so far and introduces the main contribution of the research, The Meaningful Things Framework, and outlines its components and details its application to wargaming and other contexts.

Chapter 7 concludes the research and summarises the output and contributions for research and possible stakeholders. Finally, it outlines possible future work and concerns over issues and challenges, both previous and newfound, which as yet remain unexplored.

2 Background

2.1 Introduction

The following chapter aims to provide a concise overview of the domains, disciplines and phenomena that feed into the complex problem space that was presented in the previous chapter.

This chapter begins with an overview of the current state of the art in the domain of the Internet of Things, both in terms of current research directions and commercial endeavours. It then proceeds to an overview of the current research and studies regarding physical objects with digital records, and how these are captured, disseminated and used in crafted storytelling. Finally, it briefly delves into the practical and philosophical aspects of how various disciplines frame the relationship of people with the material world around them and how they perceive abstract and social objects.

2.2 The Internet of Things

2.2.1 Evolution of the core concept

While the Internet of Things (IoT) paradigm has grown considerably in recent years [2,8,91,150], it remains at its core a fairly straightforward concept. It essentially describes a future where the majority, or ideally all, of the 'things' around us are connected between themselves and to a larger network, thus enabling numerous functions and opportunities ranging from remote monitoring and inventory control, to mass data mining. The reality however is rather more complex.

When delving deeper, the concept becomes substantially more complicated to unpack, not least because of how it touches - and draws - upon numerous research fields, poses a lucrative commercial opportunity, and continues to evolve along with the rapidly changing socio-technological landscape.

Indeed, finding a universally accepted definition of the Internet of Things is a tricky proposition, despite the term being almost a decade old when Kevin

Ashton of the MIT Auto-ID centre popularised the Internet of Things term during a presentation to Procter & Gamble about using RFID technologies to augment their supply chain. His point at the time, and later on [7], was that using tagging technologies could automate the generation of data though Machine to Machine interaction (M2M), thus exponentially increasing its quantity and accuracy, and increasing its effective use, all with the ultimate goal of improved efficiency.

It should also be said that the concept is actually far older than that, as its ideas have been part on the concepts of Ubiquitous Computing (Ubicomp) and Ambient Intelligence from the late 80s [143–145] and Device to Device communication from Bill Joy's "Six Webs Framework" in the late 90s. The main tenet of Ubicomp 'hiding' the computer in the environment around the user is seemingly very close to the current incarnation of the IoT which is primarily based on tagged objects and networked sensors

The dichotomy of its exact nature was prevalent as early as 2010, where in their seminal survey paper, Atzori et al. [8] posit that the literature at the time would quite likely confuse readers as to what the IoT is, what ideas are behind it and what effects if might have in social, economic and technical terms. Atzori et al. reasoned that the multifaceted nature of the IoT paradigm is underpinned by three main different perspectives or "visions", which were dependant on the interests of the given stakeholder. Illustrated in Figure 2.1 below, these underpinning visions where identified as "Internet oriented", "Things oriented" and "Semantic oriented" perspectives.

The "Internet" oriented perspective was defined as being mainly concerned with reconciling the issue of connecting a projected 50 billion additional devices to the existing internet, thus it revolves around the networking protocols, platforms, standards and technologies required to make that happen. At the time the "IP for smart objects" alliance (IPSO) had been formed in 2008 [139], and led to simplified IP stacks that would be more suitable for small, low power, distributed devices.

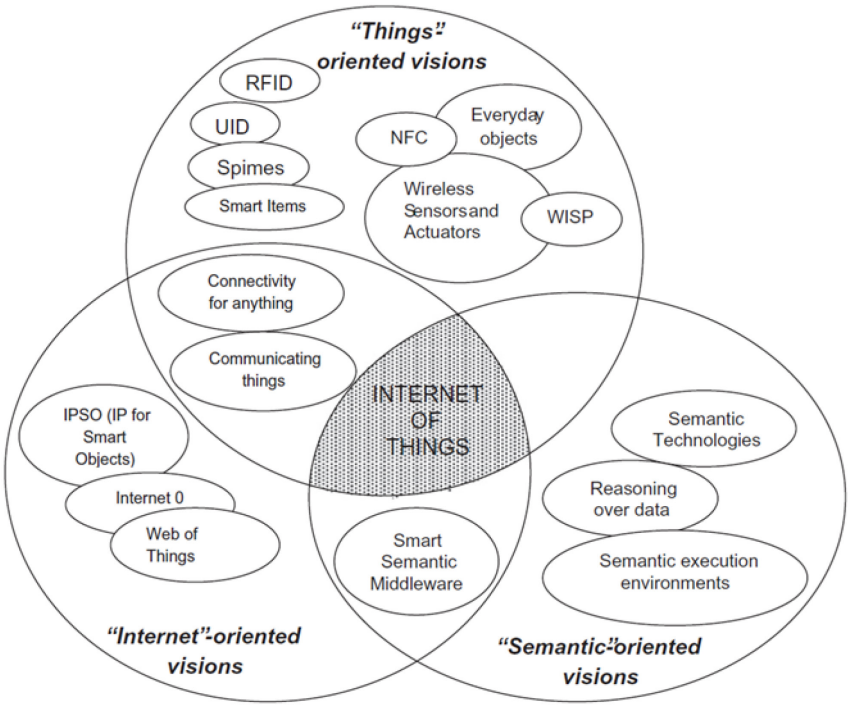


Figure 2.1. 'Internet of Things" paradigm as a result of the convergence of different visions. (Source: Atzori 2010 [8])

The "Semantic" oriented perspective is closely linked to the "Internet" vision, and concerns the issues regarding the management of the – increasingly numerous and complex - connected 'things' and the data they generate. To be able to make sense and use of this data, methods for representing, storing, searching and interconnecting would have to be developed. A large part of this is also the issue of uniquely identifying each of the 'things'. The way this was envisioned at the time was to employ Semantic Technologies [102,141].

The perspective most pertinent to this thesis, and the most complex and multifaceted one, is that of the 'Things' in the IoT. Initially the term was meant to refer to Radio-Frequency Identification (RFID) tags. Envisioned by Auto-ID labs and EPCglobal [80,163], the idea was to be able to better track the location of objects during production and transportation, effectively as a barcoding technology. However, as Atzori et al. stressed at the time, the IoT cannot be limited simply to a network of traceable tags. Instead, in order to reach the full potential that was envisioned, it would have to include the networking of

everyday objects [23,164]. This thinking, alongside the visions of Ubicomp, gave birth to ideas and Notions of Smart or Intelligent Items, that would be networked and thus report and use data.

A concept that was often referred to in this context was that of Bruce Stirling's "Spimes" in his book *Shaping Things* [130]. These were defined by Stirling as objects which can be tracked and traced through space and time throughout their lifetime. Envisioned as sustainable, enhanceable and identifiable, to exist as conceived the Spimes relied on the convergence of at least six different technologies. These included: A way of effectively uniquely identifying each one, such as with RFID; A way to accurately locate them, such as with GPS (at least outdoors); A way to get large amount of desired and contextualised data from them – such as with a search engine; A method to virtually design the objects, so sophisticated CAD tools; Rapid fabrication technology for the designs, envisioned at the time as 3D printing; And a "Cradle-to-Cradle" life span to emphasize sustainable recycling of the Spimes or their raw materials. A given example of a Spime object was that of a pair of shoes, that could be virtually designed by anybody to their exact specifications, fabricated rapidly in their home, be tracked and traced through its life time while giving useful data back to the wearer, such as material wear, usage patterns and the like, and then be recycled into raw materials to be made into a new pair.

Understandably, the fully-realised concept of a Spime remains purely hypothetical, however its idea remains as the ideal of a "Smart Item" or "Smart Object", and parts of the concept find their way into real-world implementations, if even partially and ephemerally. Visions of an Internet of Things populated by objects that are 'Smart' leads to ideas of things who, using the data they have access to via the IoT, can be in some way autonomous, proactive and context aware. This notion eventually led to some of the more commonly seen products associated with the IoT, such as Smart Meters, Thermostats and the like, which are nowadays referred to as the Domestic IoT.

The increasingly complex and far reaching views of what the IoT is and might mean led to wider and vague definitions [8] such as the Intranational

Telecommunication Unions' (ITU) definition of the IoT wherein "*from anytime, anyplace connectivity to anyone, we will now have connected to anything*" [111]. And the more specific but still far reaching European Commission's definition of the IoT as "*Things having identities and virtual personalities operating in smart spaces using intelligent interface to connect and communicate within social, environmental and user contexts.*"

In these definitions, we see how, the "Things" oriented perspective of the IoT is by far the most complex and variably affective aspect of the paradigm, as it carries many different meanings depending on the beholder. It is also the hardest to pin down as the 'Thing' in the 'Internet of Things' shifts continuously in meaning and scope depending on the point of view of the stakeholder. For the "Industrial IoT" and service providers, it is an internet of tags and sensors with the aim of increasing efficiency, for entrepreneurs and designers it is an increasingly muddled assortment of proprietary 'smart objects' and IoT platforms as they each race for the "killer product". And for Futurists it is borderline 'magical' self-ware, autonomous, intelligent object, that still manages to be personally meaningful through a personalised design process [130]. In practice, the truth, as always, is somewhere in between all these visions, as the Internet of Things, like other paradigms and concepts, is a fluid and changing idea that can hardly be nailed down to a particular aspect, especially when it's driving motivators – namely technology and a shifting social landscape of technological adoption, integration and usage – are ever-changing themselves.

2.2.2 Applications and Opportunities

As evidenced, encapsulating the IoT to an all-encompassing definition is a challenging proposition. A way to move forward is to holistically consider the many contexts and applications in which the paradigm has been used. It should be said that not all of these use cases have been immediate successes, but this is the case with many technology-driven movements, especially those where business interests override research and designer led endeavours.

In this subsection, several key applications of the IoT will be briefly described, with the aim of putting together the rich tapestry that the IoT can potentially encompass.

Manufacturing – Industrial Internet of Things (IIoT)

One of the most successful deployment of IoT has been in the Industrial manufacturing sector, so much so that the term "Industrial Internet of Things" has taken root in current literature [78,150] to describe the phenomenon. The suitability of the IoT for industry and manufacturing is understandable, since it was in this setting that it was originally envisioned in, with the use of RFID tags for real time inventory management [48,64,108]. However, in the intervening years the applications of the IoT in manufacturing have grown into full blown Digital Control Systems and Cyber Physical systems [78,109] which by providing accurate and real-time data about the manufacturing process, tools, materials and conditions, provide increased efficiency, security (and profit), through predictive maintenance, energy optimisation and centralised remote control interfaces. In practice, the Industrial IoT is made up of networks of sensors and tags, which provide data to knowledgeable operators. As such, they are relatively closed systems.

The Smart Home

One of the most popular conceptions of the IoT is that of the Smart Home. This vision, which has been pursued in one form or another for several decades, seemed to finally begin to become a reality through the Internet of Things.

The premise has always been one of Convenience and Quality of Life Improvement. Envisioned as the smart home, which anticipates the inhabitants needs and desires, and 'acts' to address them. The examples for this are numerous. Smart thermostats that keep the house at the most comfortable climate, while maximising energy efficiency. Front doors that recognise you as

you come home. Smart Coffee machines, that begin brewing as soon as their owner wakes up, ensuring coffee at the right temperature just as breakfast begins. Fridges that order groceries when they have run out. VCR's that tape a television show that you want to watch while you are away. This gives an idea as to how old these use cases are [98]. In fact, the popular vision of the smart home has captured the imagination for decades, going back to the 50s and beyond as evidenced by the Disneyland *Tomorrowland* exhibit and the "House of the Future" [122].

The internet, and by extension the Internet of Things, are finally beginning to make these visions a reality. They do this by providing those elements that had been previously missing, connectivity – which leads to information sharing – which leads to 'intelligence'. One only has to take a sample of the main IoT products that are being marketed currently: The Nest thermostat, Cameras and Smart Door Locks [165]; Tile Object trackers [166]; Phillips Hue Bulbs [167]; Amazon's Echo [168]; and many more. These are all current products, marketed as part of the IoT, and each promising to revolutionise one's life, each in their own heterogeneous way.

Infrastructure and Energy

Leading on from the previous theme of home automation, another IoT application that is very prevalent in the popular consciousness, is that of effective Energy Management. Starting on the scale of the home as mentioned above, and all the way up to national grids, energy management is again one of those issues whose effective and efficient management relies on data and feedback. Knowing what, why and how is consuming energy, and anticipating fluid needs and supply are key requirements for achieving such management. Here, an aspect of the IoT has quite successfully taken hold in the form of smart metering. By deploying meters within customer's homes, energy companies can poll usage data in practically real-time, thus having enough information to make better projections for grid-wide load balancing. This has knock-on effects

all the way down the chain to the level of supply and demand of energy resources. With more -and more accurate – data, the energy providers can predict usage patterns, thus making more efficient use of energy sources, with all the attendant benefits this brings – from economical to environmental. Conversely, the end-user customers benefit as well, as they are endowed with a greater understanding of their own energy usage patterns, which they usually take action to improve, as now they have immediate feedback on the benefits of doing so – most usually by observing the real-time cost calculations on the smart meters [83,125].

Transportation

The benefits of IoT-like integration have already been observed in the domain of transportation, both private and public. Many cities around the world are now using tracking and prediction systems for their public transportation. This has an immediate benefit for travellers, in that they are provided with immediate knowledge of when and where the next transport will arrive. For the controllers on the other hand, it again provides them with necessary information for decision-making on a minute-by-minute basis. The application of the IoT like technologies however does not focus entirely on the location of the vehicle. Instead it is deployed all the way down on the scale of the various vehicle components that require monitoring. Newer models use sensors to keep track of the condition of engine parts, individual wheels and chassis condition and stresses. Having such information allows for predictive and preventative maintenance – and by extension further efficiency and economy.

Similar technologies for fleet management are used by rental and logistics companies as well. And they are also employed in the higher-end private vehicles as well. Furthermore, vehicle-based IoT-like identifying technologies have been employed for a while in application such as secure area access controller and automated functions such as parking and toll booth usage. In addition, these technologies are part of the infrastructure bedrock that will be

needed to make any realistic vision of automated vehicles a reality, as the embedded and environmental IoT sensors will feed necessary data to the increasingly common autonomous vehicles.

Smart Cities and Environment

Continuing with the theme of data-based efficiency improvement, the IoT has found a natural habitat in city-sized deployments. The previously mentioned benefits of IoT application in the transportation are the first obvious boon to mention here. City planning efforts to contend with heavy traffic rely constantly on up-to-date information of road use patterns, commuter behaviour, location of chokepoints, and event and emergency handling. City-wide IoT sensing infrastructures can provide large parts of the required data, including vehicle counts, areas of congestion, etc.

Furthermore, such distributed sensing infrastructure can provide environmental readings for air and water quality, as well as noise levels. These environmental monitoring applications can naturally be scaled up and deployed in non-metropolitan areas to provide environmental feedback in caricatural, wilderness and even aquatic areas. Having up-to-date environmental data can be the key factor in dealing with long-term issues such as global warming. And they can help handle - or even prevent via early warning – more immediate emergencies such as forest fires and other environmental disasters.

Medical Healthcare

Another domain where the current IoT has had a positive impact is in Medical Healthcare. Those employed in this sector, whether Doctors, Nurses or medical orderlies, technicians and administrators, rely on accurate information in order to make decisions which often carry serious consequences for patients. While medical tests and diagnostic techniques and equipment have been for years

the mainstay source of medical data, practitioners are coming to welcome the benefits that IoT approaches have introduced, especially as they can be used both in a clinical environment and on a daily basis by the patients themselves.

The most commonly cited example are the myriad of fitness and wellbeing monitors that patients can wear every day, and which monitor their vital signs continuously, thus providing a wealth of data for medical practitioners to base their diagnoses on. Information such as heart rate, blood pressure, blood-sugar levels, medication intake, etc. can all be monitored in real-time and relatively accurately. Previously such data would require in-person medical tests and self-reporting, which is notoriously unreliable in a medical setting.

Apart from vital signs for diagnosis, the IoT offers other benefits to healthcare as well. Monitoring of elderly and vulnerable patients, such as those with Dementia for example, is also a commonly mentioned case. Importantly, they also can increase the autonomy and capabilities of such users by giving them appropriate ways of managing and interacting without the need for a carer.

Consumer IoT

The consumer aspect of the IoT is the most immediately visible side of it, being as it is driven by market forces looking to be the pioneers of a new socio-technological revolution, such as was the case with the internet, mobile phones and the like. This emphasis on targeting affluent and impressionable early-adopters, and rushing immature developments to market leads consistently to failed products, defunct services and consumers with a growing weariness of anything branded as an “IoT product”. The examples are numerous and bring forth memories of decades of ephemeral gadgets, devices and inventions that failed to live up to expectations. Most of these products are aimed at home and personal users and examples include smart appliances, such as toilets, Social Network controlled door locks, jewellery that posts your final message to social media at the moment of death, IoT bookmarks for paper books and Ingested “Intestinal trackers”, to name but a few.

The extent of this phenomenon is such, that the failings of the consumer IoT are being circulated by social media groups such as the “Internet of Shit” [169], and even parodied such as in the mock site “Internet of Useless Things” [170], which welcomes outlandish product ideas and suggestions, and then creates product promotion mock-ups for them. The recurrence of how these fake IoT products get mistaken for real ideas by the public goes some way to show how the outward facing image of the Internet of Things has been severely hampered by premature market-driven entrepreneurship. This is not a new phenomenon by any means, the Gartner Hype Cycle Chart illustrates how numerous technologies have been pushed to the public application stage far too early, thus leading to disillusionment [40,112]. In concert with the other prevalent barriers to adoption that are discussed further on, the IoT faces an uphill struggle to find acceptance in an increasingly complicated socio-technological arena.

2.2.3 Concerns about Security and Privacy

As was discussed in the previous sub-section, the IoT has enjoyed success in less publicly visible areas such as manufacturing, healthcare and complex management. However, these are areas where cyber-physical systems have long played key roles, and IoT-like systems have been employed under different labels. On the consumer front, the IoT has had to overcome substantial inertia, primarily due to the negative image it has garnered as “Yet another marketing buzzword” [136]. Proponents who envisioned an adoption rate similar to the social media phenomenon were left disappointed. And this parallel is worth examining as social media and the Internet of Things are increasingly co-dependent phenomena which both share some attributes, such as being gatherers and repositories of vast amounts of data – ripe for mining by interested parties – but they also share some issues, namely concerns on privacy and security.

Just like with Social Media, the amount of data that just a few IoT systems can generate about an individual, and their family, friends and associates, is

staggering – and it is also usually beyond comprehension. And what is worse, participation in this sort of mass data gathering will often be done with little to no informed consent, and even quite involuntarily. While social media users must – in most cases – actively create an account on the network, many IoT based systems are embedded in the everyday environment, in the wild and in public spaces, with inadequate, complex or non-existent regulation. Much like the data gathered for decades by credit companies about our spending habits, our financial data-based credit scores, and our detailed consumer profiles created by super market loyalty cards, all these disparate data points can lead to pictures of our private life that are much more detailed than we would have otherwise liked [171].

Many IoT based products and services seem innocuous and irrelevant at first. After all, what could a "Quantified Self" focused personal fitness tracker like a "Fitbit" have to do with breaches to our privacy? Recent events are actually showing it to be one of the biggest risks. For example, the data captured by Fitbit trackers was searchable via Google with users' entire profiles available. In 2011 Fitbit data was sharing millions of user's personal data with the whole world, including the metadata for the content of the activity [25,152]. This meant that data labelled as "Sexual Activity" was quickly highlighted and put online in the form of a searchable world ranking league table. Understandably this led to several embarrassing situations. But there are far darker uses for the data. Just like Credit Scores can be used to deny an individual financial assistance, insurance companies have already made moves to encourage clients to use fitness trackers and give them access to the resultant records. While the reasons for this are initially painted as beneficial, it has already been used to deny coverage to clients in need [61,104]. Similarly, personal tracker data has also been used in numerous court cases [116,138] as admissible evidence to prove both innocence's and guilt.

And just like with social media information, IoT devices are being misappropriated by criminal elements as well. Just as burglars used publicly available location status data of homeowners to burgle their houses while they

were gone, so are the numerous IoT based devices that we have brought into our lives being taken advantage of by nefarious elements. Which brings us to the major concern of Security in a world permeated by interconnected devices.

The wider world has only recently begun to realise the tremendous security risk that a hasty deployment and adoption of disparate, proprietary and in many cases, unfinished IoT products and services has created. Recent years have seen a dramatic increase in internet-enabled criminal activity, or to stick to the popular moniker, Cybercrime. While the cases of hacked computers and infrastructure systems are innumerable, it was in October of 2016 that the media first blamed the Internet of Things for being the vulnerability that allowed hackers to use unsecured IoT devices to create a massive botnet that executed a concerted Denial-of-Service Attack (DDoS) on major DNS server providers such as DYN. By targeting these critical junctures, the hackers managed to bring down a considerable number of popular sites [105,124,153]. It should be noted that the IoT 'devices' in question were cited as Home Routers and Surveillance cameras. This is a bit misleading, as home routers are not strictly speaking IoT devices, but as the Gateway of a premises to the Internet are nevertheless a vital device to which all the devices of a network would be connecting to. Surveillance cameras on the other hand, would be more accurately described as webcams which have been sold as "Home surveillance solutions". So again, they are hardly the kind of IoT devices one might think of based on the examples we mentioned earlier.

With these kinds of attacks increasing on a daily basis, and hacking coming increasingly to the forefront of the public's mind as a serious threat, it is clear that security of information systems is a vital point to their adoption, if not its practical existence. As recently as June 2017, the world has suffered from a Ransomware hacking attack which has been unpresented in scale [89]. It is bad enough when these attacks compromise personal computers and mobile phones by which billions of people manage their private affairs and finances, but the concerns grow exponentially when one considers that these

vulnerabilities can extend to vital infrastructure through IoT devices and networks [37,162].

It is therefore a given that a healthy respect and consideration for the concerns of privacy and security must be given to the Internet of Things, just like with any technology. Especially as in this case the risks are considerably higher, the extents not yet clearly understood, and worse, the will to exploit the situation is already skilfully in play.

2.2.4 Considering "The Internet of Sensors and Data"

The above examples are only a few of the applications where the IoT has become a practical reality, and analysing them in depth can help demonstrate the variety of forms it may take and the applications it may be well suited for. However, there are some common themes that seem to constantly appear through these applications, namely that the IoT seems to be currently primarily employed as a means of acquiring large amounts of disparate data, with the 'Things' of the IoT being most commonly end-point sensors and sensing devices, and the 'Internet' being a way to connect disparate sources, repositories and networks of data [2,106,112].This is understandably a purpose it is very well suited for, and the opportunities such data gathering can offer to domains such as data-mining, machine learning, large scale, predictive analytics and other is immense and already a reality. It can only really be compared to the data gathering abilities of the internet itself – which is more focused of course on the activities of the people who use it instead of objects and environments (and people also) such as in the case of the IoT. Furthermore, they share many of the same issues regarding privacy and security, with a considerable need for appropriate legislation becoming scarily apparent [137].

2.3 Everyday Things and their stories told in data

With the above in mind, it could be said that, the majority of the commercial and research efforts into the IoT are particularly focused on what could perhaps be described as the "Internet of Sensors and Data", rather than the Internet of Things. And there appears to be a, relatively speaking, unexplored and unexploited opportunity to investigate what the Internet of Things could mean for us, as people, and the meaningful and interesting objects that we collect, cherish and care about throughout our personal, familial, social and cultural lives. The following sub-sections will elaborate on some particular cases that have pursued such questions – if only in the name of fun and curiosity, rather than knowledge and financial gain.

2.3.1 Where's George?

Where's George [172] has been a long running website which from 1998 has allowed users to enter the serial numbers of US Dollar bills of all denominations, thus creating a crowd sourced tracker of individual dollar bills. The users are asked to register individual bills using their serial code and to whenever possible, enter their current zip code and ideally a description or story of how they acquired the bill and how it was used.

Dubbed as a proto-social network, Where's George gathered hundreds of thousands of early internets adopters, who adopting the moniker "*Georgers*", set about entering as many of the bills that passed through their hands into the system. Following that, the *Georgers* wait for "Hits", meaning a notification that they will receive when a bill that they have entered into the system gets reported back. Most bills do not get any hits, meaning that once they leave a *Georgers'* hands, they are not picked up by anyone who re-enters them into the system. Many bills however do get a few hits, with some getting several. The currently highest 'scoring' bill has had 15 "Hits". This means that it has been reported 15 separate times by 15 different individuals. In effect, a "Hit" is a data point containing at the very least the serial code of the bill and the zip code it was in at the time.

One Dollar Bill, Serial# **K8392----6G** Series: **2003**

This bill has traveled at least 6,757 Miles in 7 Yrs, 271 Days, 11 Hrs, 43 Mins at an average of 2.4 Miles per day.
The bill is now 974 Miles from its starting location. This travel history below is in reverse-chronological order

Entry Time (Local Time of Zip)	Location, State/Province (Green=USA, Blue=Canada, Purple=International)	Travel Time (from previous entry)	Distance (Miles)*	Average Speed (Miles Per Day)	Social Networking
05-May-2014 09:32 PM	Springfield, IL	1 Yr, 284 Days, 12 Hrs, 40 Mins	273	0.42	
25-Jul-2012 08:52 AM	Nixa, MO	96 Days, 10 Hrs, 15 Mins	529	5.5	
User's Note	George in the Ozarks.				
19-Apr-2012 10:37 PM	Gretna, LA	208 Days, 10 Hrs, 38 Mins	918	4.4	
User's Note	Folded.				
24-Sep-2011 01:00 PM	Toano, VA	1 Yr, 140 Days, 13 Hrs, 27 Mins	443	0.88	
06-May-2010 11:32 PM	Savannah, GA	280 Days, 13 Hrs, 49 Mins	673	2.4	
30-Jul-2009 08:43 AM	Fairview Heights, IL	302 Days, 9 Hrs, 16 Mins	364	1.2	
01-Oct-2008 12:27 AM	Chattanooga, TN	1 Day, 5 Hrs, 15 Mins	168	138	
29-Sep-2008 06:12 PM	Auburn, AL	100 Days, 8 Hrs, 12 Mins	458	4.6	
21-Jun-2008 11:01 AM	Bloomington, IN	223 Days, 14 Hrs, 34 Mins	156	0.70	
10-Nov-2007 06:27 PM	Bowling Green, KY	11 Days, 5 Hrs, 39 Mins	18	1.6	
30-Oct-2007 01:47 PM	Smiths Grove, KY	16 Days, 2 Hrs, 27 Mins	769	48	
14-Oct-2007 12:20 PM	Lehigh Acres, FL	1 Yr, 4 Days, 16 Hrs, 37 Mins	1,944	5.3	
User's Note	Wild George #116! Average wear, stamped in purple on front and back. Picked it up from a friend on my way out of town on vacation!				
09-Oct-2006 05:43 PM	Hardin, MT	63 Days, 8 Hrs, 55 Mins	44	0.69	
User's Note	Big Horn IGA in Hardin MT far shape				
07-Aug-2006 08:48 AM	Wyola, MT	Initial Entry	n/a	n/a	

Size: **Small Large Hide** Type: **Roadmap Terrain Satellite Hybrid**

Figure 2.2. Example of "Where's George" tracking information for a particular bill. (Source: WheresGeorge.com)

Many practices have evolved around this relatively simple mechanic. In order to improve the chances of a tracked bill being re-entered into the system, many *Georgers* use custom-made stamps with the URL of the website and their online alias to advertise the project. In addition, Georgers create various events and goals, such as bill spreading trips, meetups and games, such as 50 States Bingo and FRB Bingo, where in the former they try to get a "Hit" in each of the 50 States, and in the latter, they try to get a bill that has passed through all 12 of the Federal Reserve Banks.

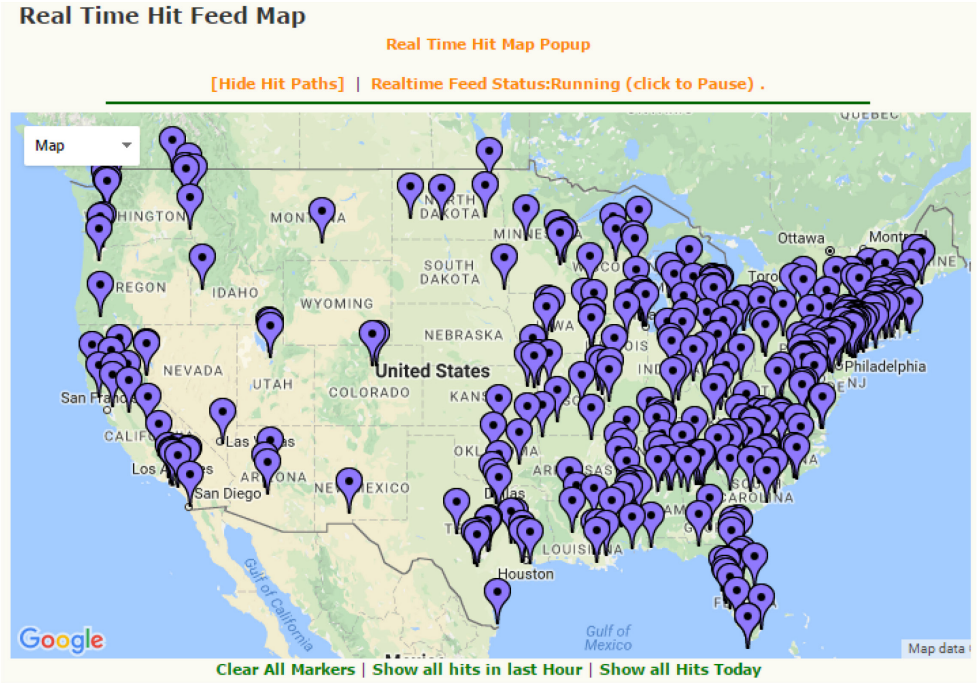


Figure 2.3. Real time "Hit" map on the "Where's George" website. Shown are the hits for the last hour. (Source: WheresGeorge.com)

While the site was made by ex-tech consultant *Hank Eskin* purely because "it was fun", the website and its now vast database have been used for a variety of research purposes. Indeed, at the time of writing the number of entered bills of all denominations was 271,794,095. And this number grows daily, with tens of thousands added every day. There are thousands of "Hits" reported everyday as well. Thus, the data the site gathers has been used to study the flow of American currency [95,173], as well as to develop statistical models for things such as infectious disease [82] and multi-scale transportation networks. It has spawned numerous regional variants, such as *EuroBillTracker* [174] for Euros and *Where's Willy* [175] for Canadian Dollars

2.3.2 Book Crossing

Similar to the Where's George project, *Book Crossing* [176] is an online community dedicated to encouraging the practice of exchanging books, which has been a common book readers' practices in one form or another for decades (or more). The core idea of the project is to register books with the website and then leave in a public place in order for them to pass on to other hands. Ideally the books will keep changing hands and be tracked at every juncture, with the readers sharing their thoughts about the book on the way.

Figure 2.4. A 10-minute sample of the real-time book map in Europe. (Source: BookCrossing.com)

What BookCrossing adds to the traditional ways of anonymous books exchanges is a mechanism for seeing where a book has been before it was picked up, and tracking its movements after it has been 'let go'. In addition, it allows readers to share "journal entries", which can detail where and how they found the book, and what they thought about it, but they can also contain reflections, musings and all sorts on introspective and retrospective stories and

tales. In practical terms, the book tracking is done manually, with users registering a book on the website and getting it assigned a BookCrossing ID (BCID) which is a numerical identifier. Then they can create custom labels bearing that ID that they can place inside the book. From that point on, the idea is that each successive owner of the book will use the website to add to the record of the registered book. Each reader is encouraged to add to the record and then pass it on to others, while keeping track of where the book ends up.

A variety of practices have evolved around book crossing, including book exchange meetups and "Official BookCrossing Zones" (OBCZ). These are various places such as public areas, shops, restaurants and coffee shops, where tracked books can be left and picked up. According to the BookCrossing website, at the time of writing there are over 1,750,500 *BookCrossers*, and over 11,973,669 books being tracked. Like Where's George, the BookCrossing provenance phenomenon has elicited several research considerations [38,47,92]

2.3.3 Marine Traffic

Designed and first deployed by researchers of the Department of Product & Systems Design Engineering of the University of the Aegean, the Marine Traffic project aimed to track and plot the positions of ships in real time.

The researchers began by deploying Automatic identification system (AIS) antennas on the islands of the Aegean on which the University has campuses. AIS is a ground and satellite based automatic tracking system intended to provide detailed information about the position and heading of seagoing vessels for a variety of purposes including vessel traffic management and collision avoidance. It functions by having each vessel over a certain size carry a standardised AIS transceiver, which broadcasts the vessel's unique identified, position, speed and course. By installing the antennas, the researchers gained access to this information which they then made openly accessible on a custom map interface, initially based on Google Maps. Critically, they also provided

instructions and parts lists which enabled hobbyists and ship watching enthusiasts to install their own antennas and connect them to the network. Combined with an increasing number of AIS compatible satellites, the coverage map at the time of writing covers most of the globe. MarineTraffic became a successful commercial spinout company and was emulated by other commercial services such as *VesselFinder* [177].

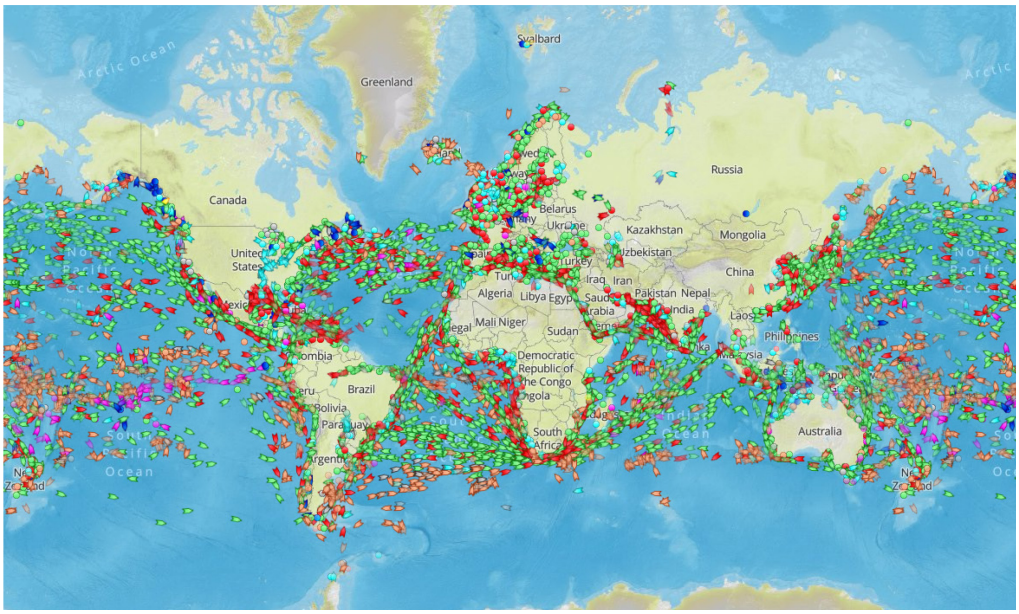


Figure 2.5. A momentary sampling of the vessels tracked by MarineTraffic. (Source: MarineTraffic.com)

Early on in its development the project's website gave users the ability to get information on any of the displayed vessels, including its current destination and its historical track. Crucially, it also allowed them to upload descriptions and media about the ships. This led to a vast amount of data, primarily images of ships, to be crowd sourced from the public. This eventually grew to include images of ports, lighthouses and other maritime entities and is the biggest difference it has with other services that track transportation, such as FlightRadar24 [49], which tracks real time air traffic, but initially was more focused around airline routes, rather than individual planes. This however has recently changed. The numerous uses of the data also exceeded initial

expectations. Starting with local travel agents, more and more people began using the platform, and the mobile application that was released for it, to track the position of the ships they travelled on and optimised their movements. With AIS data being less regulated than flight tracking information, there were more opportunities for accurate data, which led to concerns about the MarineTraffic platform being used by pirates off the coast of Africa during the resurgence of modern piracy in the last decade.

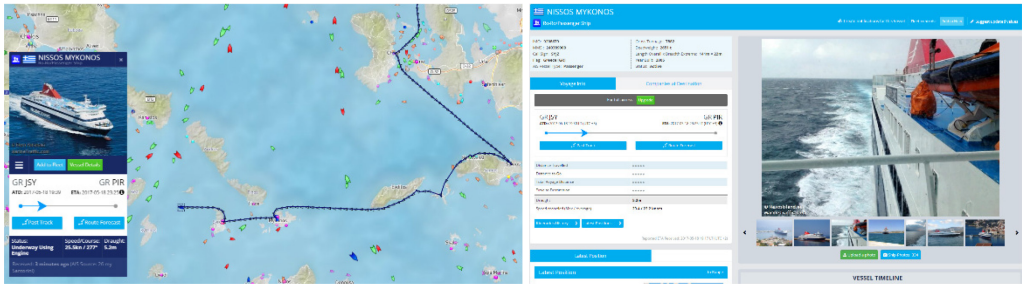


Figure 2.6. Examples of the Marine Traffic data for a specific ship. (Source: MarineTraffic.com)

Allegedly, the pirates could use AIS data to track the positions of the most lucrative shipping and using the crowd sourced images to plan attacks. Similarly, fishermen raised concerns that competitors were tracing their positions in order to steal their fishing spots. Other possible uses of such systems include maritime border control and smuggling prevention [26].

2.3.4 The Significant Objects Project

The “Significant Objects” project [178] is a particularly relevant and intriguing piece of work that took place in three phases from 2009 to 2012. With an understanding that Stories make objects more meaningful, authors Joshua Glenn and Robb Walker set out to examine a specific hypothesis: “Stories are such a powerful driver of emotional value that their effect on any given object’s subjective value can actually be measured objectively” [59]. Specifically, the lead researchers, built their hypothesis upon previous research into the

numerous and complex way by which people attach meaning and derive meaning from objects [36] and their own examinations of the links between ordinary objects and extraordinary meanings [58], and how much subjective and market value of objects can be influenced by their stories and narratives, which may not be factual or even true. Termed later as “Citizen Science”, the authors labelled themselves as “the Curators” and set about conducting an unusual experiment to investigate this hypothesis.

First, they acquired 100 ‘insignificant’ objects at flea markets, thrift stores and yard sales. With a maximum spending limit of 4 dollars per item, they spent an average of 1.25 dollars for each. The chosen objects were purposefully chosen to be as “insignificant” as possible. Therefore, they chose no object that could constitute art of any kind, as art is made to be significant. And they avoided categories of objects such as clothing, books, LPs and furniture which were considered not “object-like”. They also tried to limit the number of objects such as toys, promotional and novelty items, travel souvenirs dolls, figurines and pop culture ephemera from the period between the 1950s and 1980s in order to maintain a larger variety of objects.

Next, they contacted 100 accomplished authors who each assigned one of the objects and asked to write a short story which attributed some significance to the object. The authors included well-known and accomplished fiction writers, journalists, show staff writers and comic book writer-illustrators, as well as first time novelists. These included William Gibson of Cyberpunk *Neuromancer* fame [56] and Bruce Sterling, who we saw earlier with the concept of Spimes [130]. The authors were each furnished with an image of their given object and the stories could be written in any style or voice, as long as the object was central to it. The stories were determined to be of high quality before release.

Figure 2.7. Gibson's and Sterling's story contributions.
(Source: SignificantObjects.com)

Finally, they placed all 100 objects up for auction on eBay, using the short story of each object as the item description. The starting prices for the auctions were the prices that were paid to buy each item in the first place, and the descriptions clearly stated that the stories were fictional and linked back to the project's website. Each auction lasted the standard 7 days and the winning bidders received the object and a printout of the object's story. The proceeds of each auction were given to the respective author.

The results were quite noteworthy, with most of the object selling for many times their original value. The 100 objects that were bought for a total of $128.74 sold for a combined total of $3,612.51, and increase in perceived value of over 2,700 percent. In the words of the authors: "A fictional narrative boosted the quantitative significant of these castoff objects by more than 2,700%". Thus, they claimed their result demonstrated that an explicitly fictional narrative could inflate an object's exchange value – "Transforming a qualitatively "insignificant" object into a qualitatively "significant" one.".

With the curator's initial hypothesis proven, they set about analysing their data to see whether there were any other factors that could have had an appreciable and significant influence on the results. For example, they considered whether the fame or talent of any of the authors could have influenced the final price of the auctions, as it could be conceivable that some object's value increased due to the bidders wanting an object associated with a known author. This supposition however was not reflected in the data, with the objects whose stories where written by newer and up-and-coming authors did just as well as those by famed authors. Other potential factors such as the object type, significant type, narrative mode, duration of the study and whether the proceeds of the auction where knowingly going to charity, also had little to no apparent influence.

The success of the first wave of 100 objects was such that the 'experiment' was conducted twice more with similar results, and resulted in a collected volume of the work and stories [59]. The significant objects project goes a long way to demonstrate how stories and narratives about, or associated with, objects have a profound effect on their perceived value, meaning and significance.

2.3.5 Tales of Things and Electronic Memory (TOTeM)

Following on from the Significant Objects project, the TOTeM project was a 2010 IoT driven effort, which aimed to "Explore social memory in the emerging culture of the internet things" [79,126–129]. The project's culminating effort was the "Tales of Things" online platform [179] which allowed users to record 'memories' about objects and link them to a QR code that they could attach to the object.

Users where invited to pick a 'thing' that was somehow important to them, ideally not because of its material value but because it held some memory about some person, place, time, event or idea. The user could then upload a 'tale' about the object. These could consist of text, images, audio or video and had to be entered manually in the case of text and images, and hosted elsewhere in the case of audio and video. The majority of the tales consist of a

few lines of text and an image. By browsing the repository of 'Things' on the website, or by directly scanning the QR code sticker on one of the tagged objects, a user could then access these tales.

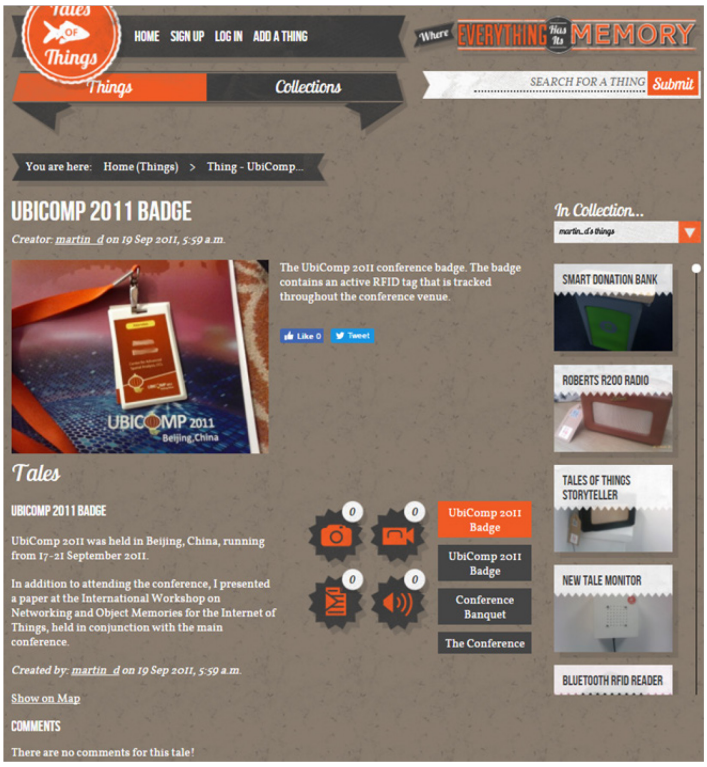


Figure 2.8. Example of one of the more detailed object tales (Source: Talesofthings.com)

Thousands of things are currently logged on the still active website, and apart from the abuse of the system by bots, there is an interesting phenomenon to be observed in the earlier – and genuine – entries. While initially there are several cases of objects described as meaningful by the contributors, there are just as many examples of 'things' that cannot easily be classified or even described as singular material things. Entries have been created about places, organisations, events, experiences, and even people, with a single image and a text description attempting to explain why. As will be discussed further on, this is a key factor in the findings of this thesis.

2.3.6 The Carolan Guitar & Accountable Artefacts

A telling example of the work in this domain is that of the *Carolan Guitar* project which was a congruent parallel research effort made at the same time as this work and to which the author contributed, with several findings and efforts mutually crossing over.

The *Carolan Guitar* project began with a different perspective from the others we have seen so far in the previous sub-sections – specifically it set out to create an object whose 'story' was tracked, recorded and shared from the moment of its conception till it's eventual obsolescence.

Inspired by many of the projects above, and drawing from the ethnographic research into wargaming for the purposes of this thesis - detailed in chapter 3 - the *Carolan* project took a Research-Through-Design (RtD) approach [157,158] to investigate the "…nature and utility of the Digital Records of Everyday Things" [12]. The RtD approach was employed via the methodology of a Technology Probe [77], in the form of a guitar, which records its existence, travels and use in a consolidated Digital Record which it communicates via inlayed interactive patterns, readable by a mobile application.

The *Carolan Guitar* was chosen to be an acoustic guitar for several reasons. First it is an object of a type that is owned and played by millions of people and is therefore an appreciated and understandable artefact. As an object, guitars are portable, unlike similar objects such as a piano or drum set for example, which would either be in a fixed setup, or impractical to travel with. Furthermore, such musical instruments have relatively long lifetimes, often spanning decades, and as will be seen further on, can accumulate substantially rich histories. These can include personal memories and mental associations, such as learning and performance experiences, as well as cult status through ownership and usage association with celebrities, etc.

The actual *Carolan Guitar* artefact, was handcrafted by a Luthier at the behest of the researchers, with particular designs inlaid into various parts of the instrument as seen below in Figure 2.9. These designs were actually machine-

readable ArtCode patterns [13,15,180] which function similarly to QR codes but can be incorporated into artworks by designers who have followed a particular set of guidelines to embed scannable regions into the design. The end result is aesthetically pleasing and meaningful art and decoration which can be linked to digital content. The researchers used this technology to link the codes to parts of the *Carolan Guitar's* Digital record. The entire process of designing and crafting the guitar was meticulously documented and made part of that record.

Figure 2.9. The finished Carolan Guitar.

With the aim of uniqueness, the guitar was given its own distinct identity and backstory, and was named after the 18th century Irish travelling harpist *Turlough O'Carolan*.

Once complete, the guitar was "…Released into the Wild" in order to build up its Digital Record. The aim was to engage a wide variety of stakeholders in a design conversation, discussing the nature of the guitar and its Digital record, and how that may influence its value and meaning. Through this process the guitar encountered numerous environments, situations and individuals. These included, apart from the lengthy and involved crafting stage in the luthier's workshop; encounters in the homes of temporary holders where the guitar was hosted while the holders used and added to its record; playing session where music was written and recorded with the guitar; live performances; learning sessions; and travel. Over the months all these encounters build up a substantial and rich record of the artefact's experiences which where curated and publicised on the projects website [181].

The record of the guitar composed of 5 primary types of information as identified by the researchers:

- Historical provenance
    - This included documentation such as certification of the maker, material sourcing, date and location of its creation, a maintenance log and an ownership and loan log.
- Personal and public archives
    - These are relatively straightforward 'bits' of information such as performances, recordings and compositions recorded as video, audio, lyric sheets and chord charts.
- Historical and Fictional Stories
    - These are narratives about other found, owned, lost, damaged and regained instruments which are inspired and recount by peoples' interactions with Carolan.
- Documentation to support ongoing use
    - This type of information was described as material such as an extended user guide for the guitar, personal set-lists, playlists for live shows and lesson materials.
- Data pertaining to Long-term wellbeing
    - This would be primarily utilitarian or practical information, such as environmental and use data. For example, location and movement data to detect transportation and storage conditions to protect the guitar from any unsupervised damage.

This record would be added to by a large variety of identified stakeholders, including the owner or custodian (or succession of owners and custodians); temporary custodians, such as friends and players who temporarily interacted with the guitar; collaborators such as band mates at performances, technicians such as luthiers during repairs or sound engineers during recording sessions; teachers and learners; and finally, audiences.

Figure 2.10. The Carolan Blog Record online.

Another aspect of the *Carolan* project was how exactly the artefact was linked with its digital record. As a guitar, the artefact is relatively complex and offers many internal spaces where technology can be embedded as well as surfaces where markers can be placed. From its conception, the guitar had *Artcode* markers embedded in places which afforded opportunities to employ them in

different contextualised ways. As seen in Figure 2.9 above, the guitar had codes on its front; back; headstock; fretboard; sound-hole; and a smaller one at the base of the neck, the nook. Each of these machine-readable codes could be linked to digital content exactly like a QR code. Some were reserved for 'canonical' uses, meaning they remained relatively fixed throughout. These included:

- The headstock marker, whose Artcode design was the logo of the project, linked to the official provenance, meaning the maker's certificate and the official curated history as hosted on the public project blog.
- The sound-hole marker was linked to the user guide – but could be personalised for individual user's requirements, such as playlists and learning materials.
- The fretboard marker, which could only be scanned when then strings were removed, remained linked to the maintenance logs and technical specifications, as these would be useful to those who might remove the strings, such as a luthier during repairs.

The other markers where employed in a more ad-hoc manner, with the links being assigned fluidly as the situation demanded:

- The front marker, described as the 'public voice' of the artefact, as it was readily visible when on display or during performances, would usually connect to media such as recordings.
- The nook code, which was more intimate and assumed both close proximity to the guitar and the ability to 'handle it', such as pick it up and examine it. Thus, this marker was used to link to 'secret bonus' content.
- Finally, the back marker was used as a link for the player's use, linking to content such as profiles, programmes and other personal information.

In addition, a variety of other artefacts were created, such as plectrums, stickers, album cases, badges and coasters which also featured the scannable project logo marker. These 'Proxies' as they were termed, allowed users to get access to the Digital Record, without having current access to the actual guitar itself. These afforded many opportunities, such as allowing people to 'stay in

touch' with the artefact through the proxy, add value to other products, and 'extend' the physical presence of the original artefact, by allowing people – such as for example the audience at a live performance – to asynchronously access it when otherwise they could not, either spatially due to lack of proximity, or temporally, because they try to do so after they or the artefact has left.

Figure 2.11. Examples of the 'memento' objects tagged with the Carolan Artcode, thus giving access to parts of the whole Record.

Pertinent to this thesis, the Carolan project resulted in the formulation of a conceptual framework to reason about the complex connections between physical artefacts and their digital records [12,14]. The framework revolves around the concept of an Accountable Artefact, described as "A 'thing' that becomes connected to an evolving digital record over its lifetime and can be interrogated to reveal diverse accounts of its history and use." The overarching concept of Accountable Artefacts is expanded into a set of more specific concepts. These begin with the cornerstone notion of the physical artefact, which are the material artefacts which are identifiable as things "*…whose qualities, properties or characteristics give them an identifiable haecceity, i.e. a sense of 'thisness', making them worthy of a name and the responsibilities of*

ownership.". In other words, these would be physical objects that, in some way, are meaningful and distinct to a beholder. The next concept is the Digital Record, which is a key concept for this thesis. It is described as a lifelong record of the artefact, that can grow to encompass a history of its making, maintenance, ownership, use and travels. This record will also grow through Digital Footprints, the innumerable bits and pieces of data and information that are created through the use of computing and internet technologies. So, the record may, apart from hand-recorded content, also contain information such as digital interaction logs, location, environmental conditions and other contextual data through IoT-like sources.

With the above concepts in mind, the main concern of the Accountable Artefacts idea are the configurable Mappings between the physical artefact and its digital record. The researchers posit two key aspects, first that there can be multiple mappings over the lifetime of an artefact, with owners or users having a choice of what part of the record a particular 'interrogation' will yield (such as scanning a particular marker in the case of the Carolan Guitar). Second, each mapping is best considered as being comprised of a bundle of links, with each link connecting a facet of the artefact to a facet of the record. This means that any given mapping can be used to link to content that is pertinent to different stakeholders in different contexts. Furthermore, the researchers describe the links, using Bieber et al.'s Hypermedia survey [17], as *Transclusive*, meaning they bring the content to the artefact, rather than take the user away from the artefact. And they are considered unidirectional, as they link the artefact to the digital record, but not the opposite. In addition, they posit the link bundles will be maintained by external *Linkbases* rather than be embedded in the artefact itself via some storage medium. Finally, *Link Anchors* can be physically manifested on the artefact. The physical form of the artefact can provide opportunities and constraints for such anchors, as does the semantic and cultural context [100].

The next set of concepts focuses on the appropriation of technologies by users who adapt them to their needs and contexts [43,44]. Driven by this, the

researchers posit that accountable artefacts need to be designed for appropriation, so that they can be adapted by their diverse users, contexts and successive owners throughout their lifetime. They propose two concepts: Digital Appropriation, which means being able to change a mapping in order to have some of its links reconnect to other parts of an artefacts record; And Physical Appropriation, which describes the creation and use of other objects as proxies for the artefact, that can be connected to its record.

The final set of concepts involves the ownership of the artefact. As the notion of ownership has been shown to be quite complex, especially in HCI terms [46,93,101,154], the researchers propose the concept of custodians. The term encompasses the various stakeholders that can be responsible for an artefact and its Digital Record, beyond its current 'legal' owner. These can include the original makers, successive legal owners (who all may have input in the digital record), and temporary custodians. Depending on the context and the artefact, some custodians may preside and exert control over the mappings of an artefact. They can be charged with curating the mappings and designing new encounters. Custodians would also be able to modify and effect the appropriation by specifying the mutability of the links, making them either temporary or fixed. Finally, the concept of acknowledgement assumes an auditable trail that allows custodians to benefit from the mappings they create and curate. This could be straightforward credit in commercial and artistic contexts, but can also be in the form of usable data and information from the use of the artefacts and mappings.

In summary, the *Carolan* project, which was conducted in close association with the research that comprises this thesis, crystallised the above concepts, many of which will be carried forward into the following chapters.

2.3.7 Brad the Toaster

Finally, another example worth mentioning is that of the speculative Addicted Products design experiment [182]. Unlike most of the examples discussed in this subsection, this project harkens back to the more "conventional" IoT visions of the future, specifically in the Domestic IoT space. Essentially, the experiment posited the idea of domestic appliances, toasters in this case, that would be part of an "internet of Toasters" by which they would be able to communicate their usage information, namely how many slices of bread they had toasted.

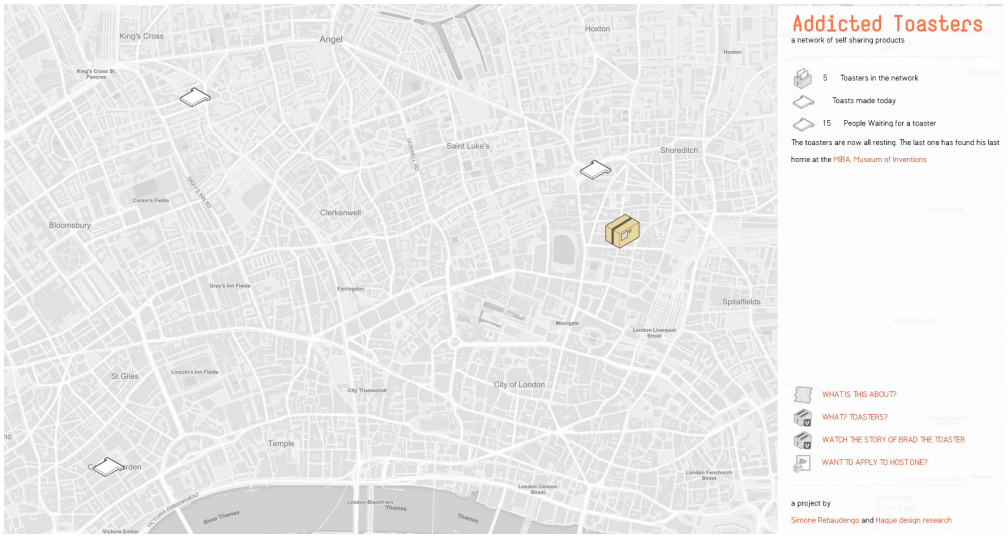


Figure 2.12. The Addicted Toasters live map.
(Source: AddictedProducts.com)

While many of the seen-before features of IoT were employed in the project, such as live location maps and live-tweeting of 'toasts', the novelty of the project lay in how it introduced "sentience" (or perhaps self-reference) to what was essentially "smart objects. This meant that the toasters would compare their usage data between themselves and would experience "peer-pressure" from the other toasters on the network. As the experiment had roots in themes of addiction, the idea was that the toasters were "addicted to making toast. As such, if the individual toasters felt they were being underused, and thus unappreciated, which was the case for the eponymous Brad, they would try to improve their situation (and their happiness). They did this by prompting their owner to make toast, and if this didn't work, they would try to get themselves

adopted by other users, to the point of trying to get themselves sent to other owners.

While only a speculative design experiment, the project succeeded in prompting questions of our relationship to such “objects of the future”. While the notion of appliances with true sentience is probably a bit far off, there are already examples of IoT driven devices that through data have the ability to make decisions that directly influence the people around them. The oft mentioned example of the smart thermostat is again appropriate here, as it is not beyond the realm of possibility that such a device may already have conflicting goals. The given goal of such a thermostat is to save energy, however data-driven personalisation may lead it to keep the heat on as it knows the home-owner’s preference for a warmer environment, even though objectively it “may know better”. Trust therefore enters the fray as well, as an understanding of how such objects make their decisions introduces a need for transparency before any acceptance or adoption can be considered, especially when this pertains to matters of safety and privacy.

2.3.8 The Internet of Interesting and Meaningful Things

While the above discussion of object centric projects is not exhaustive, it helps to illustrate how even the barest of digital information about an everyday object can lead to interesting engagements, and also open up a slew of unanswered questions.

The key point however, it the contrast between these everyday objects that became the focus of interest and HCI oriented-research, and the sensor-like devices that bear the attention of IoT research and entrepreneurship. As discussed previously, the IoT appears to currently place an emphasis on what is essentially an “Internet of Sensors and Data” that are embedded into our environment, rather than an internet of everyday objects that are interesting and meaningful to the people that use and cherish (or despise) them.

While there is no doubting the importance and long reach of the 'conventional' IoT, there is as we saw above, evident value in considering the support of practices and activities that revolve around meaningful objects. Importantly it is shown that IoT technology is not seen only as a way to 'enhance' the functionality of the objects, but as a means to document their provenance and history thus giving new ways to document and communicate their meaning.

The question therefore, as was discussed in the introduction, is whether the conventional object-centric IoT approaches are suitably equipped to handle the contextual nuances that objects may have in practice-based activities. There are concerns of shared and transitory chains of ownership; cultural and perspective differences in the interpretations of value, sense-making and meaning; and a constantly observable tendency for intangible 'things' to constantly take centre stage of any prolonged discussion of a practice's activities, however material-focused they might be. These issues both challenge the IoT-inspired approaches and also prove to be frustratingly hard to disambiguate and frame in such a way that they can be understood and resolved by the designers and developers who are called upon to support communities of practice.

We see then that the scope of the question begins to swiftly broaden, introducing concerns relating to the relationships that people have with material objects that Knowledge Disciplines outside of Computer Science have long pondered. Drawing from these disciplines can contribute to equipping us with a larger arsenal of understanding and help frame questions and concerns which are otherwise too difficult to articulate, much less attempt to answer.

2.4 Drawing on Philosophy

So far, we have examined the problem space from the point of view of the mainly technology focused IoT paradigm, which underpins the rapidly growing relevance of technologically supported objects. And the scope has been expanded in breadth by discussing several research, artistic and other domain projects that have considered in various ways the notions of objects with digital histories and records.

The next step however requires a more substantial shift of perspective, in keeping with the interdisciplinary approach of this work. While the aforementioned topics have helped build a rich picture of the space that this thesis aims to operate in, a comprehensive framing cannot be achieved without considering the points of view of a number of other disciplines who over centuries of thought have aimed to disambiguate some of the more complex, nuanced and subjective aspects of the relationship between humans and material (or abstract) objects.

A key consideration here is that such questions have been the subject of numerous disciplines and schools of philosophical thought throughout the years. These stem mainly from the Humanities and Social Sciences and include Ontology; Critical Theory; Metaphysics; Semiotics; Anthropology; Sociology; Psychology; Social Archaeology; Art and Design, to name but a few. Many of these disciplines have aspects that attempt in their own way to describe or explain Human-Object relationships, and as is usually the case, often contradict or even clash with each other. And while these theories and views shift in dominance and popularity, there are, as with most things, no clear-cut and final answers.

The following subsections, will briefly traverse the landscape of these viewpoints with the aim of drawing out the concepts that are relevant to the matter at hand and from which understanding was drawn to form the Conceptual Framework.

2.4.1 Things vs Objects

To continue any meaningful discussion, a thorough disambiguation of what is meant by the terms “Things” and “Objects” is required. These two terms are key to this work, as they are employed constantly by the literature, stakeholders and technology. However, they are used with constantly shifting definitions that vary in meaning and importance. In some cases, they are the key entities around which a point of view is formed, such as in the case of many of the aforementioned projects, and in others they are used as “catch-all” terms to refer to indistinct ‘stuff’ that is part of a system, but not the focus of interest. This is observed often in the previously discussed “Internet-oriented” perspectives, where the emphasis is on the data and the connectivity of things, rather than “…what those things are…”.

In addition, further difficulty emanates from the commonality of these terms in everyday spoken and written communication, to the point of overuse. An issue is also the highly varied meaning they have depending on the context in which they are used. As John Plotz puts it [107] :

> *“Defining what one even means by talking about things can rapidly become an arcane dispute, especially when waged by scholars quoting and counter-quoting Heidegger’s chewy phenomenological account of the “thingness of things.” But ordinary language can provide some useful guidance here. “ (Can the Sofa Speak? A Look at Thing Theory, Criticism 47.1 (2005) 109-118)*

Thus, the first step we must take to clarify their use, at least in the context of this work, is to first fall back to the basic definitions. Following this we will proceed to discuss how the terms are considered by the various disciplines that feed into the complex space the work inhabits.

The most fitting lexicological definitions of the terms describe an **“Object”** as: “*A material thing that can be seen or touched*”, or in a philosophical sense: “*A thing external to the thinking mind or subject”* [183]. Here then we see an indication that an *object* is thought of a ‘kind of’ *thing*. Conversely, the term **“Thing”**, carries many more uses and definitions. One of them defines it as an: “*An inanimate material object, distinct from a living sentient being”* [184],

another as: *"An action, event, thought, or utterance."*, while another gives it the meaning of: "*A separate and distinct individual quality, fact, idea or entity*" [185]. A further definition, couched in the domain of Metaphysics, defines a Thing as: "…*any item that can be referred to or named. It can be any constituent of the metaphysical world, including substances and properties, essences and accidents, particulars and universals, concrete and abstract objects."* [20]. When compared with objects, the definition is narrowed to the extent that "*Things have their own identity and possess qualities and relations."*

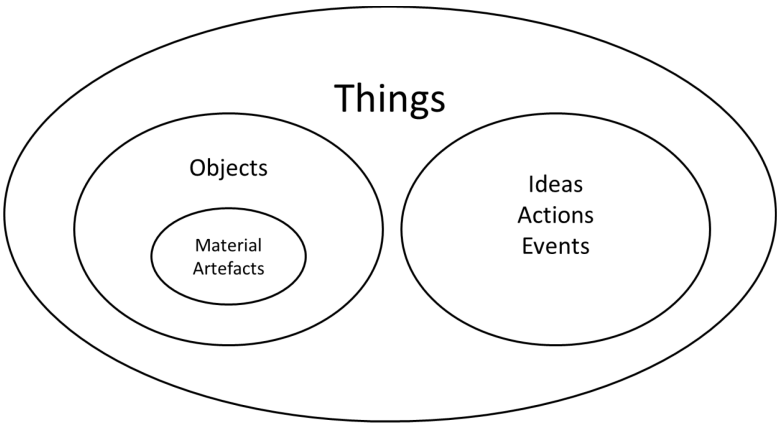


Figure 2.13. The Lexicological distinction between Things and Objects.

These definitions show that while the terms "Things" and "Objects" are often used interchangeably, when it comes to referring to material "stuff" that exists and persist beyond our perception. However, the term "Things" has a wider meaning, encompassing objects, but also abstract entities such as Ideas, Actions, Events, etc., as illustrated above in Figure 2.13 where Objects are seen as a subset of Things.

So far, this terminology may appear straightforward, however the discussion swiftly becomes more complex when we consider the centuries of accumulated thought on the questions of what 'Things' actually are. These questions are pertinent, as while the research for this thesis originated from the direction of relatively straightforward material artefacts, the findings and the eventually

proposed conceptual framework required a deeper understanding of the nature and language of things, both material and abstract. And while delving into the many conflicting schools of thought on the subject are beyond the scope of this thesis, the ideas and theories that revolve around the subject have contributions to make to the chosen interdisciplinary approach and helped shape the framework.

Listing and briefly describing the most relevant theories and schools of thought from other disciplines, we begin with the oft mentioned work of Martin Heidegger, whose works, or lectures in this case, "*Das Ding*" ("*The Thing*") [68] and "*Die Frage nach dem Ding. Zu Kants Lehre von den transzendentalen Grundsätzen*" (Translated to: "*What is a Thing*") [69] , have attempted to tackle the question of what is a 'Thing'. In these lectures Heidegger understandably evades answering this question so directly or concretely but offers three formulations of what a "The Thing" might be:

- The Thing as a Carrier or Properties
- The Thing as a unit of sensorial perceptions
- The Thing as matter moulded in a particular form

The third definition, which originates from Aristotle's *Hylomorphism* theory, is the one considered by Heidegger to be the most useful. *Hylomorphism*, from the Greek words *Υλη* (*Hyle*) and *Μορφή* (*Morphe*), which respectively mean "Matter" and "Form" states that every physical object is composed by matter and form. The basic concept is that the gap between understanding and consciousness, called the "World of Ideas", and the material universe, called the "World of matter" is bridged and negotiated through Form which applies principles to Matter. Essentially Matter by itself is inert and form gives it its meaning and existence [4,120].

It is however from his seminal work, the book "*Sein und Zeit"* ("*Being and Time*") [18] where HCI most draws from, primarily the twin notions of "*Vorhandenheit*" translated as "Present-at-Hand" and "*Zuhandenheit*" translated as "Ready-at-Hand". These two terms were meant to highlight a distinction between two ways of perceiving the world. Present-At-Hand is

interpreted to refer to the approach of just *observing* or *looking* at something, an attitude that Heidegger attaches to scientists and theorists who are only concerned with the bare facts or properties of a thing or concept. Heidegger states that this is not the usual way in which we encounter things normally. Conversely, Ready-at-Hand takes the view that we are *doing* or *acting* in order to achieve something, and in the process, we use things which we do not necessarily perceive or notice as we are focused on the task and goal, until something makes us do so, such as the thing failing to meet expectations. In particular, Heidegger refers to this as equipment, which due to its kind of *Being*, lends itself to the task. The most often quoted example of this is an ordinary hammer, it is simply picked up and used to hammer things – thus is Ready-at-Hand. But when something goes wrong, such as the hammer breaking, then it becomes Present-at-Hand as it comes to our notice. Heidegger points out three ways that an object may 'break the spell' and become *Unready-at-Hand*: Conspicuous, where the thing is damaged; Obtrusive, where a vital part of the thing is missing, making it non-functional; and Obstinate, where the thing is a hindrance to the operation – i.e. it gets in the way somehow. Another example would be using a word processor on a modern laptop. Our focus is (should be perhaps) on the text we are writing. But if the word processor crashes, or our attention shifts to the processor itself (perhaps because we are trying to do a complex operation that we are unfamiliar with) then there is a breakdown where the word processor becomes Unready-at-Hand. The word processor becomes a thing that we notice and consider (or become frustrated by) and thus becomes Present-at-Hand.

Despite the widely vaunted difficulty in comprehending Heidegger's thinking, as can be seen by the numerous publications, lectures, courses and other efforts that aim to help explain his concepts [117,186,187], he has spurred a myriad of contemporary thinkers to either adopt or critique his ideas – or parts of them. His notions of Present-at-Hand are Ready-at-Hand are mentioned by J.J. and Eleanor Gibson in their investigations of Visual Perception and Affordance [54,55], and he has been something of a mainstay of HCI ever since

– at least through Dreyfus's interpretation [45], having being considered in settings such as embodied interaction [44] and Physicality in Design [110].

His ideas have also become a mainstay of the curious space between Art, Design, Critical Inquiry and HCI. Bruno Latour, when voicing his frustrations about anti-intellectual truth-bending in his 2004 Critical Inquiry article "Why has Critique run out of Steam" [87] gives a very concise summary of Heidegger's object-thing distinction:

> *Needless to say, although he develops this etymology at length, this is not the path that Heidegger has taken. On the contrary, all his writing aims to make as sharp a distinction as possible between, on the one hand, objects, Gegenstand, and, on the other, the celebrated Thing. The handmade jug can be a thing, while the industrially made can of Coke remains an object. While the latter is abandoned to the empty mastery of science and technology, only the former, cradled in the respectful idiom of art, craftsmanship, and poetry, could deploy and gather its rich set of connections.*

Although his motivation was to highlight the limitations of Heidegger's hard dichotomy between Object and Thing, and the reliance on their makeup being drawn from the fourfold of "Earth, Sky, Divinity and Mortals", where there could be innumerable others.

Springing from this shift to Critical Inquiry and bringing the concepts more into line with this thesis's focus on Storytelling we shift gears to a more contemporary and pertinent perspective. Still working off Heidegger's distinction between objects and things, Bill Brown created **Thing Theory** as way of examining human-object relationships in literary works and human culture. The basic idea is that an object can transition into a thing, when it is misused, breaks down or is "Seen in another light". In other words, its 'normality' is interrupted. At that point its socially encoded value ceases to be the primary focus, and it becomes present, or "known" in new ways [19]. Working through examples, Bill Brown describes otherwise mundane *objects*, such as a doll, a car or a drinking glass, which are normally beneath individual notice. But when they stop being normal, either by breaking, being used in an unconventional way, or by encoding them with new associations, they are now perceived by

things, and the nature of the relationship between them and the human (owner or user for example), has changed. This theory, while relatively new, has been taken up by disciplines which focus on modernism, materiality and "New Materialism" [10,31,32,66].

Thing Theory provided a clearer lens with which to comprehend the transition of plain and indistinct material Objects, into distinct individual Things of notice. In a sense, the Things gains a "Thisness" or "Haecceity" [57] of its own, meaning it is considered a particular thing, different from others like it, in other words that object is singularised and uniquely identifiable. The difference between the indistinct **Generic Object** and the particular **Singular Object** is a key concept moving forwards and are main components of the proposed framework.

The following subsection moves the discussion to the notion of abstract things, which like the notion of material things became a primary concern over the course of the research.

2.4.2 Abstract Objects and Identities

As discussed in the introduction, a key finding of the research was the emphasis the communities of practice placed on structuring their activities, records and storytelling around characters, factions, ideas, groups and similar intangible entities. This contradicted the material objects-focused approaches of the majority of IoT thinking and heavily motivated and influenced the design of the framework. Careful consideration had to be given to understand the nature of these non-material objects and other, more theoretical, disciplines could provide guidance, if not distinct answers as the concepts are the subject of ongoing deliberation and disagreement within the philosophical community. In this subsection, the most relevant concepts will be briefly discussed.

While in the previous sub-section, the material or not-material nature of the objects and things that were discussed in Heidegger's and other writings kept shifting, here we shall focus on the distinction between the two. This is a topic

which in philosophical circles is just as controversial, if not more, than the nature of the things we discussed before.

The main idea is the distinction between tangible material objects and intangible abstract things. In a way, this is common sense and we as humans make use of both objects daily. We live in a material world surrounded by material objects that we make; covet; use, trade; live with, on and inside of. We also communicate with, think and imagine with things that are not *really there*, they exist only in our minds and in our words. Nor do these intangible objects & things that we think *with* & *about* have to necessarily be facsimiles of objects that occur in the 'real' material world. Note here that the terms abstract object and abstract thing are used interchangeably in this context – and its literature. Common examples of abstract objects are things like Numbers, Ideas, Stories, Colours etc. Many of these can be manifested by a material object in some way. There can be a red box, manifesting the colour red. There can be a printed copy of Lord of the Rings, manifesting Tolkien's *Story.* There can even be numerous (some good, some bad) films that visualise the story. However, are those films manifestations? Or are the original film reels and innumerable copies of the physical manifestation of the story while the films remain an intangible thing again as a collection of visions and ideas…?

Other questions are raised as well about the aforementioned haecceity or singularity of certain objects. Put plainly, when objects are referred to and thought about, they are given a particular identity, and before long the inherent complex nature of the object raises questions about what actually "is" the object? In Philosophy, a common example of this is *Theseus's Paradox*, more commonly known as the *Ship of Theseus*. First mentioned by Plutarch [188], the question is if a ship has had every single part of it replaced over a period of time, is it the same ship? If every piece, every plank and rope has been changed, how can it still be the same ship? The context for this question comes from Theseus, the Mythical founder of Athens, who sailed to Crete to defeat the Minotaur in the Maze. Upon his successful return to Athens, his ship had to be maintained, as it was part of an earlier pledge to honour the God

Apollo, whereupon every year the same ship would have to sail to the island of Delos. Thus, each and every part of the ship was replaced over the years to keep it seaworthy which led to philosophers to question the ship's identity. From that story, numerous other example paradoxes have been used over the years. John Locke used the analogy of darned socks [159], while Douglas Adams in his book *Last Chance to See* [1], talked about the Gold Pavilion temple in Toyo. Japanese Shinto shrines are rebuilt every 20 years with new wood. In some case it is from the same source as the original building. Adams showed a realisation that the Identity of the shrine transcended the mere materials it was made of by writing that:

> *"The idea of the building, the intention of it, its design, are all immutable and are the essence of the building. The intention of the original builders is what survives. The wood of which the design is constructed decays and is replaced when necessary. To be overly concerned with the original materials, which are merely sentimental souvenirs of the past, is to fail to see the living building itself."*

Adams later returned often to this though in his well-known Hitchhiker's Guide to the Galaxy *"Trilogy in four or five parts"* with characters being distinguished into old and new due to having feeling they had lost their identity due to all their parts being replaced [189]. The conundrum has often been a source of thought and bemusement in literature.

Figure 2.14. Trigger's treasured broom from Only Fools and Horses is an heirloom, despite not remaining quite the same over the years.

We see then that while the notions of abstract things as ideas and of identity as an immutable unique identifier can be appear relatively simple, they have troubled Philosophers for a while, however between Plato's relevant thoughts on *Forms* [131], and the late 19th century work of Frege [6,50], the subject was not a main topic of philosophy, apart from John Locke's distinction between Objects and Ideas [159]. Thus, in this section we shall discuss what are considered relatively contemporary views on the subject, namely Abstract Objects and Abstract Object Theory and the contradicting schools of thought within them.

To begin with, it is widely understood that every entity falls into one of two categories. Some are ***Abstract*** and the others are ***Concrete***. The issue at hand, similarly to the previous much discussed topic of Things vs Objects, is how the two categories are distinguished. The difficulty lies in the disagreement of how the two categories are defined for all cases. It has been shown that there is general agreement on the classification of certain things as abstract (if one believes that abstract objects exists, as we shall discuss further on), such as numbers, mathematical objects, ideas, colours, letters, stories etc. While others are clearly concrete, such as rocks, trees, humans and Stars. Or even the letter 'D' written in your notebook, or your copy of the first edition of The Disappearing computer.

Thus, a loose definition of Abstract Objects is that they are those that don't exist in space and time and are causally inert, meaning they cannot make anything 'happen' in the material universe. These are called Abstracta, plural of Abstractus. While Concrete objects are conversely those that have a place in space and time and can somehow affect and be affected.

Herein begins the main disagreement between philosophers, namely that some believe that abstract objects exist, or it is useful to think that they exist, while others believe that they simply do not exist. In Metaphysics, Platonism describes the contemporary view that Abstract Objects exist. These objects are considered to not exist in space or time, but rather in a "Third Realm" outside of the material realm and the consciousness [6]. The opposite view is that of

"Nominalism", which states that only concrete objects exist [190]. Note that this version of Nominalism is not the same as the Nominalism which states that Universals don't exist and that all things are "Particulars". The core argument of the Nominalist approach is that abstract objects cannot be perceived, they cannot affect or be affected, and do not have a place is space and time. In other words: They don't exist.

Returning however to the distinction between the two categories, the need for a way to distinguish the two begun initially with the work of Frege [6,50] who, while discussing the nature of mathematics, posited the existence of objects in a "*Third Realm"* that exists neither in the material realm, nor in the realm of thought. Essentially, he questioned how numbers and mathematical objects can exist since they are neither concrete objects, nor can they be purely mental objects – meaning how can two minds share the concept of the number '6', or of a triangle. From this work, the previously mentioned lively philosophical debate has ensued. Currently from Edward Zalta's 1983 Axiomatic approach to Abstract Objects [151], and David Lewis's discussions in his Book, *The Plurality of Worlds* [90] there exist four methods, or ways, of categorising things as either concrete or abstract :

The Way of Negation

This first method stems from Frege's opinion on the distinction between abstract and concrete objects, and is termed by Lewis as the Way of Negation. It states that objects are abstract because they lack features and properties that given concrete objects can have – specifically Frege states:

> *"And object is abstract if and only if it is both non-mental and non-sensible."*

Defining something as non-mental, or mind-independent is a challenge in itself. In straightforward terms, this states that an object is mind-depended if it cannot exist without minds existing. This however does not work as it conflicts with objects that are clearly concrete, but mind-dependent, such as any object of human artifice, such as a house, a car or a tool. In metaphysical sense, to be mind-dependent means that a thing owes its existence to some sort of mental

activity. This introduces additional issues of temporality, such as the question of whether an object survives the demise of the mind that conceived it.

Further issues are created by the notion of non-sensible, or in other words that the abstract objects do not exist in space and time and cannot be perceived by human senses. This leads to further questions, for example how can a story, which was created at a certain time and place by an author or storyteller, exist outside space and time? Some philosophers would argue that the stories are simply encodings rather than creations, but the common sense approach is that they are, and that they are also in some way reliant on the mental activity of the author, and then subsequent readers. Which also assumes the existence of material instances of the story to be readable.

Other examples that conflict with Frege's distinction are concrete objects such as atoms, electrons and quarks. We cannot sense those either, nor are they dependent or our mental activity.

Therefore, Frege's criteria for the Way of Negation have been reconsidered in recent years to require abstract object to be either *non-spatial*, *causally inefficacious*, or both. Meaning they cannot exist in space and they cannot affect other things. This too however raises several questions. While the requirement for non-spatiality is easily fulfilled by some examples, such as a mathematical theorem, or the colour Green, which could be argued to be 'Nowhere and to have always been there', it does not make as much sense for some other objects. The previously mentioned example of a story still does not fit this description. Or the idea of a particular activity. The idea of a sailing race for example can be an abstract object, but *somewhere* at *some point* there was the first sailing race. Before that there wasn't, and it is not necessarily true that since then the sailing race has existed non-stop and forever. But a sailing race is clearly not a concrete object either.

Further amendments to the criteria of the Way of Negation have ensued, including limiting it to periods of time, space occupation and even breaking the

notion of the object into parts that may fulfil the criteria at different times. These definitions of course have also led to more questions.

The Way of Example

The Way of Example is substantially simpler than the Way of Negation. Essentially it entails listing and describing characteristic paradigm cases of concrete and abstract objects, aiming to arrive at an understanding of the distinction.

So, in a sense, all the examples mentioned so far can help paint a picture of what differentiates abstract and concrete objects. However, the issue here is that the nature of the examples themselves is also up for debate and thus cannot act as pillars from which to steady the criteria of distinction. For example, there would have to be a clear definition of what numbers are, in order to use them as a solid foundation.

The Way of Conflation

Another suggestion is to use the Way of Conflation. Here the difference between abstract and concrete objects is seen as the same between individual objects and sets. This would be similar to believing that an abstract object is the description of set of all the concrete objects. So as an example, the Beatles would refer specifically to John, Paul, George and Ringo, not the band, not the summary of their life, music and exploits. Another equally (distressing) example is that a story, such as for example William Gibson's Novel *Neuromancer* exists only on the form of all the individual copies of it. Once they are gone, and all who remember it are gone, it ceases to exist. This approach is the one favoured by Nominalists, as it essentially refutes the existence of the of the abstract object as a thing in itself and treats it as the sum of the concrete objects.

The way of Abstraction

As Lewis puts it, the Way of Example is a vital alternative to the Way of Abstraction. Essentially, this method relies on considering several cases of objects and ideas, disregarding the differences between them and focusing on those that make them similar. This mental process creates new conceptions.

For example, one might take a red pencil, a fire truck, a strawberry, the flag of China and the planet mars. From these objects we can abstract the idea of the colour Red. Essentially one removes the specificity from concrete objects, and arrives at a 'pure' abstract object. In other words, you can take each existing (concrete) copy of Hamlet, disregard the differences between them – such as medium, font, reader, etc. and arrive at the Abstractus of "Hamlet, the play".

Returning to the context of this thesis, considering the nature – or debatable nature – of abstract objects has helped lay a groundwork of understanding that was necessary in order to get a clearer idea of where the distinction lay between the concrete things that were the predominate focus of IoT approaches and the material object -based projects, and the intangible abstract objects that we found practitioners to be more interested in in the practices and activities. While the exact debates about whether someone's story, or the characters of that story are non-spatial; or mind independent; or just made up of sets of written accounts, isn't necessarily the depth of questioning that is pertinent here, the fact remains that for the people invested in creating and sharing the stories and ideas of their practices, these things exist. Furthermore, it introduces questions of the identity of such things. Unique identification, as we saw previously, is a key tenet of the IoT, and there are no straightforward answers when it comes to distinguishing between two instances or manifestations of an abstract object. When it comes to keeping a digital record of the history and provenance of a 'thing', how can this be accomplished when the thing is abstract? When it is a made-up character for example? And what happens when that abstract object has multiple physical manifestations, which are each unique concrete objects in their own right? Do we still consider the Digital Record of the originating abstract object to be the only record? Or do we now have multiple Records, one for the original abstract object and one for each of the concrete objects manifesting it? And what if the Abstract Object can 'father' multiple Abstract Object copies due to, for example, different practitioners appropriating a given character, and taking them in different directions.

2.4.3 Meaningful Objects

In this subsection, we shall attempt to elucidate is the meaningfulness of material objects - what makes one or another object 'special' and distinct from all the rest to someone. Living in a material world, we are surrounded by things that fit the description of meaningful items, whether because they have a personal association, a cultural significance, a particular symbology, or simply because they are commodified and have a particular monetary value. The contemporary disciplines of material culture studies, materiality, behavioural and cognitive archaeology and others stemming from wider fields of sociology, anthropology and psychology all have numerous stances on the topic. In the present subsection, we will briefly list some of the more pertinent perspectives on the relationships of humans and things and in particular how things feature in and shape practice-based storytelling. The wider investigations of the entanglement of Humanity and Things is beyond the scope of this thesis, however interesting and extensive reading is to be found [36,73,191].

On the subject of communicating stories, narratives and histories, objects have long been a particularly capable vehicle. Tangible artefacts help people visualise the elements of the story [53,74,129]. Curated objects are a mainstay of history museums due to their ability to enable visitors to see, experience and connect with the past in ways that other mediums simply cannot [5,24,33]. In HCI objects are also considered widely as conveyors and maintainers of memory [52,121,156] and can help people visualise the elements of a story

Designers have also considered how they can 'Design for Meaning' whether in the realm of art or commodities and products. Ruth Mugge, on the subject of why consumers become attached to objects [62], determined that people became attached to products through four factors: Self-expression, meaning whether people could express themselves through the product - "*I'm cool because I own a new iPhone.*"; Group Affinity, meaning whether ownership of the product conveyed membership to a group – "*I belong to the Apple faithful now that I have a new MacBook Pro*"; Pleasure, meaning broadly that the product, through ownership and/or use provides pleasure to the owner –

"*Driving my new car is a sublime experience that has improved my daily life*."; and Memories, meaning any good memories (and therefore associations) that the owner has with the product – "*This scarf was a gift from my mother and I've travelled everywhere with it. I'm wearing it in every picture*". While designing for meaning – or more appropriately designing for a meaningful experience is a stated objective of some designers, others are dubious about the possibility of imbuing meaning and significance into a product by design for all users [41,42]. They understandably believe that the derived meaning and significance are personal things – one person's totem might be another person's rubbish. The belief is that you can only design to encourage the possibility of a meaningful experience. Peter-Paul Verbeek, in his book "What things do" [140], outlines the idea that object co-shape the relationship between Humans and the world around them based on how those objects were used (and therefore experienced). Using an object in such a way that it grows in significance to its owner, for example buying your first car with your first pay check, using it to go on memorable road trips and holidays, bringing it back from the brink when it breaks down lead to a far more meaningful association over time than if you were to rent a different car each time – or use the train. That car will grow to be a companion and character in the memories and the stories that will follow, especially if misbehaved by breaking down, and become a Thing of note as we saw Thing Theory posit earlier. As Verbeek put it:

> *"Products to which people develop an attachment are not generally as emotionally charged and irreplaceably present as heirlooms, but neither are they as anonymous as a throw-away item...what distinguishes these goods from our most loved possessions is that they are used rather than cherished." (Page 226)*

Therefore, *Use* can be said to be a key factor in how objects become meaningful – at least in the case of commodified products. Perhaps not necessarily in the case of objects with an inherent symbolic meaning.

2.5 Drawing it together and moving forwards

In concluding this chapter, it will be beneficial to summarise the key takeaways that will be helpful – and perhaps necessary – to be equipped with moving forwards. In a sense, the following is an arsenal of ideas, which have working definitions informed by the above literature and aim to move the discussion forwards to the creation and discussion of the Meaningful Things Framework.

To summarise, while the nature of thingness transpires to be complex and contested, philosophy and related disciplines offer us several perspectives that can guide our thinking as to how to shape their design in the emerging IoT. Specifically, three concepts can be surmised: First, through a lens informed by Heidegger, Latour, Brown and others, we might consider and identify how certain ordinary **objects** can come to be notable **things**. Second, we can see how they acquire meaning whether through design, or later associations of use and ownership. And third, we can be cognisant of the relationships between material and abstract things, and how an abstract identity can surpass a material artefact in persistence and distinctness, especially when considering the inherently mutable and compound nature of material things. Having laid some theoretical foundations, we can now see these issues play out in practice.

From consideration of the work described earlier we can also form some working concepts that aid in disambiguating, illustrating and communicating the activities we will see in practice. First, we have the **Record**, which is defined as the summary of the information and data which pertains to a particular Thing. This is further distinguished into the **Digital Record**, which presumes that the Record maintained in an indexed and searchable form and is comprised of a variety of media. This brings us to the idea of the **Footprints**, or **Digital Footprints**. Within this work these terms refer to the bits and pieces of raw information and data that comprise the overall Record. These can include any sort of non-mental media, whether text, graphic or audio. The mental footprints, such as information and data that exist only in a person's memory are also applicable as footprints, however until there are in some form extracted and committed to a persistent form they cannot really be considered

part of the record. We move on the much-discussed ideas of Objects and Things. For the purposes of this thesis, **Objects** are considered to be tangible material artefacts, while the term **Things** will be used primarily to discuss and describe abstract entities, such as ideas, concepts and characters. The term **Identity** will be used to refer to those Things that have a distinct Record.

We move now on to the second part of the thesis, where we take a close look at the practice of wargaming, using its inherently diverse nature to form a rich picture of activities in a real-world practice, to which we can begin applying the concepts discussed till now.

3 Exploring Tabletop Miniature Wargaming

3.1 Introduction

This chapter details the ethnographic fieldwork that was conducted to gain a broad and sufficiently deep understanding of the practice of the Tabletop Miniature Wargaming pastime.

We begin with an overview of Wargaming and its culture and proceed to summarise the current state of the pastime and it's attending closely related industry. Next we introduce the particular wargame and community that was chose as the focus of this work: Games Workshop's well known Warhammer 40,000 franchise [192]. Closely following these we detail the findings of the fieldwork, uncovering the many aspects of the pastime, such as collecting, crafting, gameplay, curation and narrative-creation, followed by a summary of the working conclusions.

The findings of this chapter of the thesis are summarised and published in the Data Driven Lives of Wargaming Miniatures [39]:

Dimitrios Paris Darzentas, Michael A. Brown, Martin Flintham, and Steve Benford. 2015. The Data Driven Lives of Wargaming Miniatures. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15).

3.2 Uncovering the Wargaming Culture

Miniature wargaming has been the subject of a previous ethnographic studies [21,22,67], which have focused on the phenomenon as a culture and have defined it as a multi-faceted **pastime** that involves a variety of complex and interlinked practices including collecting, crafting, casual and competitive gameplay and creative storytelling. For the purposes of this thesis, there was a need to adopt an HCI-orientated perspective and take a closer look at the activities, attitudes and perceptions of the communities with regards to the miniatures as tangible objects and storytelling activities that had often been

witnessed. The approach was inspired directly by prior experience of studying creative cultural practices including those of both DJs [3] and Irish Musicians [16].

As the researcher had little to no prior experience with wargaming there was the opportunity to observe and experience the practice through direct unbiased participation. The process began by engaging with local wargaming communities as a beginner and going through an accelerated familiarisation in order to experience as much of the pasttime as possible. A deciding factor to take the research forward in this direction was the proximity of the world's largest and most successful miniatures company, Games Workshop, and the fact that in the immediate Nottingham area there is the largest concentration of miniature designers and manufactures in the world. Many of these companies have been created by previous employees of Games Workshop and this has created a tendency for designers and sculptors to gravitate to the Area. Some of the local companies include: Warlord Games; Mantic Games; Spectre Miniatures; Foundry Miniatures; North Star Miniatures; Perry Miniatures; and many others. This has led to Nottingham being referred by Wargaming communities as the "Lead Belt" (in reference to early miniatures being made out of lead), with thousands of Wargamers visiting each year for events and tournaments. This creates a relatively unusual situation with regards to the existence of local gaming clubs and communities, which tend to congregate around the facilities of the aforementioned companies and manufacturers, unlike in other areas where the communities form around independent local shops, stores and clubs.

Thus, in order to acquire a wider picture of the pastime, two different communities were chosen in the initial stage, Nottingham University's wargaming society known as "RPGSoc" [193] and the community at Game's Workshop's own gaming space, "Warhammer World" [194]. In the case of the Former, the community was smaller and well-suited to receiving new and inexperienced players, as new students would join each year, often with little prior experience. In the latter case, the unique nature of Warhammer World

provided access to a particularly large range of insights into the wargaming community. By being situated in the very facility that houses the writers, designers and manufacturing of the Warhammer franchise, Warhammer World is a multipurpose facility situated in the centre of the Game's Workshop campus. The campus itself houses the corporate, Research & Design, and Manufacturing facilities of the company, which are not normally open to the public. Warhammer World on the other hand is a visitor facility that is open to the public every day of the week and features a large multipurpose event and gameplay area with over 40 gaming tables, which visitors can book for their own games as seen below in Figure 3.1.

Figure 3.1. The Warhammer World Gaming Hall (Source: GW PLC)

It is also used for official Game's Workshop Tournaments and Events such as open days where visitors can talk to the design team and see upcoming products. Furthermore, it houses the largest Game's Workshop retail store, as well as specialty stores such as the *Forge World* 'boutique' store that sells more expensive and limited resin products, and the *Black Library* book store that carries the tie-in novels and artworks of Games Workshop's game universes. Both the Forge World and Black Library stores are unique to the Warhammer World facility, unlike the Game's Workshop store which numbers among the over 300 brick-and-mortar stores that Games Workshop maintains around the world. Finally, the Warhammer World also houses the Bugman's Bar, a pub that is adjacent to the game room, and most pertinently, the Warhammer Exhibition centre which is a multi-room museum space that houses dioramas

and displays of Games Workshop miniatures as seen below in Figure 3.2. The exhibition is the only ticketed part of the facility and launched as a headline attraction to the facility when it was rebuilt in 2015.

Figure 3.2. One of the several room sized diorama's in the Warhammer World exhibit hall.

The Warhammer World facility is visited by hundreds of wargamers from all over the world each week, with numbers increasing exponentially during scheduled events. Having access to this space offered a deep look at the industry and the most prevalent practices, while providing an unceasing procession of wargamers of all backgrounds to engage with. Crucially it also demonstrated first-hand some of the most involved and diverse examples and cases of crafting, storytelling, narrative sharing and performance that could be observed in the entire pasttime.

In practical terms, the investigation began with an intensive 10 month long ethnographical engagement that aimed to get the researcher acquainted with the wargaming setting, context, activities and communities. Importantly, the ethnographic process did not cease after this initial period, but continued in the background of further activities until the end of the research. This took the form of continued engagement with the participants through workshops and

technology probes which will be discussed in the following chapter, and thus the understanding of the context continued to expand and deepen, with the newer insights being incorporated constantly.

Early activities focused on acquiring a degree of competence in the practice so as to better understand it by following the path of many aspiring hobbyists in attempting to 'build an army'. This included following along introductory sessions as offered by the RPGSoc, and attending sessions of the Games Workshop Beginner's Academy training course to learn the basics of modelling, basic and advanced painting and all aspects of gameplay through guided tutorials. In parallel with these sessions, the researcher went through the process of collecting and building an example collection, becoming proficient with the practice and making contact with local gaming communities.

Later fieldwork involved engaging with the wider community of practitioners through observation of dozens of games, tournaments exhibitions and shows. This included participation of the researcher in a number of games, beyond the aforementioned tutorials. Unstructured interviews and discussions were conducted with dozens of participants, discussing topics ranging over the sum of the practices, but with a focus on their handling of the miniatures and their attitudes towards them, especially with regards to how they maintained any records or told stories about them.

Importantly, substantial Online (or Cyber) Ethnography [11,34] took place, with the researcher engaging with as many wargaming related internet organisations as possible. These included discussion hobbyist blogs & forums, Online Wargaming clubs and communities and social media groups.

The following subsections will provide a brief description of the origins of wargaming, the current state of the pastime and its supporting industry, and the particular game of Warhammer 40,000 that was chosen as the focus of the research.

3.2.1 The Origins of Wargaming

The exact historical origins of Wargaming are not clear. The act of Play using some form of object that resembles a miniature representation of some real-world thing or person has been recorded in human history since ancient times, with tangible evidence existing from archaeological finds of miniatures depicting ancient soldiers [119]. Similarly, more abstract games of tabletop strategy such as *Chess* and *Go*, which have been played for centuries, indicate that the practice has been present for thousands of years.

Captain Abe Greenberg of the U.S. Navy attributes [63] the invention of the first wargame to Sun Tzu, the Chinese general and military philosopher who authored the Art of War [135]. He is credited with the creation of the game Wei Hai, which translates as 'encirclement', approximately 5000 years ago. Not many details are known about the actual game itself but there are indications that it is the original version of the Japanese game Go [160] mentioned above. Like Go, Wei Hai used a specially designed playing board on which the players moved their armies, represented by coloured stones.

A more well-known example is that of Chess, which it is agreed, originally evolved from a game known as Chaturanga which originated in India as a pastime for nobles [103,195]. Evidence suggests that initially, Chaturanga was a game for 4 players and dice were used for the movement of the pieces, however this eventually evolved into the two player, prescribed movement model known today. In contrast to the minimalistic aesthetic of Go, Chaturanga was characterised by the elaborate aesthetics of the tangible objects involved ranging from the intricate miniatures to the game tables and surfaces themselves. In this form, Chaturanga eventually formed into the popular game of chess that persists to this day, cementing itself as the longest living game of its type.

It should be noted that the above examples of wargaming represent warfare in an extremely abstract way. The stylised depiction and formalised, and also restricted, options demonstrate that, with regards to learning, they were not intended to be much more than introductions to the basic principles of military

thinking. In the case of chess, the clear objective and knowledge of their own, and their opponents capabilities teach the player to analyse and weigh their movements and devise strategies to overcome their opponents and achieve that objective. These are concepts central to basic military thinking but they are a far cry from the tumultuous realities of real warfare.

It was the above point that led to the creation of variations of the basic Chess formula in the mid-seventeenth century with attempts to create a wargame that would be more representative of the warfare of the time. The first such game to be recorded was Königsspiel or 'King's Games' invented in Ulm by Christopher Weikhmann. Königsspiel was based on chess, but used a larger board and each player utilised thirty pieces. These pieces were named for characters and ranks prevalent in the militaries of that time, such as kings; marshals; lieutenants, etc. and each had its own movement capabilities. Essentially, Königsspiel was an over-elaborate variation of chess and it, and other similar games, became collectively known as 'War Chess' or 'Military Chess', which while promoted as officer corps training aids, remain of dubious value as an effective training tool.

However, it is these very attempts that eventually led to the introduction of three fundamental concepts in the development of wargaming. These all appeared in a game invented by Dr C.L. Helwig in 1870. Helwig's game was the first to use aggregation, where a single game piece represents not a single soldier but a larger number of them or an entire military unit. It also replaced the chess board type surfaces with a board representing different types of terrain. Finally, it employed an umpire to supervise the gameplay. Helwig was the Duke of Brunswick's master of pages, and therefore his duties included both entertaining and educating the noblemen in his care, which explains why he went the effort of designing his game with the purpose of teaching elements of military thinking and logistics. However, his game was still heavily influenced by the nature of Chess. The board was still comprised of squares, albeit there where 1666 spaces, with the various colours denoting terrain features such as red being mountains; blue being lakes and rivers; black being open terrain; etc.

The playing pieces, being basically chess pawns, represented several different types of military units such as battalions, cavalry, artillery; fortifications and even pontoons and pontoniers. Each player deployed approximately 120 different pieces.

Helwig's game enjoyed some success, spreading to France, Austria and Italy, and over the next half century spawned a number of imitations. These were clearly marketed as games, highlighting the entertainment aspect. Tailored to the nobility of the day, they were designed primarily for amusement and also as a painless and basic introduction in the terminology and principles of war as taught at the time. As rigid and formalised as the game's nature was, military philosophy at the time was viewed, historically, as much the same. This was the time of line & formation warfare or 1st Generation Warfare. Neat set-piece formation based battle plans that inevitably failed to keep to their conceiver's imaginations. As Francis McHugh [94] described it,

> *'War Chess resembled, rather than simulated, warfare. In some ways, it might be considered as having the same relationship to later war games as the game of monopoly bears to current business games.'*

In 1797, a scholar named Georg Venturini who had authored the work 'A Mathematical System of Applied Tactics and the Science of War Proper' designed a new game titled 'Rules for a new Wargame for the Use of Military Schools'. Venturini's design still used the square grid system of Chess and Helwig's game but had upped the size to about 3600 squares, each one representing one square mile. The complexity of the represented military assets was also increased, featuring even logistical details such as field bakeries. Notably, Venturini attempted to make the pieces move in accordance to their real-world counterparts, such as incorporating weather and terrain elements, although he was still limited by the square grid representation. He was also quite clear in the purpose of his creation, which was specified as an 'Officer's Exercise' in an attempt to distance it from the negative connotations of it being perceived as a game.

In the 19th century, a civilian War Councillor named Von Reisswitz discarded the War Chess square grid board and opted instead for a sand table that could be used to model a relief of actual terrain. The playing pieces were made out of wood, cut to scale to represent the military forces of the time. Von Reisswitz came into contact with a Prussian officer named Von Reiche who was the captain of cadets at the Berlin Garrison and was responsible for the instruction of the princes Friedrich and Wilhelm (later to be known as Kaiser Wilhelm I).

Following a very successful demonstration, Von Reisswitz's game came to the attention of King Friedrich Wilhelm III who was, allegedly, fascinated by the more accurate representation of war. Reisswitz used this to further develop his game by creating an elaborate set piece terrain comprised of multiple four inch square pieces of terrain that could be arranged in multiple ways to create different scenarios. The pieces were made of porcelain and the rules were predominantly to do with their movement and not combat resolution which was worked out by the players themselves.

But it was not Von Reisswitz but his son, George Heinrich who would make the decisive evolution in wargaming. George was a first lieutenant in the Prussian Guard who developed and introduced a refined version of his father's game in 1824. The most obvious difference between the two was that the sandbox had been replaced with detailed topographic maps, drawn to a scale of 1:800 meaning approximately eight inches to a mile. Furthermore, Reisswitz the younger had drawn upon his military experience to quantify the effects of combat in order to create thorough rules governing combat resolution. His designs and techniques were collectively published as 'Instructions for the Representation of Tactical Manoeuvres under the Guise of a Wargame'.

Figure 3.3. The highly abstract nature of Kriegspiel, and one of its modern derivatives, Risk. (Source: General Staff)

Following a successful demonstration to the highest echelons of the Prussian Military, the standalone term Wargame (Kriegspiel) was born, denoting not a game about war or a war game but a fully integrated Wargame meeting the need of a training aid and an enjoyable gaming experience.

The impact of Kriegspiel in the Prussian army was such that it created a division and internal conflict of which Von Reisswitz was himself a victim, leading to his transfer and eventual suicide in 1827, just a few years after his success. Despite the demise of its inventor, Kriegspiel persisted and grew in popularity including avid players such as Helmuth von Moltke, widely regarded as one of the greatest strategists of the late 19th century.

3.2.2 Modern Miniature Wargaming in the 20th century onwards

As discussed in the above section, throughout the history of wargaming there has always been some form of physical representation of the forces used in a Wargame. Be it the abstract and artistic representations used in Chess and Go, or the increasingly elaborate objects, such as Clerks ships later on. These varied in form and nature depending on the desires of the designers and the purpose of the Wargame which at the time was predominantly for military education purposes.

It was not until the 20th century that the concept wargaming as a hobby was formed. In 1912 the Science Fiction author and Historian, H.G. Wells published a work entitled 'Floor Games' followed shortly later in 1913 by another work titled 'Little Wars' [146,147]. In these books, H.G. Wells detailed a system for

playing out battles using lead soldiers and featuring terrains composed of model houses, trees and terrain features.

Figure 3.4. Newspaper clipping depicting H.G. Wells demonstrating "Little Wars". (Source: BBC [133])

While the concept of play with toy soldiers was by no means something new, Well's system was the first to be widely adopted as it was easy to implement and was easily extended and adapted to a variety of scenarios, adding or removing complexity as needed. Well's himself intended the system as nothing more than an amusement but at the urge of military professionals, wrote an appendix on how his system could be applied to the version of Kriegspiel that was current at the time.

Thus, with the ease of use of the game system described in Little Wars and the ready availability and affordability of the objects required, wargaming gained widespread adoption as a hobby and therefore H.G. Wells is usually considered the father of modern miniature wargaming. Indeed companies and individuals who made a significant contribution to the practice were awarded the 'H.G. Wells Award' [133,196].

Figure 3.5. A typical wargaming session of a contemporary wargame, with appropriate tabletop terrain, armies of crafted and painted models, and active players.

Since Little Wars the nature of Miniature or Tabletop Wargames has remained relatively stable. Namely it involves the collection of appropriate looking miniatures, that are usually assembled from kits and painted by the hobbyists, who then use them in organised gameplay between two or more players on an appropriate surface, which is usually a tabletop, all as illustrated above in Figure 3.5. Building and painting the miniatures is in itself a very involved and creative activity, requiring patience, skill and persistence from the hobbyists who chose to do it. Similarly, the gameplay is in its own right a hobby. The game rulesets set the players in the role of the commanders of an assembled 'army' of miniatures. Within the limitations of the rules, the players dictate the 'actions' of their armies, by moving the models and deciding their actions on a turn by turn basis in order to complete objectives. Most often the rules dictate the use of dice, cards or other gaming aids to determine the success or failure of the actions. Hobbyists who take part in gameplay become engaged by learning the rulesets, understanding the various strategies, and developing effective tactics

The above activities are each quite varied, diverse, involved and open-ended. Therefore, in practice while many of the hobbyists do indeed partake in the entire process, not all of them do. Some find they have a particular liking or affinity for only some of them, such as the crafting aspects of building and painting. Others find that they like the game, but don't have the time or

patience to craft their army themselves. Some prefer casual or narrative gameplay, while others find it more appealing to be competitive players and thus attend tournaments. The variety and non-compulsory nature of the various aspects of the hobby, which can appeal to very different attitudes, skillsets and dispositions, create a diverse community and culture among the hobbyists.

Figure 3.6. Two examples of very different wargames. On the left the historical WW2 themed Bolt Action, and on the Right the Competitive-focused Fantasy game Warmachine.

In recent years, Miniature Wargaming has grown in popularity, maintaining a large player base and an industry that has fared well, despite economic downturns and competition from massively popular digital games. Franchises have grown covering settings such as Historical, Medieval, Imperial, 20th century, Modern and Science fiction, furnishing hobbyists with a plethora of choice. Since then it has grown in popularity and established itself as a phenomenon involving millions of people worldwide as well as a multi-million dollar industry [81,96,197]. This has come about due to a number of factors that came about in recent years. Specifically, the resurgence of the popularity of board and tabletop games has shown that there is a substantial market for them, which is further fuelled by the increase in franchised board games [198]. In addition, the proliferation of 3D printing has revamped the traditional technique for making 3D miniatures, which was through laborious and skill-dependent hand sculpting. Currently the majority of companies have switched to a 3D modelling based technique, whereupon 3D modelers can rapidly create designs, print masters on high-fidelity 3D printers, and then use those masters to make production molds. This had has had the effect of opening up the

possibility of miniature production to 3D artists. Finally, tabletop games have been one of the most popular crowdfunded projects on platforms such as Kickstarter and Indiegogo, and have some of the highest Kickstarter success rates [65].

As far as the objects themselves go, the miniatures featured in these games range in scale from 2 to 6mm for mass combat games simulating large-scale warfare, all the way up to 54mm scale or larger, for skirmish level engagements with fewer models. The most popular scales are 15mm, which is commonly used in historical wargaming and 28mm which is used in most contemporary wargames, such as Games Workshop's Warhammer Fantasy and 40K franchises. In practical terms, this means that a figure's scale is roughly equal to the stature of a human. This is not an exact science as the scales vary greatly depending on the method that each modeller uses to measure the scale, for example some include the base, while others measure to a figures eyes, rather than to the top of the model. The proportions also vary, with some companies opting for realism while others adopting more 'heroic' proportions that are more robust and easier to paint. This is as often down to manufacturing technique limitations as it is due to style and artistic considerations. As these games are rarely limited to human like figures alone, especially in the case of the science fiction themed ones, it is very often the case that the models are much larger as seen in the case of vehicle models below in Figure 3.7 which also shows how a single game-ready army can be comprised of a very large array of varying miniatures that changes from session to session.

Figure 3.7. Examples of game-ready armies, showing the variety of models and their wide size range.

In addition to the miniatures, there is a substantial practice and industry for making accessory terrain and other features for the tabletop environments that the games are played on. This also creates an appeal for hobbyists who are interested in diorama and miniature terrain making.

Notably, wargaming miniatures have been produced to represent practically all major conflicts in human history, and quite a few obscure ones. Many fictional settings and franchises from other media such as films, moves, Role Playing Games and video games have also been turned into miniature wargames with figures representing major characters. Finally, many fictional universes are crafted entirely as a setting for some wargames, as is the case with Warhammer 40,000, and others are based on "What-if" scenarios, such as World War 3 or a prolonged Second World War. Figure 3.8 below briefly lists some well-known examples for each category. Many of these can be considered quite niche areas of interest, especially in the case of some of many of the historical wargames which tend to attract collectors and players who have particular interest for various periods of history, and whose interests often cross-over into re-enactment. Conversely, the fictional settings, which are often mainstream franchises, draw a wider variety of hobbyists with levels of interest ranging from casual players all the way to enthusiasts such as Live Action Role-players and Cosplayers.

Real World and Historical Settings	**Franchised Fictional Settings**	**Novel Fictional Settings**	**"Alternative History" Settings**
World War 2	Lord of the Rings	Warhammer 40,000	Team Yankee
Napoleonic Wars	Game of Thrones	Gates of Antares	Konflict '47
American Civil War	Doctor Who	Infinity	Dust 1947
Viking Invasions	Call of Cthulhu	Age of Sigmar	
Vietnam War	Dungeons & Dragons	Dark Age	
Modern Warfare (Iraq etc.)	Aliens	Wild West Exodus	
Zulu War	Star Wars	Malifaux	
Spanish Civil War	Star Trek	Dropfleet Commander	
Ancient Warfare	The Walking Dead	Guild Ball	

Figure 3.8. This table shows the variety of settings that wargames have been based in.

Regardless of the chosen setting or game, the next major decision point for most new entrants is choosing which army or faction they will collect and play. This is often the most asked question in wargaming forums and social media groups as the wealth of choice is often daunting.

The variety of the factions, and how distinct they are both aesthetically and in gameplay depends a lot on the game and it's setting. Similarly, the most commonly stated reasons that players respond with when asked why they chose a faction is either their aesthetics, their gameplay or their competitiveness. Respectively therefore this depends whether the hobbyists are more disposed towards collecting & crafting, or competitive gameplay.

> *"It had to be Eldar. Their background is fantastic as are the model looks. I used to play them in Dawn of War too." – Hobbyist - 5 years' experience*

> *"I searched online in forums and checked out the ITC (tournament) results to see which army was dominating the leagues. Turns out it was a White Scars Gladius Formation, so I got a tourney force commissioned." – Hobbyist - 2 years' experience*

However, it is almost always the case that players begin to collect more than one faction from a game and also begin collecting miniatures for different miniature games as well. Of the participants asked, most where collecting an average of 4 Warhammer 40,000 armies, which features over 20 distinct factions, and were also collecting and playing at least 3 other wargames.

Apart from competition and model aesthetics, another factor that was just as important was the "Lore" of the setting. This refers to the background story of the wargames setting. In the case of the historical games, the wealth of information available to the hobbyists is considerable, and is part of the appeal for enthusiasts who value and find satisfaction in recreating historical events with as much accuracy as possible. In the case of fictional settings, it was shown that the extensiveness of the background was a key factor in the success of the wargame. In many cases this was shown to be a bigger factor than the quality of the gameplay ruleset. This is understandable as the more expansive and known the background is, the more probable it is to create a loyal fan base and

to attract new players. As discussed in previous sections, Warhammer 40,000 enjoys over 30 years of worldbuilding from Game's Workshops internal publication company that has produced hundreds of tie-in novels that have built considerable 'lore'. Many hobbyists found these novels to be their entryway into the hobby. Many more were attracted through the licensed video games that were set in the Warhammer 40,000 universe, such as Relic Entertainments *Dawn of War* series [199,200]. Furthermore, Warhammer players are constantly encouraged to create their own narratives and fit them into the overall setting. Substantial space is available for creative players to inject their own stories as the official storyline makes use of the 'Unreliable Narrator' trope to leave aspects vague or open to interpretations so as not to exclude storytelling possibilities.

Nevertheless, as much as the Warhammer Universe has gained a dedicated and growing fan base, the effect of a known franchise becomes impossible to miss when considering the almost instant success of miniature wargames based on settings and franchises such as Tolkien's Lord of the Rings (LotR) and Star Wars. Games Workshop have held the rights to create wargaming miniatures based on the Lord of the Rings books and films, and their LotR product line, while substantially smaller than the Warhammer offerings, was credited with a massive influx of players when it released in 2001

Figure 3.9. Examples from Games Workshop's Lord of The Rings wargame.

The Games Workshop “Lord of the Rings Strategy Battle Game” miniatures, examples of which can be seen above in Figure 3.10, are licenced to bear the likenesses and Art direction of the Lord of the Rings and Hobbit motion pictures, and have products to represent all the featured characters and factions. However, they also cover factions that were not featured in the films. It should be noted that most of the new players who engaged with miniature wargaming by beginning with the Lord of the Rings wargame, transitioned into Warhammer and other games eventually.

Other games took advantage of established franchises and fan followings, most notably Fantasy Flight’s X-wing, a game which recreates space combat based on the characteristic scenes and aesthetics of the Star Wars movies. Within 3 years of its first release X-Wing was ranked as the second bestselling miniature wargame and the second most popular game at tournaments and wargaming conventions. Many reasons have been given for its popularity, including the popularity of the setting and the quality of the ruleset. Interestingly, X-Wing is one of the few wargames that uses pre-painted miniatures. This has the dual effect of removing an entry barrier for players who are not interested in the crafting aspects of the hobby, but wish to play and compete. Conversely, it alienates hobbyists who are interested in crafting and collecting miniatures.

3.2.3 Picking a wargaming community – Warhammer 40,000

To progress the work, the decision was made to focus on one particular wargame and its community. Despite the aforementioned wealth of options, the final choice was quite easy with Games Workshop’s flagship franchise, Warhammer 40,000, abbreviated as ‘40K’, becoming the primary focus from that point onwards.

Released in 1988 and set in a dystopian ‘science-fantasy’ universe, 40K is well-established and enjoys worldwide popularity. It consists of a vast transmedia intellectual property set including, besides just the models, novels, artwork and digital games.

The primary product around which the rest of the franchise is built, is the "Warhammer 40,000" miniature game. Described as a hobby by the marketing literature, it encompasses the activities of Collecting, Building, Painting miniatures from the Warhammer setting, and using them in casual and competitive gameplay using the Warhammer 40,000 ruleset. In theory, hobbyists are meant to pick one or more of the factions that are available from the product line, decide on the composition of their army based on the rules and options for that army, purchase, assemble and paint the models, and finally field them in tabletop gameplay.

Among the reasons for choosing 40K as the main focus of the research was that 40K is by far the most popular wargame, with millions of fans and players around the world. While this and the proximity of Games Workshop (GW) were reason enough, there are other quite compelling benefits as well. As mentioned previously, unlike many other wargames, especially those based on historical settings, 40K is set in a well-developed fictional background setting that has been designed from the ground up as a broad canvas for hobbyists to inject their own creativity. This has been done by creating a setting that has enough detail, depth and 'mythology' for hobbyist to be inspired, yet leaves enough flexibility and 'narrative room' for fans to fit their own stories, narratives and characters. GW's publications, both the rulebooks and the novels published by its Black Library (BL) publishing subsidiary provide hobbyists with information on environments; factions; organisations; characters; way of life; technology; and of course, warfare perpetuated in the fictional universe, while providing an underlying vagueness and mystery, either through 'Unreliable Narrator' storytelling methods or obvious contradictions. This creates a tension where the canonical overarching story – or the 'canon' – is constantly challenged. The background narrative is summarised as the **Lore** of the setting, as is the case with other such fictional universe.

> *"Don't take anything for granted. The universe is 40000 years old and historical records are bound to be unreliable." – Hobbyist discussing the fate of a particular character in the setting*

> *"It's a big universe. There might be a planet where they do things differently! It's your hobby and models, do what you want." – Hobbyist when asked whether a particular army composition was thematically appropriate.*

The *Lore* of 40K has been built up through hundreds of official publications including rulebooks; artbooks; background and reference books; novels and short stories; audio dramas; digital games; and short films. Critically however, a key part of what GW promotes as part of the hobby is that each player can contribute to setting and carve out their own niche, such as for example by creating their own characters, factions and stories for their collections. As we will see further on, this manifests in numerous ways, ranging from relatively simple examples such as custom paint schemes, all the way to completely fan-made rules and factions. This also has the effect of further expanding the setting's background, as fan creations have been known to become part of the established lore, either because they were adopted officially by GW, or because they were incorporated into the various unofficial references and wikis of the community.

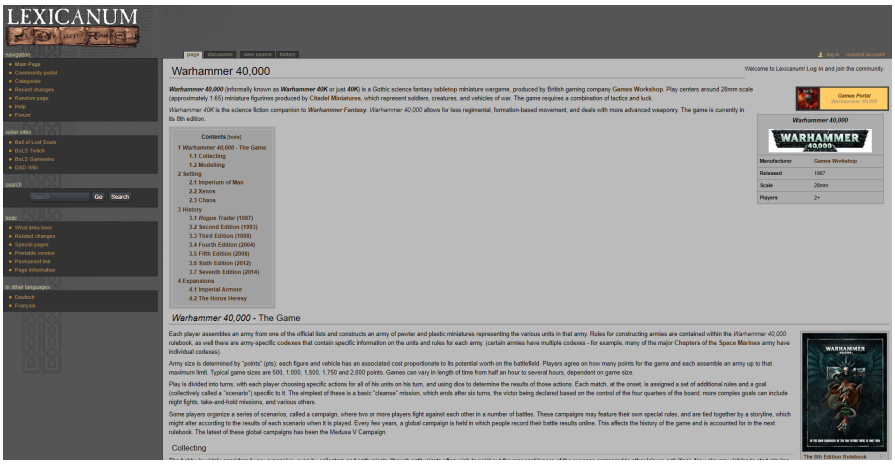


Figure 3.10. The most popular of the community-driven Warhammer Knowledgebases, the Lexicanum.

Such crowd-sourced and maintained knowledge bases and wikis-like web portals are particularly popular with fans for an incredibly diverse number of subjects. The best-known examples specifically for 40K, and the go-to online

references for 40K's lore are the online sites *Lexicanum* [201], illustrated in Figure 3.10 above, and *The Warhammer 40K Wiki* [202].

3.3 The Practice of Wargaming

Having provided the above overview of Wargaming, the following section presents key findings from the practices that make up the Wargaming pastime. Particularly attention is on the role and community perception of the physical objects that are at the heart of the practice, meaning the miniature modes, while also especially noting how the practices involve record keeping activities and generating record footprints which are subsequently used to create narratives and stories.

The following subsections will describe in detail the various aspects of the wargaming hobby and list the insights that helped illustrate the particular ways by which the objects and activities involved in miniature wargaming serve as a telling example of creative crafting and storytelling.

3.3.1 Collecting and Building an army

A major part of miniature wargaming is owning a collection of models, which can then be assembled into cohesive 'armies'. The hobby of 'Collecting', is very much at the heart of wargaming, whether the hobbyists actually use the miniatures for gameplay or not. Some hobbyists are more interested in the crafting aspects of the hobby, such as building, converting and painting. Others like to collect models in order to represent factions and characters from the background lore and exhibit them. Others wish to collect and store them as possessions and investments. The physical properties of the miniatures, as well as the process of their creation, makes them very well-matched to constitute collectables, especially in the case of limited runs, obscure manufacturers and the additional value added when the miniature has been painted to a high standard. In most cases hobbyists belong to all three of these personality categories to varying degrees, and have various motivations for each.

The following subsections focus on the crafting aspects of the miniature wargaming pastime, specifically how the miniatures are built, assembled and converted, and how they are painted.

3.3.1.1 Getting physical – Assembling and Modelling an army

The miniatures are made of either metal, resin or plastic, and depending on the material are marketed and packaged differently. Traditional miniatures were made of metal, usually lead however this has transitioned to pewter or other white metals. Many manufactures still produce metal miniatures as the material is preferred by many and creating moulds for them is easier and cheaper than creating moulds for plastic production. Metal miniatures tend to be single sculpts, with few – if any – additional parts, and they are usually small due to the weight of the metal.

Figure 3.11. Examples of unassembled metal models and their casting process.

Resin is the next most popular material, as it shares the same manufacturing process as metal miniatures meaning it is easier for smaller companies to produce with little investment in equipment. Compared to metal and most plastic, it also has the ability to hold much better surface detail, therefore it is preferred for highly detailed kits, often with many small and intricate parts. This means it is the material of choice for premium models such as those sold by GW's subsidiary *Forgeworld.* Resin is used for boutique models are made out of, such collectibles and models that are meant for exhibition instead of

gameplay. This is compounded by the fact that resin is by far the most fragile material and requires careful handling and precautions both during assembly and use. Therefore, resin models are not recommended for beginner modelers. In addition, as resin is lighter than the metal (although it can still be heavier than plastic) it is the preferred material for larger models, with some Forge World examples being over 3 feet tall and weighing in excess of 20kg.

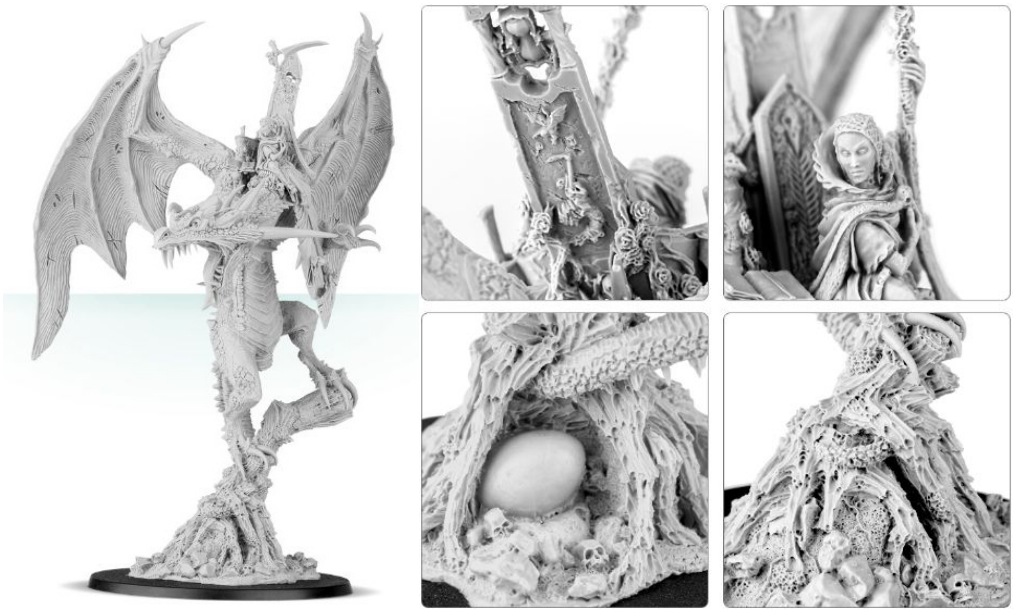


Figure 3.12. Example of a detailed resin miniature. (Source: Forgeworld)

It is also the most popular material for companies to make smaller bits for customising other models, such as different head or equipment options as seen in Figure 3.13 below. These are referred to as 'Bits' and there is a thriving market for 3rd party bits to customise the more popular product lines, such as Games Workshop's plastic models. The moulds for resin and metal models are made out of silicone or similar materials, and degrade with time and use. Therefore, resin and metal are best suited for limited or low volume production runs. This also has the effect of creating a market for 'First-run' models, which were among the first produced by a mould. These tend to have crisper detail and be of better overall quality. Older moulds can degrade to the point where the assembly of the models becomes impossible.

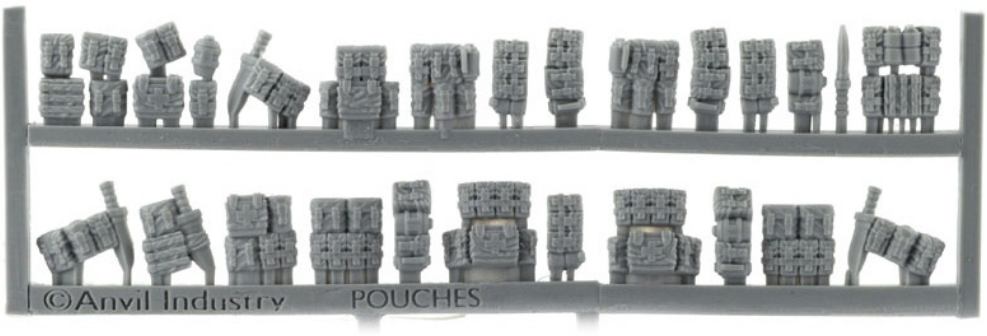


Figure 3.13. Examples of 3rd party resin addon 'bits'. (Source: Anvil Industries)

Plastic models are quite unlike metal and resin miniatures, both in the manufacture and in their properties and "meta-practices". Plastic models are most often sold as kits which contain all the components required to assemble them. The components vary in size depending on the kit and can be as small and specific as individual arms, legs and accessories.

The components are set in plastic frames, known as sprues. This is primarily an artefact of the plastic manufacturing process which requires the mould to be as flat as possible. This means that models have to be broken into as many parts as possible and arranged on the sprue in such a way so that the detail is on the top or bottom plane of the sprue. Apart from this complicated procedure, the moulds need to be made of machine metal and be used with plastic injection techniques in a vacuum in order to avoid air bubbles and similar issues. All this has the end result that creating even a single plastic model kit is a substantial investment – a single mould can cost over 2 million dollars. Thus, plastic models are primarily the domain of the larger companies, such as Game's Workshop, and scale model companies such as Tamiya and Italeri. Essentially each kit must sell a much larger volume in order for the investment to be worthwhile compared to the silicon moulds for resin or metal which can even be homemade. Some miniature companies, such as Warlord Games in Nottingham outsource some plastic kits to other companies.

Plastic has a large number of advantages. First the material is stronger and lighter, and with recent techniques and materials can hold as much surface detail as the resin models. In addition, the material is much easier to work with and is ideal for beginner modellers. Another meta-effect is that since the models are sold in multipart sprues with multiple build options, the unused extra components are saved by hobbyists who either use them to convert and scratch-build other models, or trade them.

Unlike the metal kits, that are usually one piece and thus only require painting, or the resin models, that are often component based and encourage modelers to assemble them as they wish, the plastic kits are often designed to be assembled in one or more specific ways. For example, a vehicle kit may be intended to be assembled in 3 different configurations. These configurations may be due to realistic or historical reasons, such as in the case of models representing real life examples, or they may be due to the game's rules that stipulates specific configurations for game balance. Despite this, customising the assembly of the models is still possible and encouraged. The addition of small details is the most common aspect of this, however complete customisation and conversion is also very popular. In general creativity is lauded within the miniature wargaming community, with hobbyists often going to great lengths to add multiple levels of individuality to each of their miniatures. Some assemble models with components from different kits, a process known as "Kit Bashing", while some even go as far as sculpting entirely new parts using materials such as sculpting putty.

There are however two forms of resistance to customising models. The first is when hobbyists made changes or additions to the model that may have a 'functional' use in the game which may confuse gameplay. In general, organised or competitive play implements a "What you see is what you get" rule, meaning that any model used in such play must resemble what it represents in the rules of the game. The most common example is that models must actually have modelled on them the equipment (such as weapons, etc.) that they are said to be equipped with in the rules and the player's army roster.

Otherwise the opponents may not have a clear idea of what the model is capable, or the owning player may claim that the model is equipped with something that he has not actually equipped it with. As will be discussed in the gameplay section further on in this chapter, most games balance the armies between two players by having some sort of power rating mechanic for each model or composition of models which a player has to 'pay' out of a maximum allotment. And their equipment may also have a 'cost' based on its gameplay effectiveness, which also must be accounted for.

The second source of tension is when the customisation of a model goes against the established or canonical *lore* of the setting. In historical settings, some hobbyists are enthusiasts of historical accuracy (known in the community as "Rivet Counters"), and will notice historical inaccuracies such as anachronistic equipment or paint schemes. Whether this is an issue is dependent on the situation at hand. Most wargaming hobbyists tend not to be overly strict about such things, but hobbyists who are engaged with modelling due to an interest in historical re-enactment tend to emphasize accuracy in their creations. In fictional setting, like Warhammer, the issues can be similar, where a hobbyist might convert a model in such a way that it does not fit in with the *canon* lore. Such as, for example, equipping a model with a weapon from another (normally hostile) faction, or mixing and matching units from opposing factions. However as discussed previously, the background lore of 40K has been composed in such a way so as to leave room for different interpretations and hobbyist creativity, and the official rules of the game openly encourage such experimentation through a gameplay type called 'Open Play'. This is in addition to the types of 'Narrative Play' and 'Matched Play' which will be detailed further on.

Balancing the desire to customise their models while still adhering to WYSIWIG rules or background material is described as a constant effort for hobbyists who emphasize crafting while still wanting to participate in organised gameplay.

Important to the research is what parts of this assembly and modelling process the hobbyists try to record and how they value and share this information with

the community. In the case of “single piece” models, there is not much assembly involved. The same applies to any “mono-pose” multi-part models that can only be assembled in one way. Therefore, there is not much individual ‘craft’ to record and share, unless the hobbyist aims to make a tutorial as some do. More modular multi-part kits that allow for a variety of configurations give modellers more opportunities to make unique models, which are often shared in the community via pictures that are posted on blogs and social media. A more advanced technique is known as ‘kit-bashing’, were modellers combine various parts from different kits that are not necessarily compatible. These creations are often completely unique, and along with images and guides for how they made them, modellers will also share the parts list – especially as a request for it is the first comment that the blog or social media post will get. The most advanced form of modelling is when hobbyists sculpt additions and details on their models using modelling putty. This is an exercise that requires considerable skill, nevertheless quite a few modellers attempt it as some point.

Figure 3.14. The process and outcomes of sculpting conversions. The green parts are the sculpted additions over the original grey plastic model.

A similar technique is called ‘scratch-building’ where modellers make enhancements to existing models or entirely new models out of raw materials such as plastic card, cardboard, or even household materials, such as boxes, packaging materials and cans that would otherwise be discarded. This technique is most commonly used for building the model terrain that is used on gaming tables, however some modellers take it upon themselves to scratch-

build models that exist only in text descriptions and concept art, or are entirely their own unique creations. Some also use children's toys that they heavily modify and paint to fit in with the wargaming miniatures.

> *"Everyone down at the club hoards packing foam. When my new monitor arrived, I was more excited about the foam it came packed in. A few additions and a paintjob and now it's a bunker complex!"*
> *– Hobbyists discussing scratch-built terrain.*

Entire social media groups and blogs are dedicated to these advanced techniques, where modellers who are well known within the community share step-by-step progress on their creations. Many often do commission work as well – a phenomenon that will be discussed in depth further on.

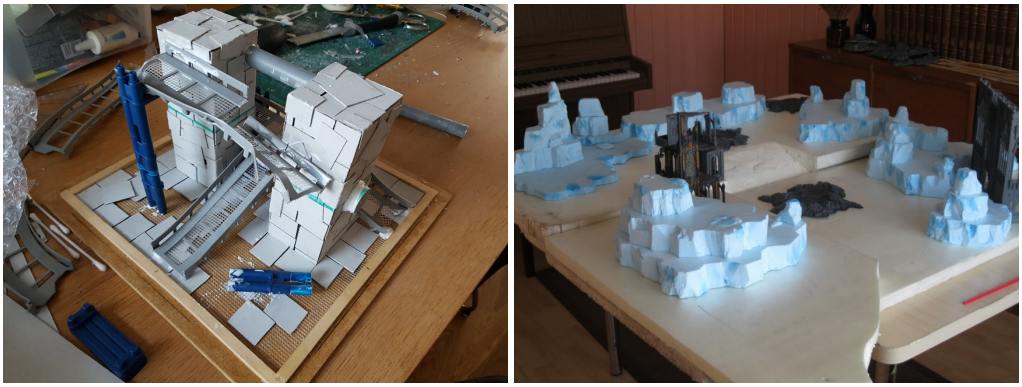


Figure 3.15. Examples of Work in Progress 'Scratch-built' terrain that has not been painted yet.

3.3.1.2 Adding the unique touch - Painting an army

Following the assembly of the models, the next step is for the hobbyists to paint them – although many hobbyists who are more interested in gameplay will field the models as soon as they are assembled. As an activity, painting the models sounds straightforward, however hobbyists have many decisions to make before they can even pick up a paint brush.

The paint scheme, or paintjob of a miniature model is one of the strongest indicators of its “identity”. By adding colour, liveries and symbols to a model, the hobbyist is making a number of determinations and statements about that model – although this depends very much on the context. In the case of Warhammer 40K, there are many models, which can be used by various factions and sub-factions of the background lore. These factions also have different game rules and gameplay styles, and they are also perceived to say something about the character of the player. In practice, the main way of showing this difference (or allegiance) is by painting a model with the appropriate paint scheme and markings.

Therefore, just like with the assembly and modelling, there are contextual reasons that govern what the ‘correct’ scheme and livery is. Below in Figure 3.16 we see just a small sample of the paint schemes for various sub factions of the game’s most popular faction, the space marines. Furthermore, this can vary and shift with the fictional timeline – this is seen as an incentive for enthusiasts to paint different models according to different epochs of the setting. The schemes also include various liveries, markings and symbols that can also vary within various specialisations and ranks within each sub-faction. This is also considered a challenge for dedicated hobbyists to emulate.

Figure 3.16. A modest portion of the official colour schemes for the ‘Adeptus Astartes’ faction of Warhammer 40,000 – more commonly known as the Space Marines

For many, painting the miniatures is not only the most exciting and creative task, but also the most daunting. The level of skill involved is considerable and it can take years of practice, in order to achieve the best results. Add this skill requirement to the fact that most collections number in the hundreds of models and it becomes apparent why army building projects are affairs that usually last years.

Miniature painting is an involved practice with countless techniques, approaches and attitudes. Outside of the context of wargaming miniatures, miniature painting is already considered an accomplished art form with artists creating miniatures and miniature dioramas as artworks and display pieces. Large online communities such as *Cool Mini or Not* (CCON) [203] are artist-oriented hubs, similar to other communities such as *Flickr* [204], *ArtStation* [205] and *DeviantArt* [206], where creators can upload their work to share with others, and create a personal portfolio. CCON allows miniature painters to upload their work with the rest of the community, who can comment on it and rate it. The artists also share their techniques and other painting tips and procedures.

In the case of wargaming miniatures, there are a few differences when compared to miniature painting. While the miniature models used in tabletop wargaming can be just as detailed and intricate as those which are made as display pieces, there are some key differences. First, a wargaming army is comprised of anything between a handful to a few hundred miniatures. To paint each of these as a display piece, what is known as a 'Display Standard', would be a task beyond the skills of many hobbyists. Such an effort would be the equivalent of many months full-time work, and as such is the provenance of professional painters. Second, many hobbyists are much more interested in the gameplay aspect of the hobby, and adapt their army rosters constantly in order to remain competitive. This means that they are continuously switching up their armies and models, and thus need to have them prepared as fast as possible. Thus, they aim to have their models painted as fast and efficiently as possible, with results that are acceptable to themselves. This is commonly

known as ‘Tabletop Standard” painting, meaning the miniatures look good enough on the tabletop, but are not necessarily of display quality. Many armies often have most of their miniatures painted in such a way, especially the more numerous and similar looking ones, such as normal troops, while their bigger or more special ‘centrepiece’ models, are treated with more attention and have a better-quality build and paintjob. Many players will also use unpainted or part painted models in games, however the vast majority Warhammer tournaments require fully painted models to be used as it is considered a major part of the hobby and part of the event experience is to play with and against fully painted armies.

Painting is therefore a major aspect of the wargaming pastime, but due to the commitment involved, many hobbyists have issues with it. Apart from the gameplay-oriented hobbyists, there are those who feel they lack the time and skill required to complete such a project. Often, hobbyists expressed that they felt self-conscious displaying and using miniatures they had painted as they felt they were ‘not good enough’ to be displayed or seen on the tabletop.

> *“Some of these I painted when I was a teenager. It’s kind of embarrassing to field them. Someday I will repaint them.” – Hobbyist - 19 years’ experience.*

Just as many hobbyists however feel that they develop substantial skills over time as their painting experience grows. These they very often share, together with their results. Detailed journals, blogs and websites exist, maintained by dedicated hobbyists, who share all sorts of information, from paint techniques and procedures to beginner guides and showcases.

YouTube [207] painting tutorials are particularly popular and many painters who share their techniques are finding additional income through crowdfunding and donation platforms such as *Kickstarter* [208] and *Patreon* [209] to support their activities. In the last two years, image-based social media platforms such as Instagram have become particularly popular with miniature painters who share daily updates with their fans, who often number in the thousands.

The task of physically assembling and painting the miniatures that will comprise one's collection is often the most time-consuming and intensive aspect of the hobby. However, it is notable that many hobbyists state this as the most rewarding and creative part of the pastime. Some are interested purely in this aspect and rarely, or never play games.

> *"There is a definite 'I made this' moment when you first put your fully completed army on the table. You don't often get that anywhere else." – Hobbyist - 20 years' experience*

This is particularly exemplified by the various miniature painting competitions. These can be observed as standalone events, or as part of almost all wargaming events. For many hobbyists, participating and winning or 'placing' as a finalist in a painting competition is the most motivating and desirable outcome. Thus, every year there are hundreds of events a painter can submit their work too. One of the most prestigious is the Golden Demon competition [210] that is run by Games Workshop. The competitions have many categories to compete in, including "best single miniatures", such as characters or vehicles, but also "best squad or unit" were multiple models are submitted as a unit, as seen below in Figure 3.17. Also shown are examples of the other categories which are more thematic or attempt to tell a story, such as the "Open" and "Duel" categories.

Figure 3.17. Examples of entries into the Golden Demon painting competition.

Many hobbyists thus toil for months before their chosen wargaming event to prepare their entry, with the outcome often being far more anticipated than

the gameplay, which is often considered more of a 'fun' activity then a competitive one by such hobbyists.

Conversely however, it also very popular for wargamers to commission professional miniature painters and painting studios to paint their armies for them. There are many reasons for this, including the game oriented players mentioned previously, and hobbyists who feel they don't have the time, space, resources or skills to paint their armies the way they wish. Some commission only the centre-piece models of their army which are often larger and more expensive as they are the most visually conspicuous thing on the game table or their display areas and cabinets.

These professionals can charge fees in the thousands of dollars for their services, which include focusing on individual models all the way to the assembly and painting of an entire army. Many companies and individuals offering these services advertise predominantly online with websites containing showcase galleries, as well as maintaining active social media presences. There can be an element of secrecy surrounding this practice as some service providers treat their techniques as valuable commodities.

Some hobbyists consider commissioning an army 'cheating', stating that those who don't paint their own armies are missing out on one of the most important aspects of the pastime. It is especially frowned upon if the professionally painted models are entered into painting competitions without crediting the painter. However, the practice in general is quite popular and is growing continuously.

> *"It's part of the hobby. If you don't paint your own stuff you are missing out on one of the most rewarding bits." – Hobbyist - 17 years' experience*

In general, the activities in the crafting stage are treated as long-term projects and many hobbyists maintain records of their builds. These range from simple written notes and still images all the way to time-lapse and real-time videos. These vary in scope, from the construction of an entire army to a single, particularly customised, model. These are the core content on many online

communities such as *DakkaDakka* [211] which includes a 'Hobby Blog' section that enables users to host a micro-blog for their projects, which also highlights that the crafting aspect is not limited to the models themselves but also extends to the other aspects such as digital additions, photography and narrative.

While a game can be played on a simple flat table, hobbyists go to great lengths to include some sort of terrain for their games and exhibitions. Similarly, to the creation of dioramas, the gaming tables represent scale terrain and other features that provide additional layers of 'meaning' to both the gameplay and the creativity aspects of the pastime.

3.3.2 Getting Competitive – Gameplay for fun or challenge

We saw above that gameplay is a primary aspect of tabletop wargaming pastime, and how often it influences the other aspects and activities of the hobby.

We saw earlier how tabletop wargames are played by using wargaming rulesets and game systems to organised players armies and dictate the possible actions and their outcomes. Hundreds of wargames have been released over the years, with our chosen pick – Warhammer 40,000, being particularly popular with a player base and community that far exceeds its nearest rival. The game systems and rulesets are most commonly released in the form of large rulebooks, often with a single Core rulebook that is followed by other books that have detailed rules for specific armies, as seen below in Figure 3.18 for the case of Warlord Game's *Bolt Action*, a tabletop wargame with a World War 2 Setting that has been created by ex-Game's Workshop designers.

Figure 3.18. A representative wargaming release structure: A core rulebook and several faction books.

The gameplay mechanics and rules, as well as the attitudes and tendencies of the players, have an effect on what models are made, how they are assembled and painted, how they are grouped and used, and also how quickly they become obsolete.

In particular the gameplay is also one of the main motivators for the creation of further narratives, as through the successes or failures of the miniatures 'actions' on the tabletop, spontaneous events and stories are created. These are used for narrative and for competitive purposes and are among the most coveted and shared user-created bits of content – or footprints. In turn, they sometimes have further effects on the miniatures themselves.

In the following subsections, the various key activities and phenomena of wargaming gameplay will be detailed, emphasizing those that hobbyists feel they want to record and share.

3.3.2.1 Drafting an Army List

The first major element of the gameplay is determining which models will be used for a game or gaming event. It is almost the case that, due to game mechanics and practical reasons, players cannot field their entire collection in a single game. Their models must be composed into cohesive and structured armies, following the army composition rules that are a part of practically every tabletop wargaming system or set of rules. The most common elements that

armies are made up of are individual models, such as characters and vehicles; groups of models, such as squads, sections and fireteams; and groups of such individual models and groups of models, which are composed into formations or detachments. Each model or group of models that act 'as on' are most commonly called a **Unit**, so a character, vehicle or a squad would be referred to and treated as a Unit. A very common structure is that of a Platoon, comprised of a leader such as an officer, and several squads of troops. The names and terms used are depended on the game system, which often borrow from the context of their setting, whether real-world historical or fictional.

In the case of Warhammer 40K, the ruleset is currently in its 8th edition and each edition has had slightly altered rules for how players may compose their armies, so the ways in which players organised their models based on the game rules tend to change often. In the current edition players make up their armies using *Detachments*. Each Detachment is made up of a specific composition of Units, with a minimum type of units required in order to make the detachment "legal", in game terms.

As seen below in figure 3.19, the current Warhammer 40K ruleset specifies a number of possible unit combinations, the choice of which can depend on the size of the game that players want to have, or the type of units they want to use or restrict for thematic or competitive reasons.

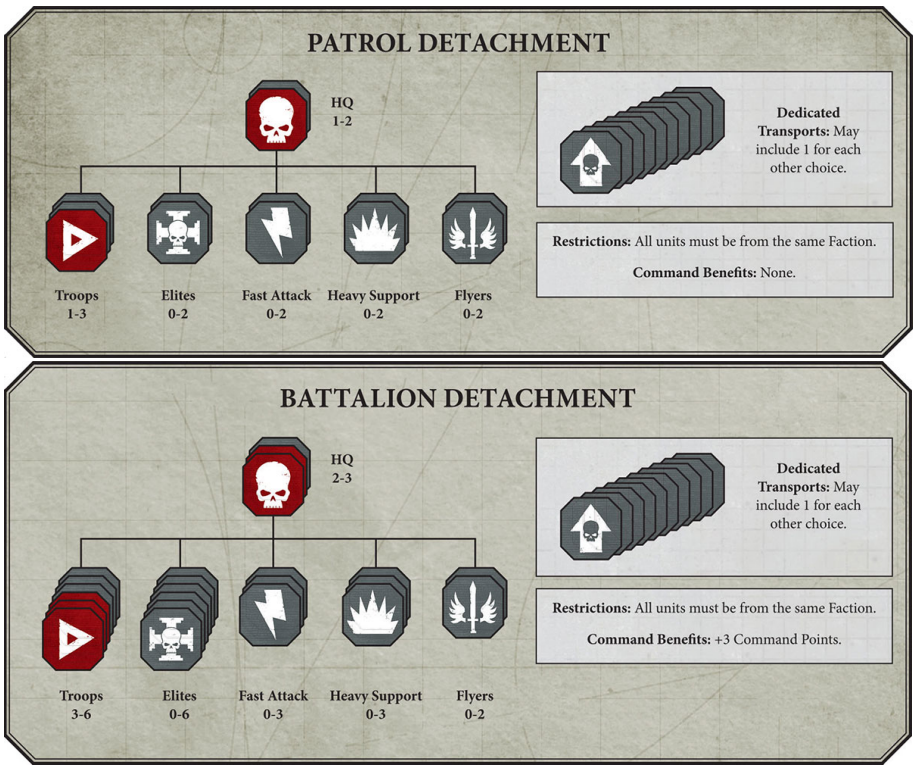
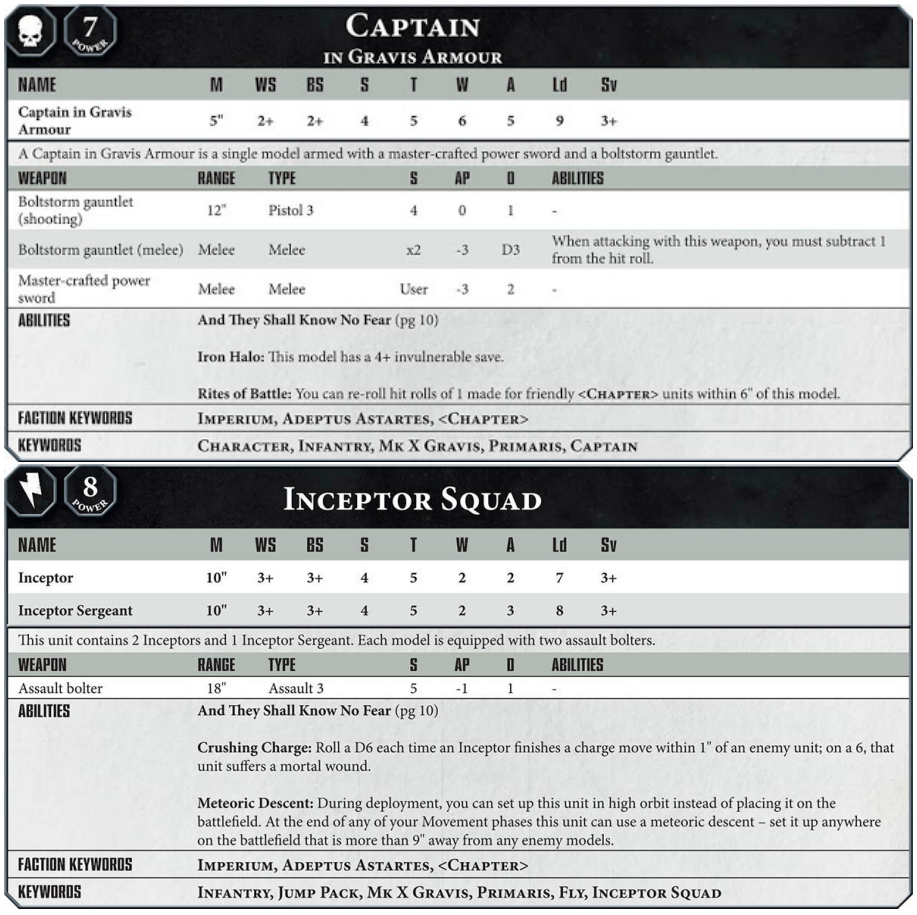


Figure 3.19. Examples of 40k's army building and composition rules

Therefore, before a game, the players consult the rules and prepare their respective armies by creating their Army Roster, which is most commonly referred to as the *Army List*. In practical terms, it is a list of the miniatures, similar to a roster sheet, which a player will use to list the units that their army will be made up of. Note that what the Army Lists contain are Units and not specific models. After the army list is composed players will then 'fill out' each unit they chose by assigning appropriate models to it. The nature and composition of units is again stipulated by the rules, so no all models can be used to represent it. So, a model of an armoured vehicle cannot be used to represent an aircraft unit, or an infantry model with a rifle cannot be used to represent a member of a unit that is supposed to be carrying a missile launcher. Figure 3.20 below shows an example of a unit's rules in Warhammer 40K, which is known as a "Unit Datasheet". The Datasheet contains all the required rules which enable the gameplay and will be detailed further on.



CAPTAIN
IN GRAVIS ARMOUR

7 POWER

NAME	M	WS	BS	S	T	W	A	Ld	Sv
Captain in Gravis Armour	5"	2+	2+	4	5	6	5	9	3+

A Captain in Gravis Armour is a single model armed with a master-crafted power sword and a boltstorm gauntlet.

WEAPON	RANGE	TYPE	S	AP	D	ABILITIES
Boltstorm gauntlet (shooting)	12"	Pistol 3	4	0	1	-
Boltstorm gauntlet (melee)	Melee	Melee	x2	-3	D3	When attacking with this weapon, you must subtract 1 from the hit roll.
Master-crafted power sword	Melee	Melee	User	-3	2	-

ABILITIES

And They Shall Know No Fear (pg 10)

Iron Halo: This model has a 4+ invulnerable save.

Rites of Battle: You can re-roll hit rolls of 1 made for friendly <CHAPTER> units within 6" of this model.

FACTION KEYWORDS: IMPERIUM, ADEPTUS ASTARTES, <CHAPTER>

KEYWORDS: CHARACTER, INFANTRY, MK X GRAVIS, PRIMARIS, CAPTAIN

INCEPTOR SQUAD

8 POWER

NAME	M	WS	BS	S	T	W	A	Ld	Sv
Inceptor	10"	3+	3+	4	5	2	2	7	3+
Inceptor Sergeant	10"	3+	3+	4	5	2	3	8	3+

This unit contains 2 Inceptors and 1 Inceptor Sergeant. Each model is equipped with two assault bolters.

WEAPON	RANGE	TYPE	S	AP	D	ABILITIES
Assault bolter	18"	Assault 3	5	-1	1	-

ABILITIES

And They Shall Know No Fear (pg 10)

Crushing Charge: Roll a D6 each time an Inceptor finishes a charge move within 1" of an enemy unit; on a 6, that unit suffers a mortal wound.

Meteoric Descent: During deployment, you can set up this unit in high orbit instead of placing it on the battlefield. At the end of any of your Movement phases this unit can use a meteoric descent – set it up anywhere on the battlefield that is more than 9" away from any enemy models.

FACTION KEYWORDS: IMPERIUM, ADEPTUS ASTARTES, <CHAPTER>

KEYWORDS: INFANTRY, JUMP PACK, MK X GRAVIS, PRIMARIS, FLY, INCEPTOR SQUAD

Figure 3.20. Examples of Datasheets for a single model unit (Captain), and a multi model unit (Inceptor Squad). Note how the rules stipulate what the models should be equipped with and what kind of unit type they are for the purposes of the detachment.

Physically, the army lists vary substantially. They can be as straightforward as a handwritten list or as elaborate as a digital interactive roster or an entire performance. Traditionally army list building has been done “with pen, paper and rulebook”. However commercial and freeware digital “Army Builders” in the form of desktop, mobile and web based software have become increasingly popular to the point where major wargaming companies have released, or are planning to release, their own in-house Army List applications as seen in Figure 3.21 below.

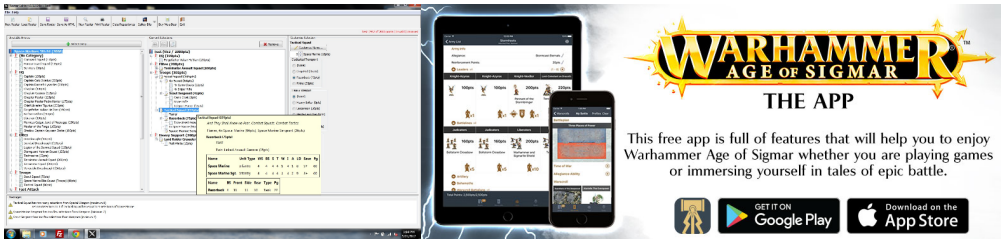


Figure 3.21. Examples of open source and official Army List applications.

For game balance purposes, the construction of an Army List is restricted to the Points' Limit which is used to dictate the size of a game. Each model is assigned a point cost based on its rules. This represents its value in gameplay terms and effectively means that something like a standard trooper might 'cost' a few points while a powerful vehicle or hero character might cost hundreds. Game point limits vary depending on the event. Usually limits are set at about 1500 to 2000 points in games of Warhammer 40K, which amounts to about 50-150 models per player, depending on their army type.

Apart from the above restrictions, players usually create their army lists based on the same two factors that influenced what models they made and how they painted them: competitiveness and theme. A competitive army list is one that is designed to win games, while a thematic or 'fluffy' list is one that describes an army that follows a theme or narrative that appeals to their player, regardless of its effectiveness during gameplay.

> *"I built this army around an airborne theme. Everybody rides in aircraft. It's hit and miss to be honest. Sometimes they all get shot down and I've lost by turn 2. Other times it works and looks fantastic! Either way I have fun." – Hobbyist & Club organiser - 24 years' experience*

Hobbyists, even those who seldom play, consider the act of conceiving armies, tactics and lists very appealing.

> *"It's like a mental exercise. Part of my mind is always working at it. I'll grab a piece of paper and jot down a new list. Then I'll run the numbers and see if it is viable. I play often enough that I can test them within a week or so. Then I post the list on the forum and see what other Imperial Guard players think and update the tactics*

section of the website." – Hobbyist & Tactics blog contributor - 18 years' experience

Numerous approaches and methods exist for creating and capturing army lists, and list construction itself is often the talk of the community with discussions and guides constantly updated and available online. Some players use simple pen and paper to draft and sketch out their lists and battle plans, while others use visual methods such as arranging their available models to build formations to visualise the army composition and capabilities. Over time, players accumulate many army lists and corresponding battle plans and tactics. Many collect them in binders, however nowadays it is increasingly common for these to be created and stored digitally.

The Software tools mentioned earlier have also become popular because of how quickly players can make, share and get feedback on their lists. The applications use crowd-sourced, for legal reasons, codifications of the rulesets as well as the individual unit profiles and costs. This allows players to rapidly compose lists with immediate feedback on the list validity and automatic calculation of the point costs. The tools support exporting conveniently structured lists that are suitable for printing and quick referencing. Following a tournament, the lists that performed best are analysed by community articles and reviews with debates and trends carrying on for months and in some cases years. During tournaments, there are sometimes awards for the most creative presentations of army lists. Award winners range from stylised lists all the way to elaborate performances, including props and media.

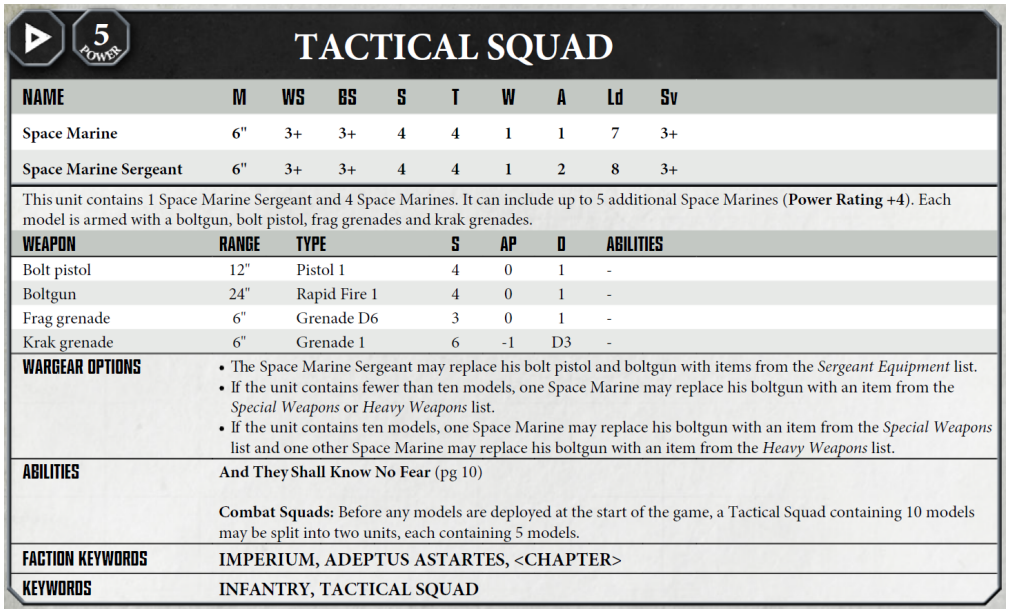
While Army Lists are a major part of tabletop wargaming, they are an especially important element in how individual miniature models are perceived and treated by their owners, and how their record comes into being. When a player creates an army list, and assigns a model to a particular unit, he is in effect endowing that miniature model with an identity or role and a set of capabilities within the game rules. From that point, onwards they have a gameplay purpose and use and effectively transcend from being an inanimate object, into a thing of importance and a relatively degree of agency, as we shall see further on in

the gameplays sub-section below. Army lists are the bridging point between the crafting of a miniature model, and its gameplay use.

3.3.3 Little Wars - Playing a game

The following section gives a short overview of the actual gameplay mechanics used in Warhammer 40K, which are quire representative of the majority of tabletop wargames. This will provide an understanding of how gameplay creates emergent narratives and stories that are often spontaneous and beyond the control or expectations of the players, which makes their recording and sharing a particular prevalent practice.

The primary mechanic for the game is dice rolling. The success or failure of the actions a commanding player attempts to make with his army's units during the game are stipulated by whether he rolled above or below a minimum number of a six-sided die. For example, in order to test whether a model managed to successfully hit a target it was aiming at, the player would need to roll a number of dice equal to the number of shots the unit made. Each die that rolls above the required number, for example, above a 3 (denoted as a 3+) is a successful roll, or a successful hit in this case. What the required dice roll is can be influenced by many factors during gameplay, but the base number is listed in each unit's datasheet. These datasheets list numerous unit characteristics and capabilities, as seen below in Figure 3.22 with the example of a Tactical Squad of Marines.



TACTICAL SQUAD

5 POWER

NAME	M	WS	BS	S	T	W	A	Ld	Sv
Space Marine	6"	3+	3+	4	4	1	1	7	3+
Space Marine Sergeant	6"	3+	3+	4	4	1	2	8	3+

This unit contains 1 Space Marine Sergeant and 4 Space Marines. It can include up to 5 additional Space Marines (**Power Rating +4**). Each model is armed with a boltgun, bolt pistol, frag grenades and krak grenades.

WEAPON	RANGE	TYPE	S	AP	D	ABILITIES
Bolt pistol	12"	Pistol 1	4	0	1	-
Boltgun	24"	Rapid Fire 1	4	0	1	-
Frag grenade	6"	Grenade D6	3	0	1	-
Krak grenade	6"	Grenade 1	6	-1	D3	-

WARGEAR OPTIONS

- The Space Marine Sergeant may replace his bolt pistol and boltgun with items from the *Sergeant Equipment* list.
- If the unit contains fewer than ten models, one Space Marine may replace his boltgun with an item from the *Special Weapons* or *Heavy Weapons* list.
- If the unit contains ten models, one Space Marine may replace his boltgun with an item from the *Special Weapons* list and one other Space Marine may replace his boltgun with an item from the *Heavy Weapons* list.

ABILITIES

And They Shall Know No Fear (pg 10)

Combat Squads: Before any models are deployed at the start of the game, a Tactical Squad containing 10 models may be split into two units, each containing 5 models.

FACTION KEYWORDS IMPERIUM, ADEPTUS ASTARTES, <CHAPTER>

KEYWORDS INFANTRY, TACTICAL SQUAD

Figure 3.22. Example of the data sheet for a tactical squad of space marine, one of the most common units in Warhammer 40K.

Their characteristics can include how far they can move (M), the roll needed to hit a target in close and ranged combat (WS and BS), and other characteristics such as Strength, Toughness and Leadership. All units also have a save roll (Sv) which lists the number that needs to be rolled on a six-sided die in order for a model in the unit to avoid being wounded. The datasheets also list the composition options for the units, including model types, quantities and their possible equipment options, which further modify their capabilities.

In terms of game mechanics, Warhammer 40K is a turn based game with an “I go, You go” turn sequence, where each turn is broken up into distinct phases. In the current edition of 40K each turn is broken up into the Movement Phase where the current player can elect to move their units. Each unit can move up to a specified distance, which is stipulated by its type, such as infantry or vehicle and is measured in inches, which the player measures with a ruler or tape measure. This is then followed by the Shooting Phase, where the same player nominates what target each of his units will shoot at – if able – and performs a sequence of dice rolls to successively see whether the unit hit and then wounded its target as was described previously. At this point the other player can make a counter-roll, known as a ‘Save roll’, in order to try and avoid taking

casualties. Next is the Charge Phase, were the current player can attempt to charge his units into close combat by moving them into close proximity to the opponent's units. The success or failure of these attempts are again dictated by dice roll – a 'Charge' rolls in this case where the player needs to roll the equal to or above the distance between the units on a set number of dice. If he succeeds the unit makes the charge, if he does not the unit has failed. Therefore, there is a constant element of risk and reward to the gameplay. The two final phases, the Combat and Morale phases, are where the players resolve any close combat due to successful charges – again with the relevant dice rolls – and also make the relevant dice rolls for the game's morale mechanic, which can cause depleted units to flee the battlefield.

During the course of a game, the miniatures, will traverse the tabletop battlefield, interacting between themselves and other game elements such as objectives, terrain, buildings and of course the opponent's army. The prevalence of dice rolls does introduce an element of randomness to the game, which the players attempt to constantly mitigate by making choices about the placement and synergy of their armies, therefore minimising where possible the negative outcomes of each action. As with most games involving both skill and luck, there are emergent situations which serve to engage and engross players and observers in the moment. The semi-random flow of the game constantly generates situations that were unanticipated by the players. Events take place, in and out of context and situations are created in which the control of the player is limited. They can decide the movement and attempted actions of the miniatures, but the outcome is determined by chance with the dice.

> *"I was about to lose but in the last turn my scouts really came through. In cinematic move they dove in, captured the last objective, and survived the inevitable counterattack! That got me up to second place in the tournament!" – Hobbyist – 9 years' experience*

Throughout a battle, the success or failure of actions are attributed to the miniatures, often leading the players to express their feelings towards them

and assign them a measure of character which then directly affects their relationship with the model – and subsequent use.

> *"I really love the look of this model. I spent ages getting it just right. But he is terrible on the table. Either he dies in turn 1 without taking a shot or just misses everything. To this day he had maybe two kills. He mostly gathers dust on the shelf nowadays." – Hobbyist – 25 years' experience*

Players and event organisers are aware of the capacity of miniature wargaming to create such provenance, thus this is both used and celebrated. During many events, the acts of miniatures during gameplay, and the corresponding stories, are captured, recounted and awarded. For example, in official Games Workshop tournaments, the 'Most Heroic Action' award is given to the miniature - not the owner - that accomplished the most heroic deed during a game. Another example are narrative campaigns, which are a very common type of wargaming event. These are effectively series of games, set within a contextual theme, where the outcomes and events of each battle are used to determine the course of the campaign, similar to a league table but focused on the storytelling aspects.

3.3.3.1 Post Mortem – Creating and Sharing Battle Reports

As highlighted above, during gameplay many contextual events take place that are completely unexpected by the players and make the basis for exciting narratives and popular stories. Thus, recording the events and progression of a battle is very popular practice among hobbyists and the results of this are known collectively as *Battle Reporting*.

Battle Reports take many forms. At their simplest, they are brief descriptions of a played game, either turn by turn or just the highlights. Some players write up their battle reports into detailed "After Action" reports, complete with images and schematics that illustrate the unit positions at various points in the game. Some of the Reports are written in a thematic narrative style, or even from the point of view of one or more of the characters or units who took part in the battle. Photo diary type battle reports are also quite popular, with

players using image slideshows with descriptive captions for each image. These are often favoured as there is less writing required. A less prevalent method is using software to recreate the battles step-by-step. This method is not very common as there are no real specialised tools available, and the only one that comes close is actually an application, named *Vassal* [212], that was originally made to allow players to simulate tabletop wargames for online play. Similar to online chess games, it uses highly abstracted graphics and has no native rules validation. Examples of various battle reports can be seen below in figure 3.23.

Figure 3.23. (Left) A printed battle report in a wargaming magazine.
(Right) A Turn-by-Turn Illustrated Battle Report created in the Vassal engine.

One of the more popular forms of Battle Reporting is using video. Many players and groups of players record their games and upload the video, either as-is or with some post-production editing to social media and video sharing websites. Similarly, to live video game streaming, the practices has grown tremendously in recent years, with many companies being formed with the purpose of producing Battle Report videos. Apart from Battle Reports, these individual hobbyists and companies also make videos about tactics, painting tutorials, product reviews and similar content. Various business models exist to support these activities, including advertising, merchandising, subscriptions and donations.

Figure 3.24. Typical narrated video battle report. (Source Miniwargaming).

Whatever the method used to make them, Battle Reports are tremendously popular in the community and are shared on blogs, forums, social media sites and magazines. They are used to tell stories that are created for and from the games and to sharethe many exciting and unexpected moments that have occurred. In addition, players use them to learn how particular factions and armies perform and to inform their own tactics and army lists.

As for motivations, some players state that they wish to do so for purely competitive reasons, many desire the information simply to support reminiscence. Often, players will maintain records on an army level, detailing its performance as a whole. However, the most common case is when battle reports are used to demonstrate the game performance and tactics of an army list. And the reports are also often used to recount the accomplishments and performance of an individual miniature.

> *"Stats tracking is big in everything, not just in video games and sports. I've considered recording everything each mini does, but it slows the game down too much. I only do it for characters and units." – Hobbyist on tracking gameplay*

> *"I'd love to show off my armies' accomplishments: Win/Loss ratio, Kills/Deaths per mini - you name it. Not just for bragging rights, but*

also to know the effectiveness of my lists and tactics." Hobbyist on tracking gameplay.

The sharing and retelling of Battle Reports were some of the most explicit examples of hobbyist's noting and describing the provenances and histories of individual miniatures and thus generating a distinct record of their very own that is made up of footprints such as the textual accounts and the images and videos. When asked, many of the hobbyists would inadvertently begin reminiscing about specific instances and occurrences of miniatures that performed inexpertly, thus making them stand out noteworthy miniatures from their collections.

3.3.4 Display and Curation

When not used in gameplay, the miniature models are most often found either in storage, or on display, and the methods used for either of these states vary greatly depending on the environmental circumstances, but also how the hobbyists perceive and treat their miniatures, and how they display and curate their collections. It is also common to display models in thematic setups, known as display boards, which will be detailed further below.

Most often, when space and budget allows, dedicated setups are created, with shelving and cabinets to protect and display the models. Their nature varies and depends on many factors, mostly with regards to the living circumstances. Some simply have a shelf in their bedroom, some have glass cabinets as seen in Figure 3.25 below. Others have dedicated hobby spaces, colloquially referred to as 'man-caves' or 'war-rooms'. These are usually spare rooms, lofts, basements and garages where hobbyists set up their workshops, gaming spaces and displays as seen in figure below.

Figure 3.25. Examples of home Hobby areas with crafting, gaming and display spaces.

Space limitations and other factors dictate that hobbyists also often have the bulk of their collections stored in purpose built cases. These are often the same cases that they use to transport armies to and from games and events. They usually take the form of boxes with a hard-outer shell, made out of hard plastic or heavy-duty cardboard, which inside have many layers of foam inserts that have cut-outs to accommodate the models. These are often custom cut to house specific models as seen in Figure 3.26 below. Some cases also use magnets to keep models immobile. Many hobbyists also make their own cases, which in some case are also themed, or use unusual containers, such as custom carved wooden boxes, or old metal ammunition containers.

Figure 3.26. Commercial Hard and Soft type carry cases.

The permanent displays, whether shelves, tables or cabinets are designed to protect and present the models. Quite often they have spotlights and

sometimes thematic lighting, such as coloured lighting and specifically placed light sources, such as within models of vehicles and buildings.

> *"To my wife's distress I have my collection in large glass IKEA cabinets in the living room. One for each army." – Hobbyist on displaying models.*

There are many occasions, when the models are on public display. For example, during a competition, or an exhibition or when they are on loan to a gaming club for display in their dedicated exhibits. In most cases, the models are accompanied by some information about themselves, usually in the form of a stand or plaque with a short text description of what they are, who they represent, how they were made, any awards or notable features, etc. and pertinently they also often feature short stories and descriptions of the miniature's character and exploits 'on the battlefield' describing memorable highlights and events, such as the example below in Figure 3.27.

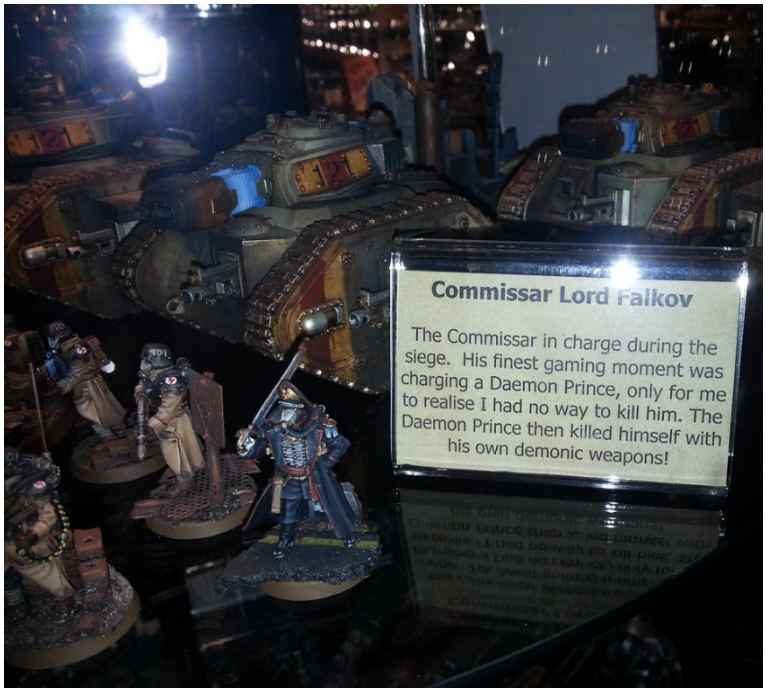


Figure 3.27. Guest exhibit hosted for a time at Warhammer World. The sigh shares a snippet of the miniature's (or the characters) Record.

A very important aspect of displays are the aforementioned display boards. These are in effect dioramas that are designed and made by the hobbyists to

present their entire armies in a thematic way. They are most often made for permanent display and for participation in painting competitions. In practice, they are usually dioramas set on a 2 by 2-foot square board, with scenery and terrain that has been modelled in such a way so as to be able to fit a player's army. While the display boards are very similar to the highly detailed dioramas that scale modelers make, there is a key difference which is that the models are removable and usually just placed on the diorama.

Figure 3.28. Examples of static dioramas created for permanent display purposes.

This is because the models are used in gameplay, rather than being just display piece such as those shown in above in Figure 3.28. The images below in figure 3.29 show various examples of display boards, some of which also include additional items such as information booklets about the creation of the display board, the army on display and the story of the scene that is being depicted.

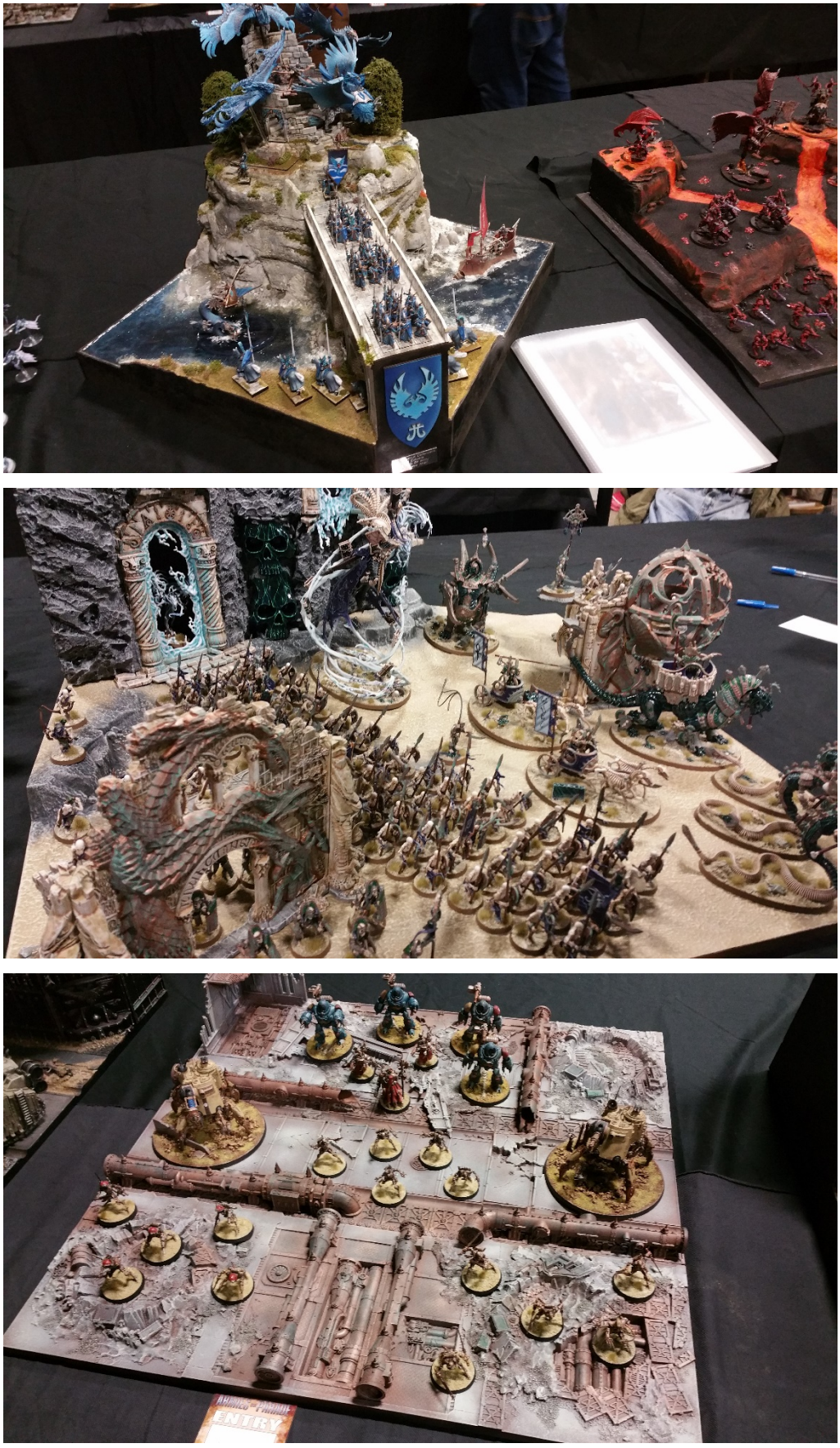


Figure 3.29. Examples of thematic Army Display Boards being judged during a gaming event.

3.3.5 Ownership and Trading

In terms of ownership and permanence, the miniatures are treated by their owners as valuable items and with no obvious 'end-of-life' point. Indeed, there were no indications of a miniature ever being willingly discarded.

However, this is not to say that miniatures never change hands. In fact, there is a thriving trade for models on many trading organisations such as eBay and Amazon Marketplace, as well as more ad-hoc examples such as Facebook groups. Sellers usually cited a financial need as their reason for selling, or sometimes changing life circumstances that rendered ownership unfeasible.

In most cases where miniatures were sold accompanied by information regarding their creation and use. Some were advertised with explanations of their construction, especially in the case of heavily modified or customised models. In some cases, collections were sold with information about their deeds, either from battle 'on the tabletop' or in modelling competitions. It must be said that wargaming models command high values in second-hand markets, and the examples that came with some measure of provenance information typically sold for many times their original retail price.

Additionally, there was much evidence of collections being kept in families and passed on to younger generations. Many cases emerged of multiple members of a single family maintaining their own collections, which they used and displayed both individually and collectively. In fact, it was very common to observe fathers with their sons and daughters browsing they exhibition halls and planning the family collection.

Finally, as miniatures change hands, they also transition to different uses. Examples were observed where models that were used only for display purposes were sold to hobbyists who swiftly incorporated them into their active armies. Such 'rescuing' of miniatures was often quoted as an engaging 'archaeological' activity. Many interviews described the thrill of discovering an old miniature that they would then restore to the tabletop.

3.4 Conclusions

The ethnographic approach led to a well-rounded understanding of the wargaming pasttime. In particular, the fieldwork gave first-hand insights into how wargaming hobbyists go about the multitude of activities that make up the various practices, while providing an insider's understanding of the background context, that was revealed to be a critical instigator of the storytelling aspects that are pertinent to the core idea of objects with rich histories.

In summary, we saw how the major aspects of the pastime, crafting and gameplay, both create footprints of data and information that hobbyists strive to collect and share in ways that are valued and meaningful to themselves and the rest of the community. Crafting information such as tutorials, paint schemes and conversion guides are recorded just as much as post-game battle reports, tales of heroism and failure. Both the above cases are underpinned by narratives that are couched in the surrounding fictional universe of Warhammer 40K – or the equivalent historical or fictional universe in other tabletop wargames. These narratives, whether about individual characters, units or entire armies and factions, are central motivators for how hobbyists go about crafting their miniatures, and how they use them in gameplay. And they are themselves core footprints in the records that the hobbyists keep.

We also saw how various instances of digital technology have established themselves in most of the everyday activities of tabletop wargaming. The internet is key for sharing and discussing all the above recorded information, and tools, such as army list building apps have become widely accepted.

Critically, it very quickly emerged that the common denominator, or building block, of the wargaming, storytelling and record-keeping activities were not always the physical miniature models themselves. It was much more often the case that the central elements around which records were kept and stories were told were groups of models, such as units, squads and armies. To further complicate this picture, it became apparent that the subject of most records and storytelling were abstract entities or identities, such as characters or the

fictional factions that the miniatures 'belonged' to. The miniatures themselves often seem to 'fluidly' take on the identity of characters, or be associated with different units, armies and factions for limited periods of time, such as for single games or events. These early findings created a much more complex picture than the ones inspired by conventional IoT, where the common denominator would be the individual miniature models.

Motivated by the findings, the next step in the research process was to take a much closer look at some of the more telling examples and instances that were revealed during the ethnography, and to elicit new responses and opinions from seasoned hobbyists on the potential effects of new technologies that would support their existing record keeping and sharing practices. The next chapter details the findings of a series of focus groups conducted with experienced hobbyists, who offered deep insights into the questions raised by the ethnography and provided feedback on a number of technology probes that were developed to demonstrate novel technological support.

4 Focused investigation with Technology Probes

4.1 Introduction

As was concluded in the previous chapter, the ethnographic work granted a deeper understanding and insight into the practices of wargaming and validated the initial presumptions about the value that the hobbyists placed on capturing records of their activities and sharing them with the community. However, it also revealed how these records – and the corresponding narratives and storytelling – were structured. In practice, it was the case that they were not commonly based around individual miniature models, which are assumed to be the focal points of all wargaming activities. Instead it was shown that narratives revolved around groups of miniatures, or even abstract entities such as characters, organisations, or more accurately: Identities.

This challenged the conventional IoT approach of focusing on the physical objects that are involved in a practice. While individual miniatures could be technologically augmented, it began to appear as if such an approach would be both insufficient and undesirable by the community. It became apparent that a shift in perspective was necessary, in order to consider the ways by which hobbyists considered things collectively, either in the forms of groups of physical objects, or by treating them by some collective identity. Furthermore, the prevalence of abstract things, such as characters and organisations with distinct Identities kept coming to the fore as the way most hobbyists talked about and structured their narratives about their miniature collections and their gameplay exploits.

Coupled with the original objective of examining how technology could support and expand the existing record-keeping activities of the wargaming community, an approach was formulated that would take into account the initial findings and attempt to establish a clearer picture of what had become a much more complex situation.

First, a set of Technology Probes were designed and developed, informed by the findings so far. Following Hutchinson et al. [77], a technology probe is "an instrument that is deployed to find out about the unknown – returning with useful or interesting data". It should balance three goals: inspiring reflection on emerging technologies; appreciating needs and desires; and field-testing. Four interlinked probes were developed.

Then, a series of workshops were conducted with experienced hobbyists who were invited to share and discuss their thoughts on their wargaming activities and to engage with the technology probes and challenge their design and approach. We sought to engage the practitioners as critical thinkers and attain a more holistic understanding of their activities.

Furthermore, the groups were introduced to the early findings and were encouraged to consider and discuss how they saw the situation, and how they handled and structured their narratives. Through their discussions and debates, they shared their thoughts and opinions on what they felt were the actually pertinent aspects and elements of the practice to support, and which technological approaches would potentially be acceptable. Finally, the focus groups provided a number of detailed insights into the practices that were first seen the ethnography, that cultivated in the creation of a set of case studies, or vignettes, which illustrate some of the most characteristic instances of how hobbyists actually structure their records and narratives around objects, groups of objects and abstract identities, and how these fluidly changed over time. These vignettes helped form the basis of the eventual framework, and will be referred from this chapter onwards.

In the following subsections, we will first detail the design and functionality of the technology probes. This will then be followed by a detailed description of the workshop process and participants. The findings will then be presented, in particular with the introduction of the three case study vignettes.

4.2 Technology Probes

At this point in the research a number of potential technologies, primarily inspired by the IoT, had been considered for the creation of tools and platforms that would support and expand the existing record keeping practices found in miniature wargaming communities, and could potentially enable new methods and forms of expression. Specifically, there were two main avenues to pursue: technologies for capturing footprints that could be added to a record, and technologies to presenting, curating and browsing records.

To investigate the effects of these technologies, and to elicit reactions from the community, a flexible technology probe approach was chosen as it would also help further understand the initial findings of the ethnography by aiding reflection by the hobbyists and guiding further design. The probes served both as demonstrators and enablers of typical IoT functionality, and also an expandable 'toolbox' to capture practice activities and evoke inspiration. Their nature was chosen to cover areas of the practice identified by the ethnography both as important to the practitioners as the ones that could elucidate different aspects of the research challenges. They were deliberately kept functionally simple, so that their design and implementation would not unduly influence the participants, but rather encourage them to experiment.

The following sub-section detail the four main technology probes.

4.2.1 Tagging Probe

The first technology focused on providing one of the cornerstones of basic IoT functionality [85], the capability to uniquely identify individual objects, in this case individual miniatures. The premise here being the same as with most IoT applications in that each object in the 'network' must be uniquely addressable in some way. Unique identification was also seen as important for hobbyists, who sometimes individualised models that they deemed to be important in order to make them stand out. This was usually done at the modelling and painting stage by modelling them more elaborately, and adorning them with markings and painting them at a higher standard.

To this end, a number of approaches were considered, including RFID and Computer Vision based identification. The small size of most of the miniatures –approximately 3 centimetres tall – combined with their visual complexity favoured the former approach. In particular, the computer vision approach proved problematic, as despite every miniature being practically unique due to the variances in assembly and painting, the differences can be indistinguishable between some models. Especially on the smaller models that are used in large numbers, such as basic troops that make up the bulk of most armies, as seen in Figure 4.1 below which can lead to false positives.

Figure 4.1. Two extremes of identification challenges that a vision based system would have to overcome. Several similar looking objects with complex geometries and textures susceptible to lighting.

Therefore, the former RFID approach was pursued. Tests were conducted using Bluetooth Low Energy (BLE) [60] and Near Field Communication (NFC) technologies [142], however the latter was chosen for its advantages in low cost and maintenance. BLE technology has many capabilities beyond unique identifications and would enable proximity interactions and potentially some basic positioning through its signal-strength based range finding. However, BLE tags are active and thus require a power source, which necessitates regular maintenance and unsustainable long-term upkeep. NFC tags are passive and while they have a much-reduced range they require no additional maintenance and are far more robust. Examples of both tags can be seen below in Figure 4.2.

Figure 4.2. Examples of readily available commercial BLE disk beacons and NFC sticker tags.

The NFC tags are unobtrusive, being effectually flat, and in the chosen round sticker form, could easily be attached to the miniatures. As for the location of the tags, it was initially determined that they should be installed on the bottom of the model bases which commonly are circular plastic or resin disks with diameters ranging from 25 to 100mm. Larger models, such as vehicles do not usually have such bases, however their size and construction allows for many possible ways to attach a tag.

The tags were distributed to the focus group participants to use and experiment with. For the purposes of the technology probe, each tag held the unique ID for the model in the form of an alphanumeric identifier. The bases, seen in Figure 4.3, acted also as interaction enablers by linking digital content to the individual miniatures.

Figure 4.3. The tagged model base probes using NFC stickers.

When scanned with an NFC reader, such as those found on mobile phones the tags would forward the user to the information page for that miniature on the Web Portal Probe shown in the next sub-section. Importantly, the tags were also used to trigger and facilitate interactions with other technology probes such as the photo booth, discussed further on.

4.2.2 Web Portal Probe

The second technology probe focused on the management, curation and conventional presentation of record content. Specifically, it consisted of a bespoke interface which was the front-end for a database of record footprints, such as text, images and video. Each footprint could be tagged with the unique identifier of the miniature that it pertained to. Through the font-end interface the users could upload or author new content and they could curate the record and share it with others.

The initial prototype was web-based in the form of an online content management system portal. It was decided to use a WordPress powered site based on a number of factors such as the prevalence of blog-type websites maintained by the community; its relative ease of use for non-technical users; and its extensibility.

Multiple versions were trialled, with the key differences being the ontology of the content. Specifically, custom ‘post types’ were considered to match up to the various so far identified elements of importance in miniature wargaming, such as armies, characters, units and the models themselves. As will be discussed further on, these attempts quickly highlighted the shortcomings of generic content management systems to handle the various topics that a specific community may be interested in.

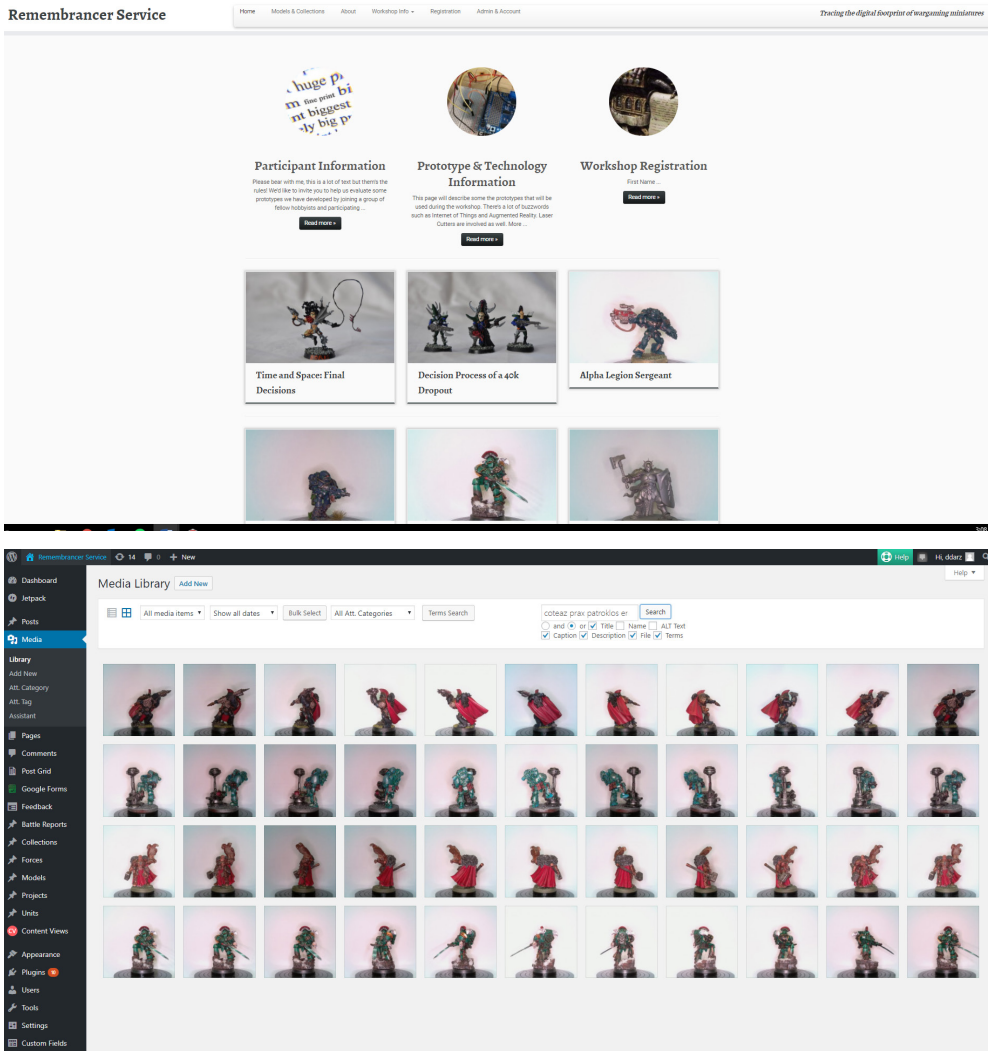


Figure 4.4. The Frontend and Backend of the web portal.

The portal, seen in Figure 4.4, and available to view online [213], offered each user the ability to upload and maintain content about their miniatures and could serve as the hub and testbed for the management and sharing of content. It also served as a platform for the participants to log and express their insights and reflections through blog post and journals. Any of these Footprints of content could be tagged with the corresponding identifier of one or more of the miniature's unique identifies.

4.2.3 Photo-booth Probe

The third technology probe focused on supporting the capturing of footprint content for a record, specifically from the crafting activities of the wargaming hobby. The ability to visually capture the crafting process in detail was one of the most highly cited requests in this and similar crafting contexts [39,113–115]. During the ethnographical fieldwork, this community desire was constantly observed, as were various elaborate and novel techniques used by hobbyists to capture their process, including photoblogs and multi-camera videos.

But while these visual footprints of a miniatures craft record are a popular and highly anticipated part of community outputs such as hobby blogs and guides, the difficulties in doing so efficiently are quoted as substantial. Studies and the fieldwork [21,22,39,67] showed that taking pictures in situ is considerably difficult: practitioners often lack the requisite equipment, space; and/or knowledge to capture high quality images. And video, which often requires copious editing, is only consistently provided by professional hobby content makers, such as the subscription-based YouTube channels mentioned in chapter 3. Especially during miniature crafting, capturing even a single image disrupts the hobbyists' crafting process – they have to put away brushes, close paint bottles, prepare a camera, lighting, etc. Thus, they either go to some length to set up a dedicated space and equipment or only capture occasional images, thus eschewing parts of the process from the record.

Leveraging capabilities enabled by the use of unique NFC tags that were detailed above, a 'Photo Booth'-like imaging device was developed that would automatically capture tagged images of miniature models. Illustrated in Figure 4.5 below, the booth used a modular layout and could be rearranged and reconfigured by users if required. In practice, the photo booth could automatically create high quality 360 image of a single miniature, just by placing the model on the rotating pedestal. This meant that a hobbyist could capture every step of the crafting process by placing their model in the booth, waiting a few seconds for the process to complete, and then continuing. The images would be captured with even and consistent lighting and would be

tagged with the miniatures' unique identified and uploaded straight to the web portal.

Technically the photobooth probe was considerably, and understandably more involved than the previous probes. The design was based around a Raspberry Pi 2 computer [214] that controlled an integrated Pi camera module which was used to capture the images. The Pi was controlled by an Arduino Uno microcontroller [215] over a serial connection. The microcontroller in turn controlled the assembly consisting of a stepper motor, an NFC reader and a programmable LED lighting circle strip. The stepper motor was fitted with a small pedestal which would rotate. Under the pedestal was the NFC reader, so that when a NFC tag or NFC tagged object, such as a tag-probe equipped miniature, was placed in the centre of the pedestal it would be in read range of the NFC reader. Main control was in the form of a Python script running on the Pi 2 computer which upon receipt of a Read signal would enable the lighting, start the stepper motor rotation at the specified speed and steps, and then start the synchronised capture of images through the camera.

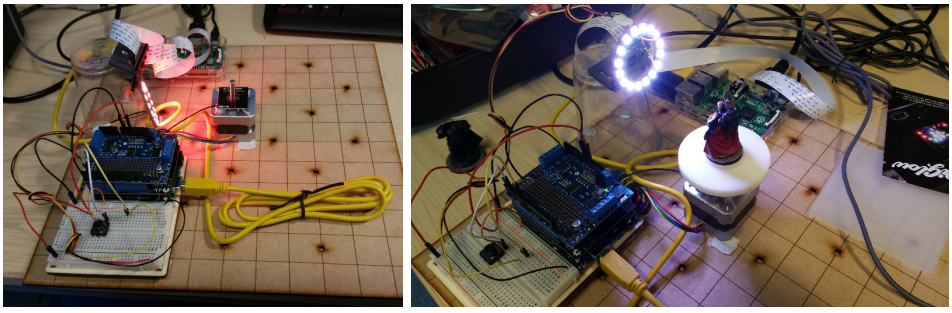


Figure 4.5. First open-plan Prototype of the Photobooth. Shown is the rotating pedestal, the lighting setup and the Pi and Arduino controllers.

Therefore, the booth would begin capturing a sequence of images as soon as a miniature with a tagged base was placed on the rotating pedestal and identified by the reader. The captured images' metadata would be appended with the ID of the miniature from the tag which would be read by the Arduino connected NFC reader and sent over serial to the Pi 2, and then the image set, consisting

usually of 36 images – one for every 10-degree rotation – would be automatically uploaded to the media library of the web portal which corresponded to the correct user and model.

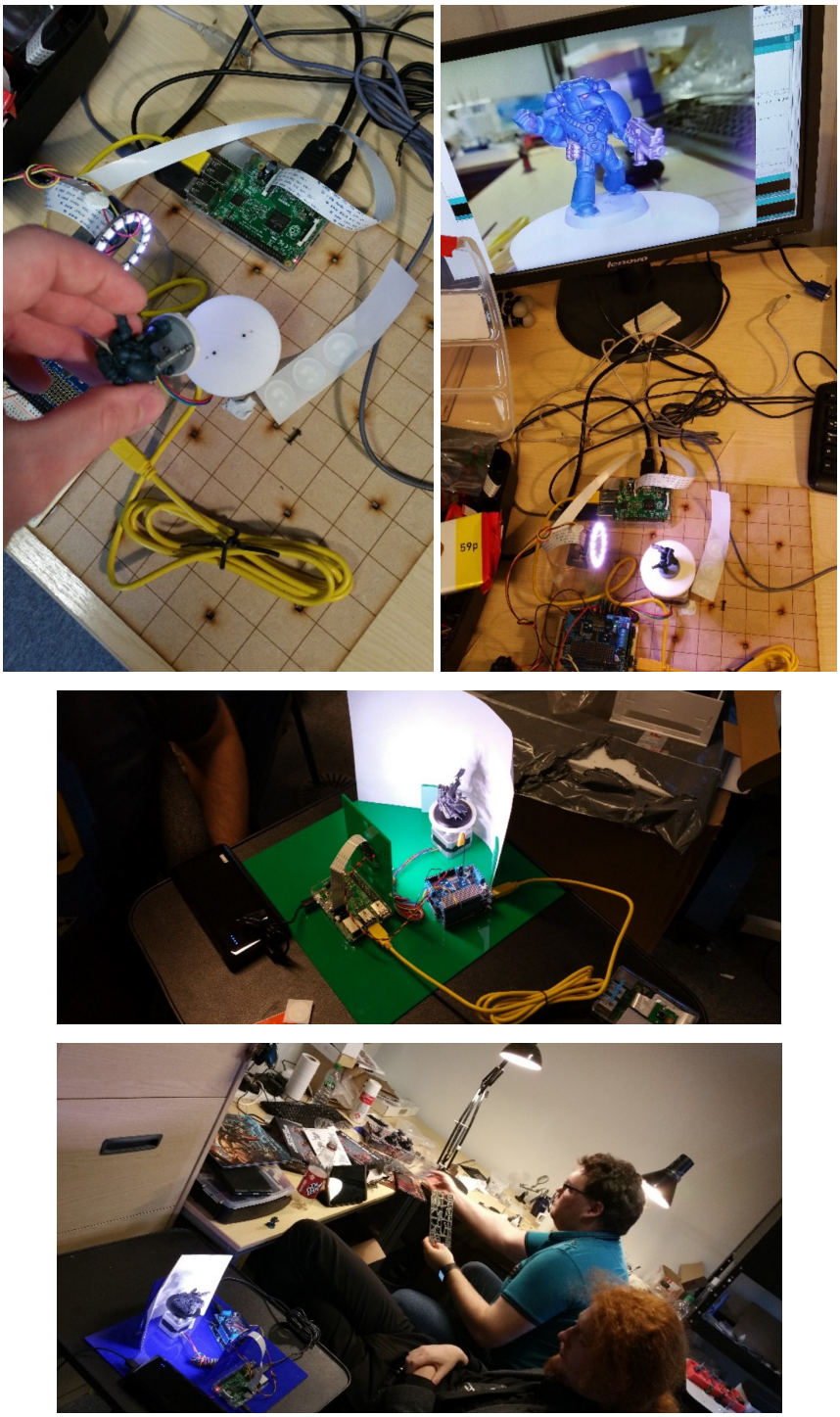


Figure 4.6. The Photobooth in action and in use by pariticpants. In total 3 functioning instances of the Photobooth were created.

4.2.4 The Gameplay Record capture 'Toolbox'

With regard to gameplay, the fourth set of probe designs were deployed more as a toolbox of varied technologies and methods, rather than working prototypes of devices, such as the photo booth. This was because the gameplay stage is quite complex, encompassing many activities that generate large amounts of rich and varied record-worthy content, which is however also highly contextual and highly subjective and dependent on the preferences of the individual wargamer.

As we saw in chapter 3, these include qualitative information such as emergent stories, anecdotal accounts, strategies and tactics, and quantitative data such as dice rolls and gameplay mechanic statistics. Competitive minded wargamers focus more on the performance-related data, while narrative wargamers focus on thematic information. The community captures, curates and shares this content, in the form of diverse outputs such as battle reports; tactics discussions; crowdsourced wiki-like reference repositories; and even thematic physical displays.

To examine the possible technological support of these gameplay recording activities, a space was made available in the lab set up as a modular sandbox gameplay environment. This space enabled the testing of a variety of approaches, both for capturing and for curating record content. The participants could set up gameplay scenarios, simulating the conditions and activities that would take place during normal wargaming while experimenting with the probes. The conditions aimed to represent a variety of possible gameplay situations to take into account various minutiae from the gameplay activities. These included aspects such as how gaming accessories were arranged, how and where dice were rolled, what players would be doing during their opponent's game turn and even how armies of models were transported to and from the 'games'. This approach was aimed at uncovering opportunities that might not have been otherwise considered.

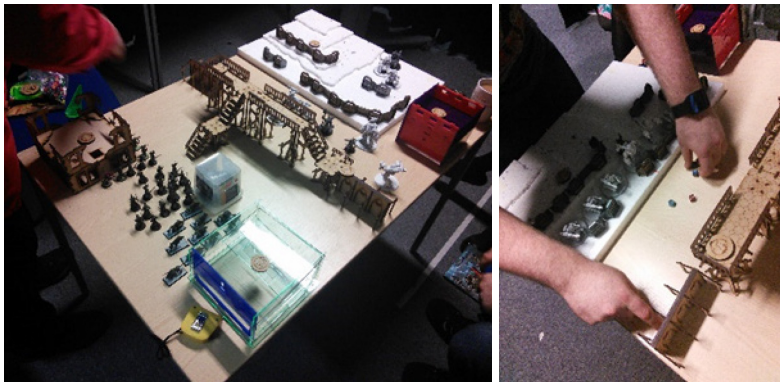


Figure 4.7. Examples of the participants engaging in gameplay in the lab while using the probes.

The 'Capture toolbox' probe contained collection of other technologies including digital tools such as 'Smart Tape measures'; and Augmented Reality (AR) and Virtual Reality (VR) technologies for content presentation and gameplay augmentation. Furthermore, since large amounts of visual content is normal in these practices, a large assortment of image and video capture devices such as wide-angle cameras, head mounted and wearable cameras Google Glass and "Autographer" type life blogging cameras were also provided in the toolbox. The devices could be set up around the space or embedded with the game table as part of the themed scenery, or held directly by the participants. Furthermore, the participants were encouraged to bring and use whatever tools and techniques they usually employed at their usual games.

Finally, art materials were also provided as well as whiteboards which were used to record thoughts and information 'in the moment' for later discussion and reflection. This in particular was illuminating as even short games ended up creating many pages worth of recorded footprint data per player, which included everything from dice rolls to tactics decision processes.

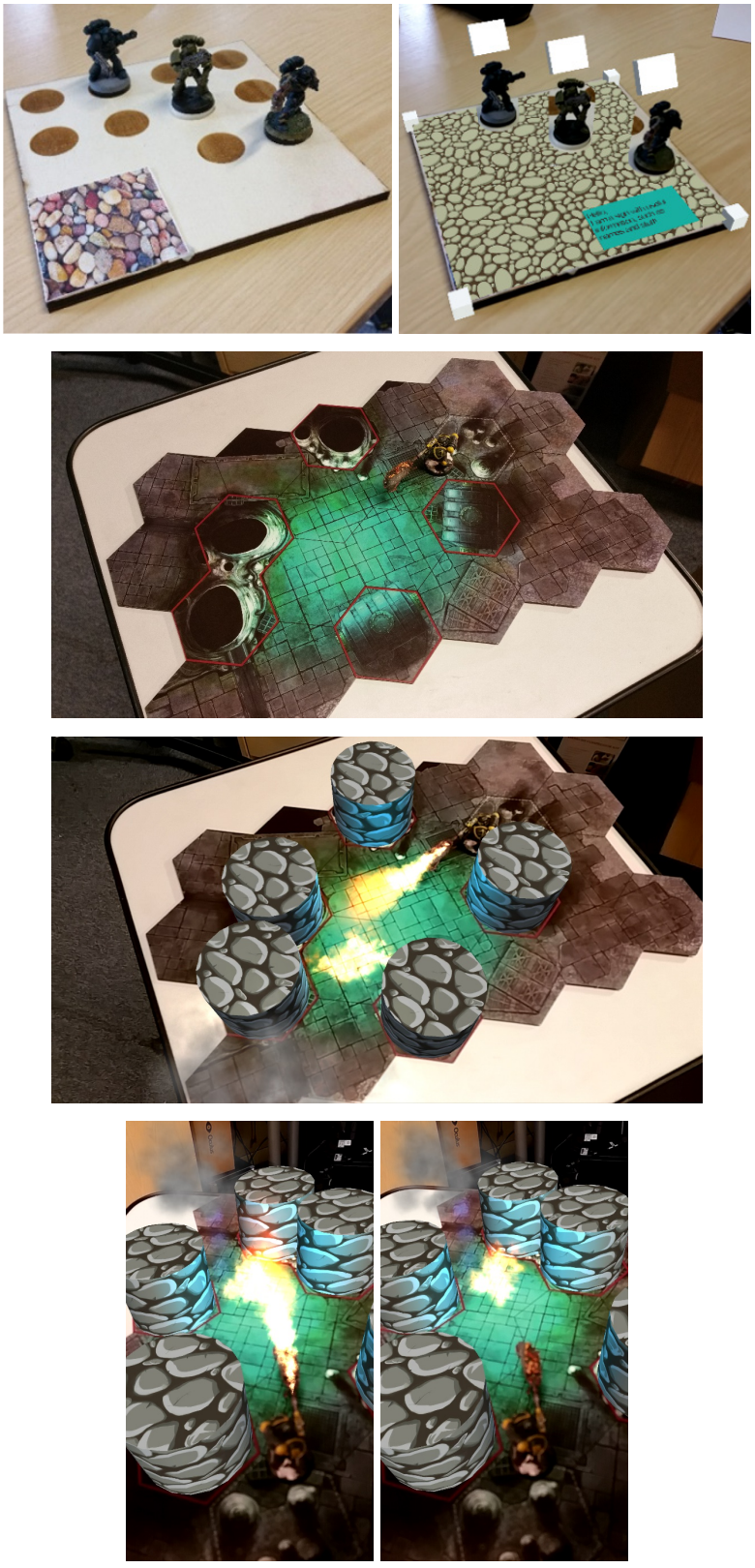


Figure 4.8. Examples of interventions made with the use of the Toolbox Probe. Seen here are Display and Game boards using Augmented Reality to visualise parts of the Records and experiment with immersion.

4.3 Reflecting with the technology probes

In the following section, we present the deployment of the technology probes and the findings that emerged from participant interactions and reflections with the technology probes that revealed the key themes.

To proceed with the focus groups, a diverse group of participants was needed to represent the large variety of hobbyists' attitudes and dispositions that appear within the wargaming community. As discussed in chapter 3, the close proximity and access to some of the world's most active gaming communities, such as Warhammer World, was instrumental in generating a wide pool of potential participants. Many hobbyists came forward and the final selection of 9 candidates was made in order to balance out experience, main hobby interest and motivation and to keep the sessions practically manageable. There were 6 male and 3 female participants. 5 considered themselves to be primarily interested in crafting and collection, while 4 of the participants were more interested in gameplay with one of them self-reporting as interested in highly competitive gameplay.

A further selection criterion was the participants stated interest in keeping records of their wargaming activities. Some of the participants were already very active and enthusiastic about creating accounts of their activities using methods such as blogging or photography, while others were not particularly interested in capturing and sharing records. Others stated that while they wanted to capture and share records, they were unable to do so adequately or consistently due to the practical problems they encountered. Thus the 9 participants represented a range of attitudes towards records, their capture and their perceived benefits. A short summary is provided Table 1 below.

Table 1. A brief outline of the nine workshop participants.

Participant No.	Pseudonym	Gender	Primary Interest	Recording Activities
1	Andy	Male	Gaming	Low
2	Ann	Female	Hobby	Average
3	James	Male	Hobby	Above Average
4	Jake	Male	Gaming	Low
5	Jonas	Male	Gaming	Above Average
6	Sarah	Female	Hobby	Very Active
7	George	Male	Gaming	Average
8	Fiona	Female	Hobby	Average
9	Jim	Male	Hobby	Very Active

The study took place over a period of 6 months. An initial session was held with all participants at which they were introduced to the research and briefed on its goals and findings up to that point. They were also introduced to the technology probes and instructed in their basic use. Over the duration of the study, several follow-up sessions, took place at weekly intervals, in a dedicated lab space that contained the technology probes as well as tools and equipment for participant experimentation with other approaches if they wished. On average, the group sessions lasted about 4 hours with many carrying on beyond that.

The first follow-up sessions were generally focused on crafting. They explored approaches that could capture and record information about the crafting of a miniature. The next set of sessions concentrated on gameplay, and the record capture approaches that could occur before, during and after gameplay. This included both narrative documentation and gameplay performance data.

Over the course of the sessions, the participants engaged in crafting and gameplay practices, while interacting with the technology probes. The primary method of data collection was through audio and video recordings which were later transcriber and scrutinised via thematic analysis. The participants also made many text-based recordings which were also considered, as seen below in Figure 4.9 Care was taken to provide the participants with opportunities to consider their activities and reflect on the influence of the technologies. Over time, a natural cycle of reflection emerged, as each participant felt comfortable

enough to discuss and present their ideas and concerns. The participants were specifically asked to note the kinds of data and information that they wanted to capture from the crafting and gameplay activities, and voice their motivation and reasoning for doing so.

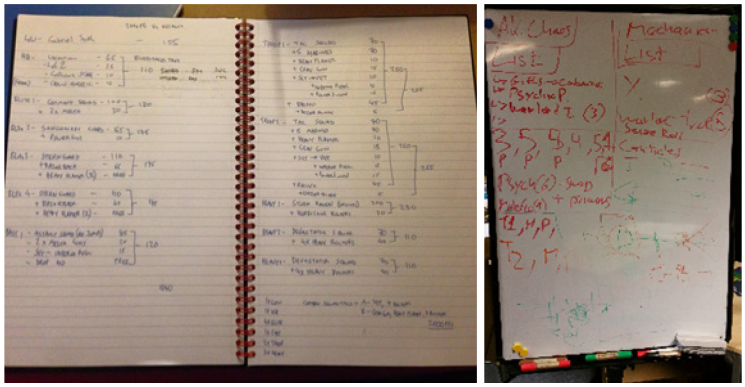


Figure 4.9. Examples of participant text recordings: A handwritten army list and a 'live journal' of decisions and dice rolls during a game which were written on a whiteboard.

From these notes, common patterns started to emerge about the kinds of data points that they most commonly chose to capture. Broadly divided into crafting and gameplay data, some of the most commonly occurring included:

- Crafting data:
    - Background concept and character design
    - Parts lists and Miniature kits used
    - Conversion techniques
    - Paints used
    - Paint scheme
    - Step by Step guides
    - Sources of kits and parts
- Gameplay data:
    - Army wins and losses
    - Unit Casualties sustained
    - Damage inflicted to the opponent's army
    - "Points cost" efficiencies
    - Tactical Synergies
    - Pivotal moments
    - Interactions between characters (duels, etc.)
    - Standout moments & and unexpected events

The Record Footprints listed above were in accord with the findings of the ethnographical work, namely that the participants were keeping track of practical crafting information for the miniatures and any occurrences during gameplay that they deemed noteworthy.

However, they also revealed the first hints about the considerable complexity of how the information was perceived and structured by the participants. This quickly became more apparent as further engagement with the technology probes began to highlight tensions with the relationship between miniatures and data facilitated by the probes.

During the sessions, each participant crafted a number of miniature models of their own choosing, while utilising the technology probes and contributing to the notes described above. Each of these new models where equipped with one of the tagging probes' augmented bases, as were many of the models of their choosing from their existing collections.

Using the unique identifier and interaction triggering capabilities of the NFC tag equipped bases, the participants used the photo booth probe to capture key moments in the crafting process of their miniatures. Additionally, they created collections of images for their existing miniatures to which NFC tags were attached. These images were linked to the individual profiles that were created for each miniature on the web portal. The participants could then use the portal to curate the images and create new content for each profile. Data and content was added to these profiles as the sessions progressed and the miniatures were used in gameplay, thus generating many of the data points that the participants found desirable to capture as part of a record.

4.4 Introducing the Vignettes

Through the focus groups, and prompted by the technology probes, several recurring themes began to surface in the space between the participants, their miniatures, their wargaming activities and their record keeping and sharing practices. These themes are best illustrated clearly through some characteristic cases - or vignettes - that were put forth by the participants as telling examples of their activities and thought processes.

The following sub-sections will introduce the vignettes which will persist throughout the rest of the thesis as running examples, and by which the design of the framework was informed.

4.4.1 The singular nature of Inquisitor Terry

The first vignette was contributed by James (his codename for anonymization purposes), one of the participants, who during the activities of the focus groups, demonstrated how many hobbyists create their own unique characters for their wargaming hobby.

Specifically, James conceptualised a new character – drawing inspiration from the background lore of Warhammer 40,000 – named "*Inquisitor Terry*". James created an elaborate backstory for Inquisitor Terry, setting him as a high-ranking member of "*The Inquisition*", a fictional organisation that already exists in the Warhammer universe and has a rich backstory to inspire hobbyist creativity. It is also one of the playable factions that a hobbyist may choose to make an army to represent and an "*Inquisitor*" is a type of one-model unit that can be fielded in that army with its own specific rules and capabilities, as seen in chapter 3. James regularly fields an Inquisition army in his games, a choice he made as it allowed him to create much more diverse characters than some of the other faction options. Apart from a backstory, his design included the appearance of Inquisitor Terry as well as his choice of equipment – a critical aspect as we saw in Chapter 3 as it directly influences how a miniature may be modelled and its legality and capabilities in game.

Having finalised the design of the character James went ahead and crafted a bespoke miniature model seen below in Figure 4.10, that resembled his description of the character, up to and including the distinctive hat that James has described his character as wearing. Having created this particular model, James used an NFC tag to give it a unique digital identifier in order to be able link it to digital content, as part of the Technology Probe use.

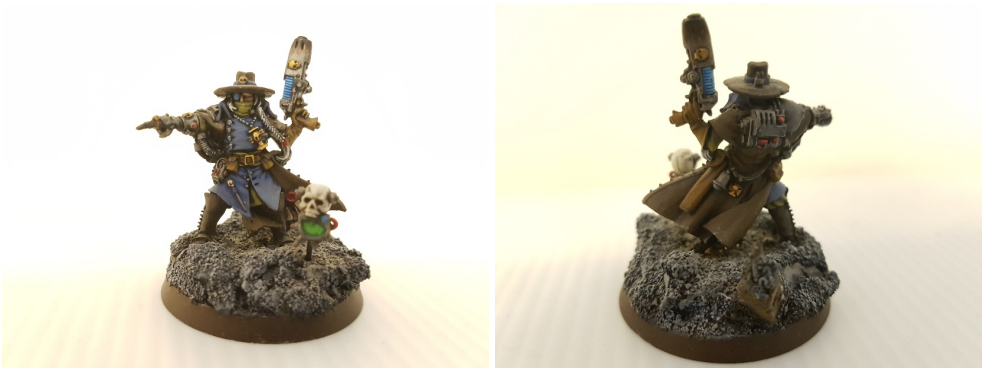


Figure 4.10. Inquisitor Terry's model

James was eager to use the Tagging probe to give *Terry* a unique digital ID and "*Bring him into the Internet of Things".* He also made enthusiastic use of the photobooth probe to create high quality image footprints for Terry's Record which he documented on the Web Portal Probe.

During the gameplay sessions, James clearly explained his intent about the character of Inquisitor Terry, and the model that represented him. In his own words, he explained how the model, which he referred to as the "*Inquisitor with the fancy Hat*" seen above in Figure 4.10, was meant to exclusively represent the character, or identity, of Inquisitor Terry. When the character 'took to the field' in games he would always be represented by that model and everything that the model did (or failed to do) on the table were attributed to Inquisitor Terry. This was important as for James, the records of Terry the character, and Terry the model, were one and the same. This included the practical crafting information of the physical miniature, such as the assembly

and painting procedure, despite it being essentially unrelated to the character in a narrative sense. For James, the model for all intents and purposes was the physical manifestation, or only physical instance, of Inquisitor Terry. However, James also shared that the character was also used by him in pen & paper RPG games set in the Warhammer Universe that he played with his gaming group. The acts and exploits of Terry during James's RPG sessions were included in the overall record, therefore demonstrating how for James at least, the character was persistent, and even active beyond the miniature model itself.

> *"Inquisitor Terry is a character who exists in my head-canon for Warhammer, whether it's when playing Warhammer or the RPG's. But when playing Warhammer, he is always that model. And the model is him." - James*

The situation described by the case of Inquisitor Terry is quite common with hobbyists who enjoy creating custom characters and situating them within the varied background of Warhammer 40,000, or other wargames and games. These players very often model miniatures to resemble how they imagine the character they have conceived and these miniatures 'take on' the identity of that character and represent him or her during the active parts of the hobby, most notably tabletop gameplay.

On the surface, this and similar case appears to be the most compatible with the conventional IoT approach and the initial way of thinking, were each model would be important and have its own distinct record and place in the network of 'things'.

4.4.2 The many faces of Lias Issodon

The second vignette was contributed by another participant, codenamed George, whose activities illustrated another very common case in wargaming, were hobbyists appropriate one of the established characters from the background story of Warhammer 40K for their armies.

George, who collects and plays an army based on the Space Marine faction of Warhammer, described how he went about making this decision, which had a

large impact on his later activities. He decided on collecting a Space Marine army as they are the iconic faction of the game since its inception, this translates into them having the most developed backstory, the most diverse selection of miniatures and compatible model kits, up to date rules, and critically for George, a very varied playstyle. This final point is in part due to the way Games Workshop has developed the backstory of this particular faction to contain a very large number of sub-factions, titled in the background story as the Space Marine chapters, which correctly number in the hundreds, each with their own backstory, playstyle and importantly unique colour scheme. Especially it is a mechanism to allow players to customise their armies and models as they see fit, rather than have their creativity hampered by strict background fiction. We first saw this earlier in chapter 3, how this was part of Games Workshop's overall strategy of creating a setting were players could either find some aspect that they liked and identified with, or be able to create their own.

Therefore, once George had settled on collecting space marines, he first researched the characteristics and backstories of many of the space marine chapters, and settled on the one which he found the most appealing, the Raptors Chapter, which we will be seeing in other vignettes too. In this particular example, we will focus on how George appropriated a character from the background of the Raptors Chapter and how he chose to physically represent that character.

Each playable army in Warhammer 40K has to be led by a leader, or a Warlord. This is both to facilitate gameplay scenarios were targeting the opponent's warlord is a gameplay objective, and to enhance the narrative aspect of fielding a cohesive and organised force. Thus, as we saw in chapter 3 and in the previous vignette of Inquisitor Terry, among the many units that a player may choose from to form their armies, there are the one-model 'character' units. These fall into two broad types, *Generic* and *Named.* Generic character units are basically archetypes such as Captains, Lieutenants, etc., as well as the aforementioned Inquisitor that was used for Inquisitor Terry. These are

character units that players may field either as anonymous units, or to represent their own character creations.

Then Named characters are altogether different. Essentially, they are pre-made characters who are drawn from the Warhammer 40K backstory. They are creations of Game's Workshop that have been developed through their rules, novels and digital game publications, and have been given gameplay rules so that players may field them in their armies. However, as these characters have a set backstory, there are often restrictions on which armies they may be appropriately fielded with. In other words, it may not make 'narrative sense' for players to use these characters in armies that they would normally be hostile to in the background story. For example, as seen below in Figure 4.11, a long-time character of the setting is *Pedro Kantor,* the Chapter Master of the Crimson Fists. As his title would imply, he is meant to be used in a Crimson Fists army, and this is reflected in his rules which only work with other units belonging to that sub-faction. A player can still use him with another army, but there will not be any gameplay benefit for doing so and there may even be penalties. In addition, some gaming events and tournaments which aim to offer a more immersive experience for their participants may completely disallow such background-incompatible armies from attending the event.

Figure 4.11. Example of Pedro Kantor's backstory from the latest publication and his official model.

An important thing to note is that many of these named characters have an official miniature model that is sold by Games Workshop as seen in Figure 4.11 above for Pedro Kantor. These models are sold unassembled and unpainted just like all the generic models, but they resemble the named character as he is described in the background fiction and any official artwork. Many named characters however do not have an official model and thus it is up to the hobbyists to create one to represent them if they wish to field that named character

We return therefore to George's case. Having chosen to create a Raptors Chapter army, George wished to use their only named character, Lias Issodon. His motivations for this were both the appealing backstory of the character, which he felt suited the theme of the army and his playstyle, but also because the games rules that Lias Issodon has been given as a named character are particularly powerful in the current edition of the game. Like many of the characters from the setting, Lias Issodon had a textual description of his appearance and equipment, but no official artwork to illustrate him. This allowed for a substantial amount of freedom in finding or creating a model to represent him during games. George had a good idea of what the character looked like in his imagination, and wanted to create it at some point, but he had not at the time found the right model parts to do so. He also wanted to improve his skill at painting the Raptors paint scheme first before he attempted to paint what would be a centrepiece model for his army. However, he also wanted to start playing games with the Raptors Army without too much delay.

> *"I needed a model to proxy Lias and see if he was any good. I picked one of the more good-looking models that had the right equipment on it in order to keep things WYSIWIG – mainly a fancy looking rifle." – George, on picking the first model to represent his Lias Issodon*

Having been collecting and playing Warhammer for over 10 years, George had a large collection of available models, many of those being space marine models painted in the schemes of a variety of chapters. While he had already begun to paint up the other models of his Raptor force he wanted to begin

using them in games and thus started fielding them without having fully completed painting them. In particular, he used one of his existing models to represent Lias Issodon in the first few games. As his painting progressed and he played more games with the Raptors, George would often switch out the model he used to represent Lias. While still planning to someday paint the definitive model, he nevertheless continued using him in every game.

The important thing to note here is that despite Lias being represented by different proxy models in every game he played, as far as George was concerned, it was the same character every time. For him, the gameplay actions of the model that was representing Lias in each game were attributed to Lias Issodon and would be part of his record going forwards. In a sense, the key element for George was the intangible abstract identity of the character, rather than any specific model. Unlike in the previous vignette where the identity of Inquisitor Terry was tied to a singular physical object. Therefore, while Lias Issodon 'wore' many faces as seen in Figure 4.12 below, his personal storyline and timeline remained unbroken in the eyes of George, his owner and custodian and curator of his record. Overall this case may sound rather specific, but it is actually one of the most commonly seen practices in wargaming, as there is an appreciable space of time and effort required between when hobbyist decide what models and characters they want to use, and when they finally (if ever) completely finish making them. This immediately challenged the Technology Probes, as suddenly the activities, and therefore documentable content for Lias's Record was split across multiple material objects, which did not always represent Lias and often would be assigned a different Identity. Thus, tagging every object as Lias was impractical and a more flexible approach was deemed necessary that could accommodate the shifting relationship between the 'Identity' of Lias, and the object that was picked to represent him at each given time.

Figure 4.12. Some of the models that George used to represent Lias Issodon on the table.

Another point of note is that despite Lias Issodon not being his own creation, and despite the character being fielded by many other players who also played Raptor Chapter armies, George felt that this was 'His' instance of Lias Issodon. In other words, he felt that for the purposes of his narratives the exploits of 'his' Lias Issodon were a direct continuation of the official or canonical backstory. This is a relatively common occurrence with any well-known historical or fictional universe were fans can in some way take on the role of established protagonists. For example, many digital games that are set in universes and franchises such as the Lord of the Rings, Star Wars, Star Trek, Harry Potter etc. have allow players to assume the identity of an established character and then act – within the scope of the game. This often creates a tension between the canonical course of events, known as the 'canon' as we discussed in chapter 3, and the actions and events that players cause in their own instances of these universes. A more relatable example can be drawn from Games Workshop's other wargame, the Lord of the Rings Battle game which is set in the titular universe and allows players to field armies – and characters – from that setting. Therefore, players paint and use such characters as Gandalf and Frodo, whose fictional histories could be considered as 'set in stone' by fans of the original Lord of the Rings trilogy of books. But just as the Lord of the Rings films created another version of those characters, so do players of the tabletop wargame.

> *"I'd read about Lias and the Raptors and I liked the style. There is not much written for him apart from some bits the Badab War books, so I had quite a bit of leeway. In any case this is just my interpretation of him. My version." – George on Issodon's canonical backstory*

The core take way from the vignette of George and his appropriation of the character of Lias Issodon is that the only thing that really mattered to George was the abstract identity of the character, which was quite explicitly not tied to, or represented by any particular physical model. This is a rather common occurrence in wargaming which immediately creates a tension with the physical object-oriented way of thinking of most of the IoT-inspired approaches and the other projects that were discussed in chapter 2. In these situations, the primary focus of the record is the abstract identity and not any one specific object. In fact, many physical objects are just manifestations of that identify at various points in time, and then only for some people, such as their owners.

4.4.3 The many jobs of The Green Marine

The third vignette that will be discussed stems again from the activities of George and his Raptor Chapter army, although it is something that almost all wargaming hobbyists do with their collections. In this Vignette, we shall see the example of the *Green Marine*, a model that had no particular identity of its own, nor stood out in any physical way. It was one of George's many space marine models, numbering over 80 at the time, that he painted in the scheme of the Raptors Chapter and was modelled with the standard equipment that those models can be equipped with according to the game rules. Essentially the model existed in order to fulfil the role of a basic troop, known as a Tactical Marine, in George's army, together with another 20 to 60 similar models, depending on the size of the game he was playing. As such the model of the Green Marine rarely came to George's notice during gameplay. The only distinguishing feature it had was a particular pose – unlike all the other marine models, it is reloading its weapon, hence it could at least be told apart from the others.

Figure 4.13. The Green Marine (Right) One of George's Marine Squads, led by its usual sergeant. Notable is the shoulderpad of the Green Marine which was eventually painted differently to the others to denote his permanently 'promoted' status.

George described that it was for this small reason that he would sometimes pick that model for other roles when he had to. In some games, where due to rules restrictions or point limits he could not use the models he would usually use for his squad sergeants, he would use the Green Marine – who had a plainer equipment loadout - as a stand in, and jokingly refer to him as Sergeant Bob, the 'budget' sergeant. But in games were the replacement was not needed, the Green Marine would get 'demoted' back to a nameless Tactical Marine. George described how after a while, Sergeant Bob became a recurring character identity in his army, and that when his presence was needed, the Green Marine was the model he used to represent him. Eventually after the model had distinguished itself in gameplay under the guise of Sergeant Bob, George made some painting modifications to the Green Marine to make him standout more as seen above in Figure 4.13.

> *"Initially that model was just another of dozens of tactical marines, but when I needed a Raptor marine that I could tell apart from the others, like for a sergeant or something, I used that one because I could tell it was him from his pose. When I did I'd refer to him as Sergeant Bob as a joke. After a while he'd done well in some games, and he became a bit of a favourite." – George, on picking the Green Marine*

Therefore, we have the situation where an otherwise unnoticed physical object, which was being used normally in its intended role, would sometimes be elevated due to necessity or other circumstances to represent an abstract

character identity. This led to the object itself becoming noticed and eventually more important and meaningful in the eyes of its owner.

This situation is very common among hobbyists, who re-task their miniatures constantly, usually at the point where they are drafting their Army Lists as we saw previously in chapter 3. Thus, the models are constantly and fluidly adopting and relinquishing different roles and identities, some of which have records of their own, or gain them in time.

4.5 Emergent Themes

Having presented the vignettes we now discuss the themes which emerged from the process. The technology probes and focus groups accomplished their task of taking a much more concentrated look at the practices of tabletop wargamers insofar as how they treat and perceive their miniature models and how they consider and structure the narratives that they are part of. Through the intense discussions and reflections that the probes prompted, the practices were picked apart and rationalised, while being constantly compared to initial and outside assumptions. In the following sub-section are discussed some of the themes that emerged.

4.5.1 Objects vs Identities

The first theme focuses on the constantly occurring distinction between the physical miniatures, and the characters and identities that the hobbyists create, discuss and value.

All three of the vignettes demonstrated how in practice the wargaming hobbyist participants gave greater consideration to characterful Identities. Terry stands out as the case of an Identity and a corresponding material object being 'In-Sync' to the point of them comfortably being considered as one thing – which would fit the initial expectations. However, the other findings challenge those expectations with Lias Issodon being a more complex case where the intangible Identity stands as a thing in its own right, with the

occasional material manifestation, thus frustrating object-tagging based technological intervention. Meanwhile, the Green Marine demonstrates the most common case in reality: Several ordinary objects that are individually beneath notice, but gain meaning when considered as a group. And also, the case of an object transitioning from ordinary to notable through use.

The early expectations were that the practices would conform to the original assumption: i.e. that the miniature models, and any characters they might happen to represent, shared the same record that detailed their crafting provenance and gameplay exploits. In fact, it turned out that this was not necessarily the case. Instead a subtle, but important distinction, began to emerge. Namely that the character identities, were separate 'things' from the models, as far as the practitioners were concerned. This distinction became apparent through participant reflections and engagement with the probes. When they linked their tagged models to the corresponding web portal profile, the "one-model one-profile" taxonomy could not accommodate their requirements. This highlighted the dichotomy between the content that the hobbyists wished to record about the miniature model, and the stories they wished to tell about the character identity, that the model represented.

In practical terms, this meant that the record of the miniature model contained true-life information and content such as gameplay statistics and details of the crafting of the model. But the more colourful information, such as the background story of the represented character and his dramatized gameplay exploits, were attributed instead directly to the identity, which participants preferred to have as a different profile on the web portal with its own record.

Thus, it emerged that often two separate records exist, one for the model, and one for the character identity. The two records are of course related, or even intertwined and overlapping, but are still two distinct things. This was the consensus of opinion, despite that in some cases, such as James's Inquisitor Terry, the model being purposefully created from the outset as the manifestation of the character.

4.5.2 Objects vs Groups of objects

The second theme concerned groups of miniatures, and how these were treated as one thing by the practitioners.

Although each miniature model is individually hand-crafted, it became apparent that the participants did not try to capture a detailed record for all of them. In fact, in some cases they did not even differentiate between them, and treated them as generic and interchangeable.

As an example, a participant named Harry crafted several generic marine models intending them to form the core of his space marine army, named the "Imperial Fists". Guided by the game's rules, he crafted the appropriate number of models while making sure that they all had the appropriate paint scheme and equipment to comply with the rules of the game. This is common practice in Warhammer 40,000 which focuses on large battles involving hundreds of miniatures. None of Harry's models were named, or singularised in any particular way, and he did not intend for any of the models to represent a specific identity. Rather, as each was part of his army, Harry considered them all to represent the identity of the Imperial Fists. This was also the case for the models in James's army which we discussed earlier and which represented the "The Inquisition" faction.

While this may appear at first to be a matter of semantics, it turns out to be an important distinction when taking a closer look at how the practitioners constructed their narratives. Specifically, it was most often the collective identities that were the focus of community-shared narratives, rather than the individual models that comprised the group. For example, stories and recounting of gameplay were typically built around the exploits of an entire army in a battle. Thus, as was the case with the theme of the singular identities, the armies too, were considered a distinct 'thing'. Each army exhibited a collective identity that correspondingly had its own record. The collective identity of an army was often far more developed than that of the models that belonged to it.

> *"My blog is mainly about the successes and failures of my Eldar army as a whole" – Sarah, on her hobby blog and how she organises the content on it.*

This theme took on new dimensions, when the participants went into detail about the nature of the gameplay. The game mechanics of Warhammer 40,000 dictate that the models are formed into groups, called units, and for the most part they undertake 'actions' such as moving, shooting or charging, as a group. This is primarily a practical matter of granularity in order to keep the gameplay fast and feasible.

> *"There were hundreds of miniatures in my army, but it is only made up of about 20 units." – Jonas, on the granularity of how he perceived the actions of his models*

Therefore, the notes taken by the participants, as well as their reflections, showed how, as these units were the main actors during gameplay, they merited their own distinct collective identity with its own gameplay-focused record.

> *"These 5 models are my scout squad; I use it in every game. As a unit, they have accomplished a lot." – Andy, on how a group of models attained an identity*

Practical expediency was also a factor in record capture. As most collections number hundreds of miniatures, it was considered impractical to create and maintain records for each model. The coarser granularity of focusing on the collective identities and records of armies and units, instead of individual models, was normal community practice.

> *"In games, units act as one, I don't need to scan each member individually, they all did the same thing." – Jim, on the practicalities of tracking every model's actions*

The above theme, was brought to the fore when the participants engaged with the technology probes. The NFC tags were meant to provide a unique identifier on a model-by-model basis. This did not suit the participants who were motivated to find ways to circumvent the shortcomings of the 'one-tag one-object' approach. In addition, these technology shortcomings also extended to the web portal probe, which by default allowed each record entry, whether

text post or media, to be linked to a single miniature ID. This was based on the original assumption that each miniature would have each own distinct record.

Figure 4.14. (Left) Example of a banner-equipped miniature. (Centre) Harry's Imperial Fists Banner(Right) The unit reference cards that were used as proxies.

Such was the participants' interest in linking collective identities to their corresponding digital records, that they suggested workarounds such as using proxy objects that could represented the units. Specifically, the participants created several examples as seen above in Figure 4.14. These included equipping a miniature in the army with a banner, and printing unit reference cards. The banner and cards were augmented with NFC tags that were then assigned a unique identifier for the army and units respectively. This meant that they could be linked to their own digital record.

4.5.3 Fluid Links and Transitions

From the discussions and reflections regarding the nature of the links between the models and identities and their distinct records, two closely interweaved themes emerged.

The first theme was that, in many cases, the links where not immutable, but rather were quite frequently fluid. This became apparent when the participants were frustrated by the relatively fixed link taxonomy of the IoT-inspired technology probes. Specifically, they pointed out that the miniature models were often 'assigned' to various units of their army on a game-by-game basis,

and therefore the members of a group could change quite often. What this implied was that the links between the models, and by extension the unique identifiers given to them by their NFC tags, had to have the capability of being linked to more than one identity, or at least be able to change it. Ideally, they wanted the ability to link the model to a number of nested identities, such as a unit, that was part of an army.

Considering the exemplars brought forth by our participants, this was less of a problem for the relatively straightforward case of James's model of Inquisitor Terry, who was a bespoke creation meant to always represent that identity. It was however apparent for Harry, whose generic models, while representing the army level identity, were only arranged into units prior to a game and rarely used the same miniatures. Following the previous insights about the nature of collective identities, these exceptions were not entirely unexpected. However, it was Sarah's contribution of her character "Archon Boris" that revealed how the links between singular identities and singular models, can also be fluid.

> *"Archon Boris has had at least 5 models in his lifetime, I want to link all of them to his story." – Sarah, on the issue of having many models tied to one identity*

She explained that, in the 15 years since she began collection her "Dark Eldar" army, as she improved her hobby skills, she has updated the model of Boris multiple times, either by replacing it with a new one or by modifying an existing one where possible, as seen in Figure 4.15 below. As far as she was concerned, he was the same character, and all the models that represented him over the years were also still relevant.

Figure 4.15. The various incarnations of Boris

Thus, while "Boris" maintained an unbroken long-term record footprint over his lifetime, his physical manifestations were much shorter lived, being modified, replaced and even discarded. However, each of these miniatures had its own distinct record footprint too, containing information such as its crafting process, and data such as its physical movements during games. Therefore, in this case alone, there are multiple different records to contend with: the one belonging to the singular identity, the records for each physical object, and the container record of the "Dark Eldar" Army of which Boris is part of. There may be additional, more ephemeral, records to consider on intermediate levels, such as the footprint of a unit that the character is a part of for the duration of a game.

This was quite a common practice, as the participants explained that they would often update or replace the model of a character, either for aesthetic reasons, or because the old model was invalidated by rule updates. Additionally, it could also occur when the hobbyists did not have an 'appropriate' model on hand, in which case they used a proxy object, such as another model. Despite this, the gameplay exploits of the stand-in model were still attributed to the character and added to his record, further demonstrating that it is the identity that persists, and takes precedence. This insight was triggered by the limitations of the one-model one-identity oriented technology probes, whose object-centric design could not accommodate an unbroken identity record over multiple objects.

The second theme to emerge from these reflections, was how otherwise non-noteworthy miniature models could transition from being treated as part of a group, to become noted singular models. As mentioned previously, only a

relatively small fraction of the models of each participant's collections are considered as singular objects from the point of their creation. These are usually those that are crafted to represent specific characters, as discussed previously. Conversely, the rest of the models, even though they too are individually crafted physical objects, do not correspond to any specific character and are thus, comparatively, generic.

However, all the participants could relate some story of an otherwise inconspicuous miniature becoming noticed due to some spontaneous and unexpected event during gameplay. Common examples were those where, due to the semi-random nature of the gameplay, some particularly improbable 'action' had been 'performed' by a miniature, thus leading to exciting narratives such as a 'heroic last stand' or a 'survival against the odds'. When such events occurred, the participants would, from that point on, individualise that miniature in some way, such as making a mark on it, in order to remember which one it was. More than this, some even proceeded to endow it with a name and a backstory, and therefore a singular identity. It was the consensus that such spontaneous micro-events were the essence of the more engaging narratives shared by the community. This occurred to the extent that some participants chose not to tag some models, preferring to do so if, and when their later 'performance' merited it.

4.5.4 Making sense of the themes

The above themes reflect the ways in which hobbyist wargamers consider and structure the records and narratives that surround the creation and use of their miniature model collections. Furthermore, they reveal how the most compelling narratives are focused around distinct individual and collective identities, rather than physical objects.

Furthermore, they shed light on how the practice of Wargaming creates and sustains narratives and records linked to the objects, identities and activities within. This quickly began to paint a picture that contrasted the initial

expectations, and revealed the considerable complexity in how practitioners perceive the interplay between objects and their records, and how these records help develop the narratives that are valued and shared within the community. In summary, 3 key themes were identities:

1. Narratives are often focused on identities, rather than the objects that represent them, and persist beyond them.
2. Additionally, groups of objects, which do not represent a specific singular identity, are often treated as part of a Collective Identity.
3. The links between identities and objects are fluid and mutable and new identities can spontaneously emerge.

In the following chapter, the we will discuss the final fieldwork of the research, which materialised in the form of a public exhibit which aimed to embody the findings of the research so far, by demonstrating an example of a “next-generation” footprint that could be part of the digital record of an object, and an interactive display that would present the record of several models and identities, in a way that was inspired by the current practices, but employed new technologies to the best of their current capabilities.

5 Mixed Reality Storytelling

5.1 Introduction

Following the conclusion of the technology probes and the focus groups, the findings began to form a rich picture of the wargaming community's approaches to record keeping and sharing. In particular, the prevalence of characterful identities for individuals and groups, and the lesser emphasis on the material objects, continued to challenge the IoT-inspired approaches. Disambiguating the complexity of the findings helped inform the creation of the Framework that will be presented in detail in the next chapter (Chapter 6). During this period of reflection, an opportunity arose to further investigate more aspects of the practice and gain insight into the acceptance of the work 'in the wild' and its possible applications and contribution to other settings.

Specifically, there was the opportunity to develop and deploy an instantiation of the research in the form of a public exhibit comprised of improved and refined versions of the probes. These were designed to demonstrate and trial the effectiveness of cutting edge technologies on the existing record capture & presentations practices of the wargaming community by taking direct inspiration from them and enhancing them. By being displayed publicly it would also have the opportunity to evoke generative interest and engagement from parties with interests other than wargaming, who could envision the generalised application of the research to their own contexts.

These efforts culminated in the well-received *Mixed Reality Storytelling* exhibit [216] , which was deployed for a month-long period at the National Videogame Arcade [217] in Nottingham. It was a two-part exhibit which consisted of what was designed as a "Next Generation" footprint capture demonstrator in the form of a 3D scanner, and an interactive augmented reality display, based on the wargaming community practice of army display boards, which presented a detailed record of a number of miniature models and character identities.

In the following section, the design and development process will be detailed, followed by a summary of how the event proceeded and it's receival by, and impact with, the community and the public.

5.2 Exhibit Development

The final exhibit which went live consisted of two main parts: The first was a display consisting of a wargaming Display board, such as those seen in chapter 3, which presented the story of a battle between two warring armies in the Warhammer 40,000. The two armies were composed of several well-made miniatures which included several highly individualised and fleshed-out characters. Each miniature and character was endowed with a rich Record, consisting of a biography, crafting history and gameplay statistics. The narrative Record of the depicted scene itself was also appropriately embellished and detailed. These Records were presented to the visitors via an Interactive Augmented Reality application, which provided context-sensitive portions of the Record based on what the visitors focused on.

The Second part of the exhibit was a 3D scanning booth – inspired by the original photobooth – which could scan reasonably sized objects using a Photogrammetry [9] process and create high quality 3D models that could be used as Digital Footprints for the Records of the original object. This was a manned station for the duration of the exhibit, and visitors were encouraged to bring objects with them to scan when they visited.

Figure 5.1. (Left) The diorama part of the exhibit in situ. (Right) The 3D scanning photobooth.

The development of the exhibit was a lengthy process as, beyond the technical development, it had to take into account the findings of the research with regard to what the community actually wished to capture as a record of their activities, how they organised and perceive it, and how they eventually share and present it.

In the following subsection, the process will be detailed, starting with the creation of the subject of the exhibit, which consistent of several miniature models and a diorama display board and their narrative and data driven backstory and record. Next will be detailed the design and development of the augmented reality display which created an engaging presentation of the records of the miniatures and the identities on display. Finally, the implementation of the 3D scanning exhibit component which would demonstrate potential future types of record content will be presented.

5.2.1 The 4th Vignette: The Last Stand of the Argo

The first step involved the creation of a telling example of the depth and variety of the record keeping and narrative aspects of tabletop wargaming in such a way that they would appeal to both wargaming hobbyists and the general public. The exhibit had to reflect the existing practices of the community both

in their physical form, and in the ways by which they structure their narratives and records.

With the above in mind, a vignette was created, inspired by the ones that emerged during the earlier research and were detailed earlier. The vignette was created to represent a well-developed example of what an experienced hobbyist might create and submit to a competition and an amalgamation of the other vignettes. It featured developed characters, such as *Inquisitor Terry*, with their own distinct Identities and corresponding models. By also having nameless and faceless models with no distinct character apart for a group identity, it also demonstrated the distinction between singular things of note and objects that were only treated collectively. Importantly it gave an emphasis to the intangible aspects, such as the fictional storyline, which included the background setting, the story of the diorama, and the circumstances that led to it, thus giving visitors a wider picture and context than just the observable objects. Specifically, the display consisted of a diorama like board inspired by the Army Display Boards that the community uses to present their armies at events as seen in the ethnographic findings. The board and manicures were commissioned froma popular professional miniature painting studio, *Awaken Realms* [218]. They were fully briefed on the purposes of the exhibit, and extensive discussions were conducted to find the most appealing and creative ways to tell the story that had been envisioned.

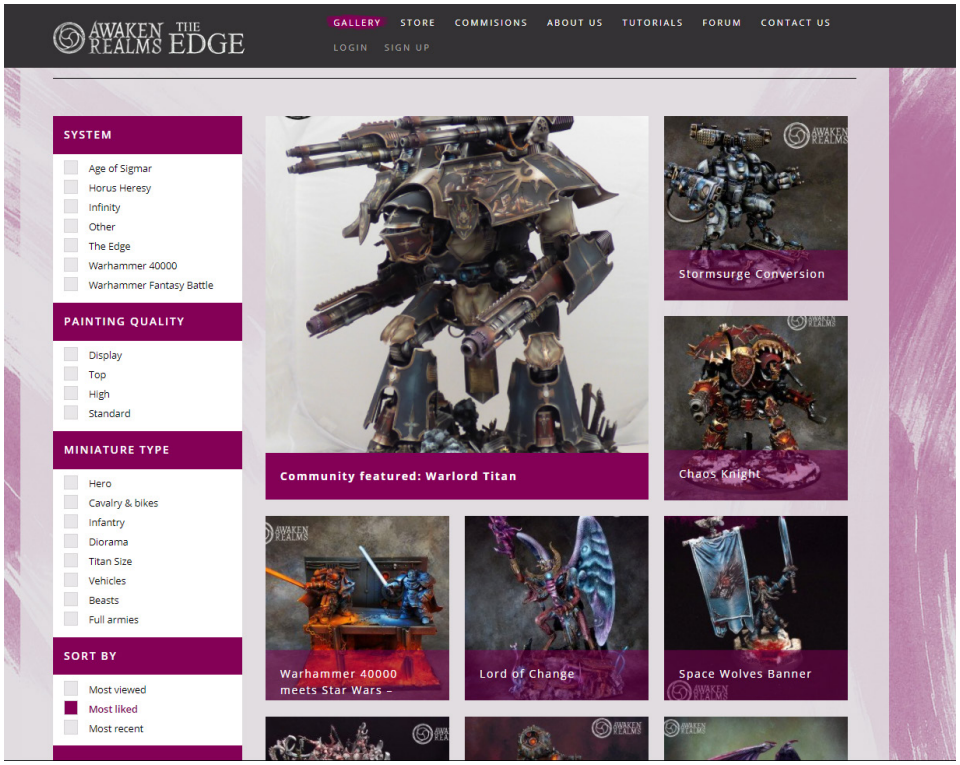


Figure 5.2. Awaken Realms online gallery, featuring a selection of their work.

The display board was 24 inches square, which is the most common size that is used, featuring modelled terrain that included the wreck of an aircraft, which was also part of the narrative. Two small sets of miniatures were produced, representing two different factions from the Warhammer 40,000 universe, and each were endowed with detailed backstories and gameplay records which represented multiple layers of narratives, ranging from the overall factions, through to the squads and organisations and down to the individual characters. The vignette was tied together via an overarching narrative that created a context for the diorama and the arrangement of the miniatures in the exhibit, seen in Figure 5.3 below.

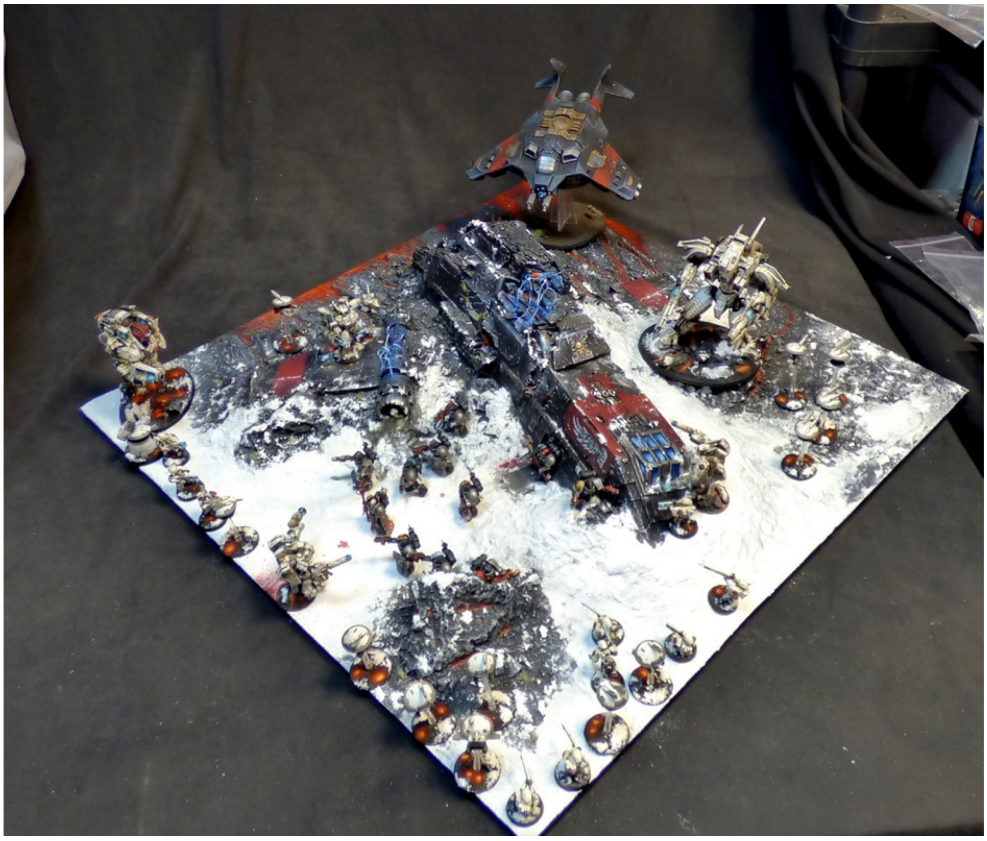


Figure 5.3. The Argo display board prior to deployment.

In brief, the overarching narrative, titled "*The Last Stand of the Argo*", tells the tale of a squad of marines whose transport aircraft, the titular *Gunship Argo*, has been shot down by Tau forces – one of the other factions from the Warhammer 40k universe. With this scenario as a backdrop, each of the miniatures on the display board was endowed with a biography of its own, as well as a sample of gameplay and crafting data, such as number of games played, kill/death ratios, paint schemes and conversion details. In addition, the crashed aircraft that was the centrepiece of the diorama, itself a highly detailed model, was also given a suitable backstory. Importantly, the various squads and the armies into which the miniatures were organised – as they would normally be based on their place in the Warhammer background and also the way the player would create their army list, were also given records and backstories, despite being abstract entities or groups of physical objects rather than single miniatures. The main one of these was the marine squad, named "Squad Tigris", which is the subject of our 4th running vignette.

Figure 5.4. The eponymous Squad Tigris, consisting of 10 members.

Squad Tigris was comprised of 10 space marine miniatures, some seen above in Figure 5.4, each representing a distinct character with a name and a detailed and flavourful backstory such as that of Inquisitor Terry from the first vignette, however they were entirely original, as opposed to Lias Issodon from the second vignette, who was appropriated from the official cast of characters of the Warhammer 40,000 universe. Each also had a gameplay record detailing their gameplay exploits so far, complete with metrics and anecdotal "Most Memorable Moments". Finally, each also had a detailed crafting record, listing the kits and parts that were used to model them, the procedure and any conversions that we made, and the paint scheme details, including a paint list and order of application. However just as each miniature had a record of its own, so did *Squad Tigris* as a unit. The squad had a backstory outlining its formation and history, as well as a list of its members. It had a detailed gameplay record but as it was an abstract identity representing a group of physical objects, it did not have a crafting record per se, but was linked to the crafting records of the miniatures it represented. Furthermore, the wrecked aircraft that is present on the display board, which represents the Argo itself, also has a record, consisting of the backstory of the aircraft (prior to being shot down), and the crafting record of the display board. Naturally there is no gameplay record in this case as the modelled display board of the wreck has not gameplay functionality - other than being used as scenery on the tabletop.

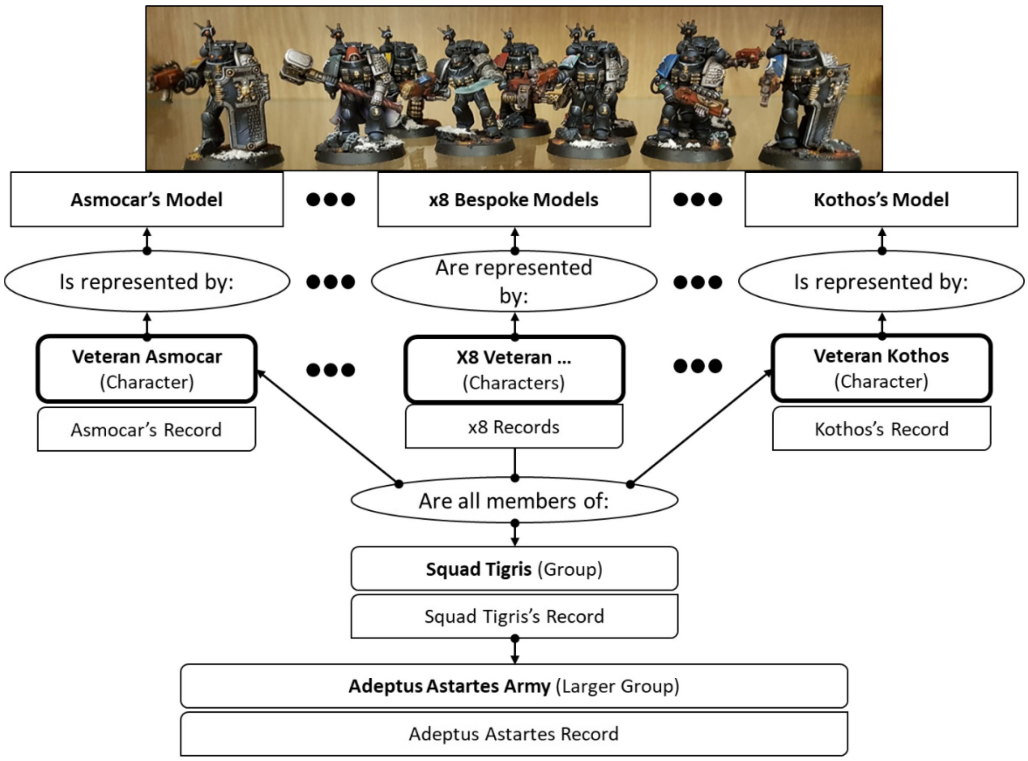


Figure 5.5. The relationship structure of Squad Tigris

We return however to the main protagonists in the form of the members of Squad Tigris. The squad is made up of the 10 members seen above in Figures 5.4 and 5.5. Each of the squad's members has a fleshed-out character identity complete with name and biography, but for brevity only two will be named here, *Veteran Asmocar* on the far left and *Veteran Kothos* on the far right, with the remaining 8 between them. As a group, or more appropriately a unit, the Squad is just one of many belonging to the *Adeptus Astartes* army.

Thus, the vignette of Squad Tigris represented a complex and multi-layered situation, that is however rather common in wargaming and other practices that involve objects, crafting, usage, narratives and records. As seen above in Figure 5.5, the identity of the squad sits at the middle of a layer of records, with it belonging to the larger record of the army that the squad belongs to, which itself belongs to a wider faction. While within the record of the squad are contained the records of the character identities that are its members, such as *Asmocar* and *Kothos*. And in this particular case each of these identities is

exclusively represented by a particular miniature model, like *Inquisitor Terry* was represented by the “Model with the fancy hat”. These in turn means that the records of the miniatures, containing information such as crafting data, are also a part of the squad’s wider record. This demonstrates how records become nested within larger records that have a wider scope.

5.2.2 Engaging Record Presentation

The records of the miniatures and identities that were part of the exhibit, while primarily in text and image form, had to be presented in an engaging and ideally interactive way. The most common ways of presenting such content with army display boards at events where they are exhibited is usually in the form of plaques, or printed materials such as booklets, as were in chapter 3.

Building upon this, it was decided to use Augmented Reality (AR) as the basis for the presentation. Augmented Reality has long been pursued as a technology in the domain of wargaming, as shown by the various examples of research commercial games that have tried to adopt it and other similar technologies [71,72,219] and the enthusiasm of many members of the wargaming community who believed that mixed reality applications were the future of miniature wargaming, if only as a way to enhance the visuals [99,132]. This was of course assuming the technology was cheap and accessible enough and critically did not alter or interfere with the gameplay [39]. Furthermore, Augmented Reality, has long been a staple of research and commercial efforts into interactive museum and public exhibits [97,118,149]. The advancement of the technology in recent years, as well as the rapidly increasing capabilities of the ubiquitous mobile devices that the public has access to are also factors in the growing popularity of Augmented Reality. Although not quite fully mainstream yet, the advancement of Virtual Reality, and in particular mobile virtual reality using inexpensive headsets that utilise mobile phones is also a factor, with the two often being combined seamlessly into Mixed Reality applications.

Thus, a mobile application was created, to contextually display the record content of the exhibit. Specifically, the application was developed in the Unity 3D engine which allowed it to be deployed on a variety of platforms. The Augmented Reality functionality was enabled primarily by the Vuforia Augmented Reality library [220]. Like most current augmented reality approaches, Vuforia relies on the detection of known markers in order to correctly determine the position of the device in comparison to the real environment. While Vuforia can use a multitude of marker types, including cylindrical, cube, and scanned point clouds, for this application the basic, and most reliable, 2D marker type was used, as will be detailed further on.

The core idea behind the record presentation was relatively straightforward. Each miniature and identity would have a small AR info card hovering above it, which would feature its record content. The content consisted of 4 slides: one with the biography of the character or group, one with its gameplay data and most memorable gaming moment, and one with any relevant modelling information, as seen below in Figure 5.6 with the example of Watch Master Telemachus who accompanies Squad Tigris on the display board. Apart from an info card for each miniature, there was also an info card for Squad Tigris as a whole, and for the wreck of the *Argo*. There was also one to represent the entire diorama of the *Last Stand of the Argo*, which detailed the overall story.

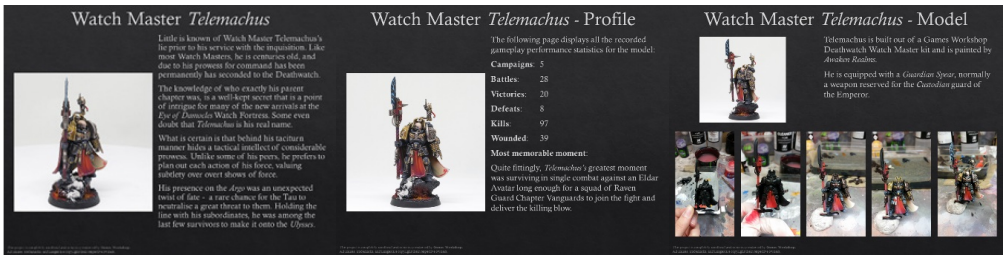


Figure 5.6. The three info cards corresponding to Watch Master Telemachus, a character set apart from the aforementioned Squad Tigris, but also belonging to the same army and included in the diorama.

In practice, the hovering info cards would be made visible to visitors who used a mobile device to view the exhibit through the device's camera. Two dedicated Android tablets were used for this purpose, which were tethered securely to

the exhibit. The app was kept very simple, only having the camera view of the device on screen, with some short instructions which indicated to the users that they should aim the camera at the exhibit in order to start the interaction.

Figure 5.7. Example of the AR app in action. Seen above each point of interest in the display are the interactive Info Cards.

Once this was done, as seen above in Figure 5.7, the application would lock on to the 2D marker, which in this case was the 2D neoprene mat upon which the diorama was placed and which feature the image of irregular stones and rocks. This image, seen below in Figure 5.8, was chosen as the marker due to its suitability as a robust 2D marker, as it exhibits the ideal characteristics for the Natural Feature Tracking (NFT) technique that Vuforia uses. NFT is one of the most reliable computer vision methods that are in use in current Augmented Reality libraries. It operates by being given a set of known targets, 2D images in this case, where it identifies distinct and unique features, such as high contrast corners and edges, which it can then use to uniquely identity the marker and determine its distance and orientation compared to the camera in real time.

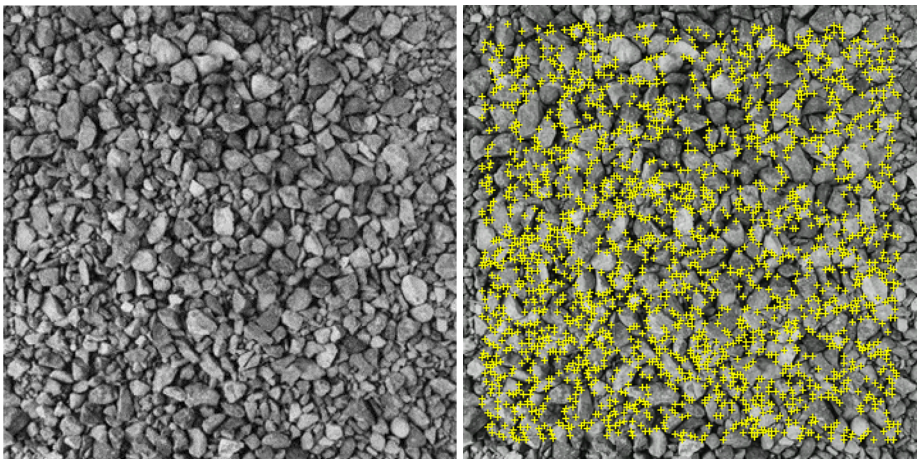


Figure 5.8. The trackable image that was printed on the neoprene mat as a marker

Once the application had locked on to the mat marker, the info cards would appear hovering over the miniature that they correspondent to, together with a red sphere which denoted that they were interactive elements. The info cards for the intangible elements, such as the main story and the squad as a whole were place in front of the display board. The info cards were semi-transparent and were designed to become more opaque as the device got closer to them which allowed users a view that was mostly unobstructed, apart from the info card that they were focusing on.

The application followed the current best-practice design guidelines [123,221,222] for mobile-device based Augmented Reality applications, and Vuforia apps in particular. A key interaction was that when users tapped on one of the info cards, the card would detach from its position in the environment and 'sail' to the screen of the device, where it stuck in an optimal position to be read. This allowed a more conventional content consumption interface which provided more familiar and comfortable ways for the users to consume the content, as they could then stop pointing the device at the object of interest and either read the content at their leisure in a more comfortable pose, or even walk away from the exhibit and sit down. Once they were finished with the content of that info card, they could dismiss it and they could then return to the display and 'collect' another info card.

5.2.3 "Next Generation" Footprint Capture

Inspired by the popularity of the photobooth probe that was used in the workshops, an effort was made to both refine its design and use, but to also expand its capabilities. The original photobooth probe was custom-built – due to the need to be compatible with the NFC tag probes and to automatically capture and append the metadata of the images – and as was shown by its use in the workshops, its use and output was very desirable but its functionality had a number of practical limitations.

Some of these limitations, such as the size constraints of the subject, the reliance on the NFC tags, the average quality and fixed angles of the images were considerations for the refinement of the next version of the photobooth, but it was also deemed desirable to further develop its output in order to demonstrate what a future record footprint might look like, beyond pictures and text. To this end the photographic capabilities were upgraded, by replacing the lab-built rotating pedestal with a commercial turntable and lightbox, and using a dedicated full-frame DSLR camera and macro lens for the images. These changes, drastically improved the quality of the captured images, and along with the addition of a high-quality tripod which could quickly alter the vertical position of the camera, allowed for shots of the objects to be taken from most of the angles that were desired. In essence, the setup was very similar to those used for commercial product photography, which by capturing multiple images of a product can then arranged them into interactive 360 product views on websites.

Figure 5.9. The 3D scanning photobooth in action.

While this setup and its output, was a drastic improvement over the previous iteration of the photobooth, there was the opportunity to go much further by using the captured 360 images to create high fidelity 3D models of the objects. This was done using a 3D scanning technique called photogrammetry which is very popular in the field of archaeology and site surveying. Similarly, to the NFT technique used by the AR app, it is a computer vision technique that functions by comparing the features images to determine the position and orientation of the camera. When a set of images depict a common subject from different angles, photogrammetry software compares the overlapping features in each image to determine motion and depth information. This in turn generates a sparse point cloud of identified features in the images that can generate a denser point cloud which can then be turned into a polygon-based 3D model.

Figure 5.10. Examples of resulting 3D scans. On the right is the familiar Inquisitor Terry.

This technique is very similar to the 3D scanning methods that use range-findings or structured light cameras, however it has distinct advantages that are critical to this application. The other systems, which can potentially be faster and even handheld, most commonly use low resolution cameras to capture the images that they use to generate the 3D models. This is sufficient for the generation of high polygon count models, but provides little texture or colour detail. Conversely, photogrammetry relies on high resolution still images, which when shot under good and consistent circumstances, as was the case with the photobooth, could also produce very high-quality textures for the generated 3D models. This was important as it enabled the accurate 3D capture of painted miniature models, where the hobbyists who tested it remarked that they could even see their brushstrokes – and to their distress all the details they had missed. There are several proprietary and open source photogrammetry applications that would be suitable for the purposes of the research. After extensive evaluation of each the choice was made to adopt *Agisoft Photoscan* [223], which proved the most consistent results, albeit with less automation than other packages. The process of generating the 3D models from the images is particularly time consuming with the quality of the original images being paramount. The processing time is considerable, ranging from a few hours for a dataset of 100 12 megapixel images, which would be considered the lowest acceptable set for a model of the desired quality. Using high specification graphics cards has a substantial impact on the processing time, as the software can take advantage of multicore environments.

The resulting 3D models were uploaded to a specific account on Sketchfab [224], a 3D model hosting and social media website, which provides an equivalent services for 3D models as YouTube does for video content. This had the advantage of providing an efficient and attractive way of presenting and distributing what is otherwise very ungainly digital content that would have required the use of dedicated 3D model viewer or editing applications. Using SketchFab allowed non-technical users to easily view the models, and its compatibility with social media and web portal platforms meant that the

models could be embedded and shared via social media and on websites, such as the exhibit's own web portal [216] where an initial gallery of scanned miniature models was added. Over the course of the project this gallery would eventually grow into a gallery containing hundreds of 3D models of contributed objects.

Once the value of the 3D scanning setup was determined, the process was streamlined as much as possible and was prepared to be deployed alongside the display board for the duration of the exhibit as a service were visitors could browse the multitude of models that had been scanned, which included all those that were featured in the display, and where they could also bring their own objects to be scanned. This would prove to be very popular, as will be detailed further on.

5.2.4 Branding the exhibit as The Mixed Reality Storytelling Project

Due to the deployment of the exhibit as an outward-facing instantiation on the research, an effort was made to form the work into a named project, and to develop an engaging brand and presence by which the research could be represented publicly.

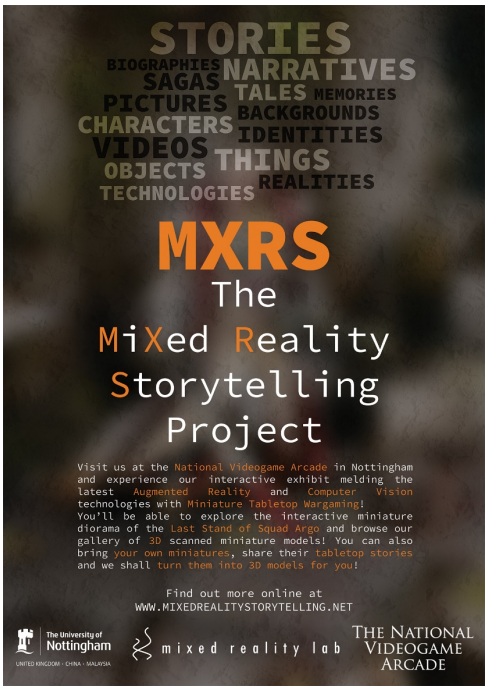


Figure 5.11. The Mixed Reality Storytelling promotional poster.

To reflect a large part of the core questions and approaches of the research, the project was titled as the *Mixed Reality Storytelling Project* (MXRS). This denoted the focus of the research on how people form and tell stories about their activities, the records they keep that help them do this, and the technologies that can potentially support them.

A new web portal was setup online [216] as the information hub for the project which included information on all aspects of the research, catering both to public and academic interest. The portal also showcased outputs, such as record and footprint examples produced from the developed technology probes and their successors, such as submitted narratives, images and 3D scans. Importantly the portal promoted current and future events, such as the exhibit, and collated press and community coverage. In addition, a number of MXRS social media accounts and pages were created and curated, including a Facebook page and a twitter account.

The portal and social media pages were monitored and their popularity and effectiveness were monitored. The upcoming section on the reception and impact of the project will summarise the recorded effects of the promotional efforts.

5.3 Exhibit Deployment

The following subsection detailed the main deployment of the exhibit and its components at the National Videogame Arcade's public exhibition hall, and also some smaller deployments that occurred during the period of the project.

5.3.1 Main Exhibit at the NVA

With the exhibit, itself finalised, it was moved to the public venue where it would be open to the public over a month-long period. The Venue of the exhibit was the main foyer space of the *National Videogame Arcade* (NVA) [217]. Situated in Nottingham's City Centre, the NVA is a multi-purpose event and exhibition hall supported by the *National Videogame Foundation* [225] whose stated aim is to promote and develop the role of videogames in culture,

education and society. Following it's opening in early 2015, the NVA has hosted a multitude of events and exhibits in its halls and spaces, including both exhibits of legacy games and gaming technology, as well as future, experimental and novel gaming and education projects.

While the majority of the NVA exhibits are part of a ticketed experience, the building features a main foyer area which is open freely to the public and where a rotating selection of engaging exhibits are on display. This area was chosen as the most appropriate space to setup the MXRS exhibit as it would guarantee the largest footfall and avoid any issues or conflicts arising from its academic and currently non-commercial nature.

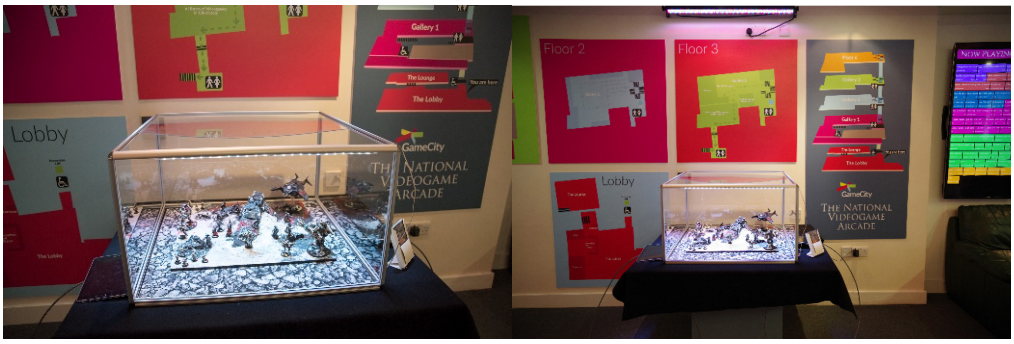


Figure 5.12. The display board deployed at the NVA

The two components of the exhibit, the display board and the 3D scanner were setup adjacent to each other in such a way that visitors to the NVA first saw the display, whose promotional material introduced them to the project and then prompted them to engage with the 3D scanner as well, which was attended by a researcher at all times. All the web presences and promotional materials encouraged visitors to bring objects that they would like to have scanned into 3D models, that they would then receive both as files and as links that they would be able to immediately share via social media or put on their own websites.

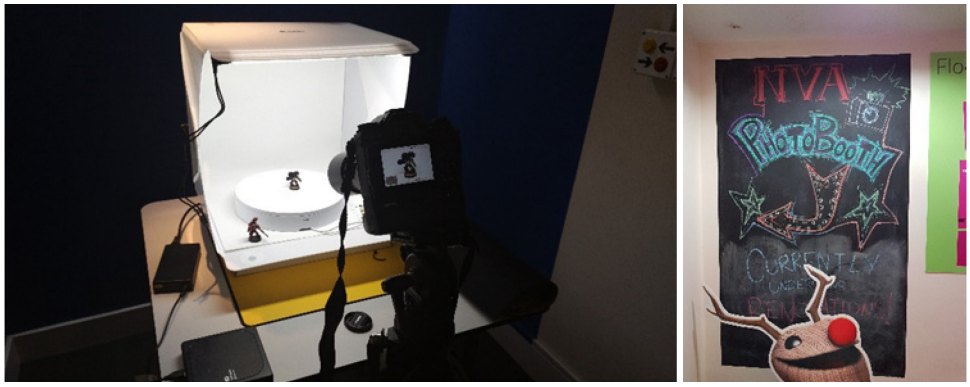


Figure 5.13. The Scanning 'Photobooth' deployed at the NVA

Through promotion via the MXRS web portal and social media outreach, and the NVA's own promotion, the month-long exhibit received over hundreds of visitors, many of whom were hobbyists and wargamers who had become aware of the project and wished to both try the Augmented Reality experience, but also to bring their own miniature models to have scanned and added to the growing library of 3D models. However, a larger portion of the visitors were people who while not hobbyists or wargamers, had heard of the project and wished to have their own objects, such as personal mementos and keepsakes scanned.

5.3.2 The Travelling Scanner

During the month-long period where the exhibit was deployed at the National Videogame Arcade, there were also some opportunities to demonstrate the project at some other events. As mentioned previously in chapter 3, the city and wider area of Nottingham is host to a considerable number of wargaming companies and miniature producers. But despite this situation, and not counting Games Workshop's array of events, there has been no particular organisation or event, such as a convention or trade show in the area, despite there being several around the country every year such as the *UK Games Expo* [226], *Historicon* [227] and *Partizan* [228]..

This changed however during the period of the exhibit when the first Nottingham-based event occurred. Titled "Red On Blue In Nottingham" [229]

and abbreviated as “ROBIN”, it was a one day event that brought together most of the companies and individual designers in the area. Part trade show and part convention, with tournaments, seminars and game demos, it was met with considerable success and will now be an annual event.

The main organisers of the event, Warlord Games, offered the MXRS project an exhibition space in the main hall for the duration of the event. Taking up this offer, the 3D scanner and promotional material were setup in the space and a researcher was at hand to engage the public and operate the scanner. While only a single-day event, this was a great opportunity to engage many members of the wargaming community, primarily from the historical and non-Games Workshop portions of the hobbyist’s population who had not been the primary focus of the ethnography earlier in the research.

Figure 5.14. The Scanner on tour at the ROBIN wargame expo.

By the end of the event, over 300 wargaming hobbyists had visited the exhibit with an expressed interest and hundreds of miniatures that the wargamers had brought with them on the day for the tournaments, had been scanned for the 3D model gallery. Many of the hobbyists subsequently visited the main exhibit at the National Videogame Arcade, or had already visited it. In addition, many companies who were exhibiting their products, including miniatures and painting and sculpting services expressed a keen interest in the technologies that were demonstrated as a way of promoting their products.

5.4 Reception and Impact

The Mixed Reality Storytelling project was very well received by the wargaming hobbyists and members of the public who engaged with it.

5.4.1 At the NVA

The exhibit was shown to be very popular, with thousands of visitors passing through the NVA and Several hundred engaging with the display and scanner over the one month period when it was deployed at the NVA. Due to the opening times of the NVA, the exhibit was accessible to the public for a total twenty 10-hour days. In the one week that coinciding with a holiday period, the NVA recorded record footfall for over 4 days consecutively.

Visitors of all ages engaged with the display, showing an interest in all the aspects, including the novelty of the Augmented Reality interaction, the innate attractiveness of the display board and the miniatures, and the record-based storytelling and narratives that were part of the exhibit.

Many visitors turned out to be wargaming hobbyists and enthusiasts who had heard about the exhibit and wished to see the display and also have their miniatures scanned, which they would bring with them. There were also many hobbyist visitors who had no prior knowledge of the nature of the exhibit but immediately recognised it for what it was and proceeded to enthusiastically engage with it and the attending researcher. Many of these visitors came back on subsequent days to have their miniature models scanned and added to the gallery. Some visitors were also involved in the wargaming Industry, such as sculptors and designers, including the author and game designer Gav Thorpe [230], who is a major presence in Games Workshop's Publisher*, Black Library.*

Some examples of input from the visitors' experiences with wargaming, can be seen in the following quotes and the scans of the miniatures they brought with to have scanned, seen below in Figure 5.15.

"This is amazing! Can I bring some of my favourite models? What's the largest model we can scan?" Alias David

"I heard about the project and bought my best painted army. It's about 80 models, is that ok?" – Alias Kevin

"I sculpt models and sell them via Etsy. Could I scan one of my sculpts to show off on my site?" – Alias Ray

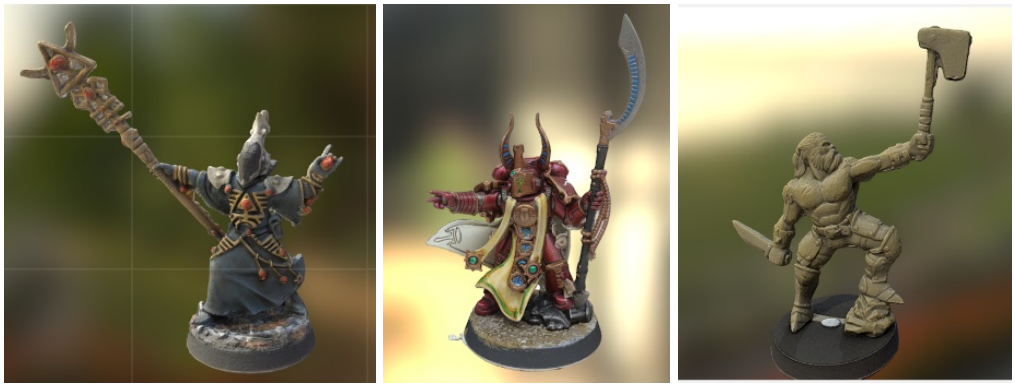


Figure 5.15. David, Kevin and Ray's models

However, most of the visitors were not familiar with tabletop miniature wargaming. Nevertheless, they engaged with the display and expressed an appreciation for all the aforementioned qualities. Often to the exclusion of the other many interactions and installation that were available to use in the space, the visitors would group around the display and observe the miniatures through the case. Almost all of them would then also use the tethered tablet devices to try the Augmented Reality interaction, which by itself proved to be popular and several stayed as long as possible to read as many of the embedded records and stories as their time allowed.

The 3D scanner however proved to be even more popular. Many visitors were aware of the 3D scanning photobooth from the promotional announcements and material and had visited the National Videogame Arcade brining objects they wanted to have a 3D model of. A large portion of the NVA visitor demographic is children accompanied by their parents. The parents had encouraged their children to bring their 'treasures' to be scanned, and some had bought their own. This led to a large number of scanned children's toys

and treasured possessions. On most of the open days, queues of visitors lined up to use the photobooth. By the end of the exhibit over 150 objects had been successfully scanned, most of them accompanied by a short description or anecdote as to why they were cherished or important enough to be brought to be scanned. Thoughts of the visitors included:

> *"It's my daughters favourite toy, they are inseparable. This way he can be onscreen too." – Alias John*
>
> *"This is Crusoe, we got him in Canada and she's been with us on every trip since! We forgot him in Italy once, and had him sent back to us." – Alias Betty*
>
> *"This is my engagement ring. Please scan it as I almost lost it this morning and almost had a heart attack." – Alias Dana*

Figure 5.16. John, Betty's and Dana's contributions

Lots of discussion was about what the models could be used for. The design of the photobooth which allowed the models to be shared via a URL and be easily embedded in all the popular social media platforms was a major boon, as the visitors immediately drew parallels between this and how they already captured and shared memories via pictures.

Following the conclusion of the exhibit plans were made to make use of the technology and the repository of models that was gathered. The suitability of the 3D models to be used in Mixed Reality Experiences was highlighted and is slated to be part of future research and impact activities, as will be briefly discussed in the final chapter.

5.4.2 Online Presence

Also successful were the online aspects of the project, meaning the web portal, social media pages and the gallery of 3D models that were being uploaded from the objects that were scanned at the exhibit, drew thousands of visitors, and hundreds of positive comments.

Via the Google Analytics platform that had been integrated into the web portal, it was determined that over 1,620 unique visitors accessed the portal in the month that the exhibit run. Of these visitors, just under half were from the United States and the United Kingdom, with the rest spread over the globe as seen below in Figure 5.17. This demonstrated the reach of the project and reaffirmed the widespread popularity of wargaming. The web portal was maintained beyond the end of the project and continues to be visited. The Facebook page was also popular but was not used as the primary platform.

Country	Acquisition		
	Sessions ↓	% New Sessions	New Users
	2,162 % of Total: 100.00% (2,162)	74.93% Avg for View: 74.93% (0.00%)	1,620 % of Total: 100.00% (1,620)
1. United States	496 (22.94%)	72.58%	360 (22.22%)
2. United Kingdom	477 (22.06%)	78.20%	373 (23.02%)
3. Germany	309 (14.29%)	36.57%	113 (6.98%)
4. Canada	91 (4.21%)	83.52%	76 (4.69%)
5. Australia	67 (3.10%)	92.54%	62 (3.83%)
6. France	54 (2.50%)	83.33%	45 (2.78%)
7. Sweden	49 (2.27%)	91.84%	45 (2.78%)
8. Brazil	44 (2.04%)	95.45%	42 (2.59%)
9. Spain	38 (1.76%)	86.84%	33 (2.04%)
10. Netherlands	38 (1.76%)	97.37%	37 (2.28%)

Figure 5.17.Web Portal visitors by county of origin

Particularly encouraging were the metrics from the Gallery of models that was hosted on SketchFab. The project generated over 13,300 views on the models, as well as hundreds of likes and dozens of followers. In particular, SketchFab itself which runs a curated model spotlight cited the gallery numerous times

and 3 of the models were picked as staff favourites, which led to the publication of a community spotlight article authored by the researcher [161].

In addition, two interview videos [27,28] were published on the YouTube Channel *Computerphile* which aimed to promote the research and garnered a total of over 85,000 views. The videos were well received and were followed up with two more videos [29,30] on future Augmented Reality Technology that was quoted to be a potential follow-up on the exhibit. These videos totalled over 210,000 views.

5.5 Conclusions

The development and deployment of the Mixed Reality Project and its exhibit had numerous research benefits beyond the measurable impact and potential future applications.

The main technological developments of the Augmented Reality display and the 3D scanning photobooth were direct refinements of the earlier technology probes, with their improved design and capabilities being guided by the findings of the technology probe use and the workshops that discussed their use.

Pursuing their development and deploying them publicly and at wargaming events allowed for a much wider and longer exposure to interested parties and the wider public. This demonstrated the viability of the findings and critically, the possibility of the generalisability of the research to contexts other than wargaming. This was especially evident in the enthusiasm of many of the visitors at the possibility of scanning objects that were personally meaningful to them, thereby creating record footprints of them. This was compounded by the ease and familiarity of the chosen footprint form with the preferred platforms of many of the visitors. In other words, once it was shown that a 3D model of their cherished object could be tweeted or posted on Facebook, many of the misgivings about the value of the technology evaporated.

The engaging nature and value of the embedded records and narratives was also demonstrated extensively. The relatively esoteric nature of the miniatures was not a deterrent or a barrier for those visitors who, despite not knowing anything about the miniatures, or the complex fictional background that they belonged to, were enthusiastically browsing the records and narratives of the miniatures and characters of the display. The addition of a few paragraphs of information, delivered with the support of interactive AR technology, was enough to turn otherwise innocuous objects into artefacts of interest and wonder. For those visitors with a knowledge of the context, the apparent engagement (and excitement) was magnified many times over.

Finally, many lengthy discussions were had with individuals and groups, who wanted to find out more and discuss the merits of the research. Many of these were wargamers themselves and these discussions further contributed to the findings of the earlier focused workshops. At this point in time the framework was being iterated upon, and the contributions of this wider audience helped further clarify the conceptual framework which presented in the next chapter.

6 The Meaningful Things Framework

6.1 Introduction - Considering the findings so far

In the previous chapters, we took a deep dive into the world of miniature wargaming, followed by a series of probes and studies into the wargaming community's storytelling practices. We observed the numerous activities, actions and 'doings' that make up the whole of the hobby and witnessed an abundance of emergent phenomena. Of these phenomena, we focused on those that involved the hobbyists capturing, curating and sharing stories, narratives and records about their wargaming miniatures, but also as it turns out, their intangible creations such as characters, organisations and events.

We saw how hobbyists created and shared narratives of their hobby activities and tangible creations – as was anticipated – but we also saw how they created stories, narratives, characters and backgrounds as a core part of the wargaming pasttime. Furthermore, we witnessed how they endeavoured to capture the spontaneous and emergent events that occurred during gameplay due to the unpredictable dice-based game mechanics, and 'forge' them into narratives that transcended the game and were attributed to the model (or character). And we saw how the recounting of these narratives, for storytelling and gameplay performance purposes, was most often structured in ways that were quite contrary to the design approaches of the technologies that were anticipated to support them.

Significantly, it emerged that the sheer variety, and complexity, of the ways by which community members perceived, considered, treated and made sense of their activities, and of 'things' and their records, quickly became overwhelming and byzantine to accurately describe and communicate. And by extension, challenging to anticipate and design for. Critically, while many of the methods and techniques used, such as the use of social media to share hobby progress for example, are common within the community, the sense-making and mental-modelling that occurs, such as how an individual hobbyist perceives

and organises his models and characters, and how they will choose to attribute actions and construct narratives, is much harder to elaborate on.

In fact, it was observed that, as with many other Human-created phenomena, it is a highly subjective approach, that varies with the individual, and is constructivistically arrived at through their own personality, knowledge, experiences and external factors. Therefore, while it was straightforward to spot the popular techniques used by the wargaming community, it was much harder to tease out the intricacies of each individual hobbyist's way of thinking when it came to **how** they actually told stories about their activities. And with good reason, as the ways were quite diverse and often hard for the study participants to put into words. Each person had a different approach and valued different aspects of the hobby, and more importantly felt differently about what aspects of it they wanted to record and share and how they wished to do that.

During the workshops, the participants were vocal about the trouble they were having with technological solutions to their recording and sharing efforts. Through discussions and experimentation prompted by the technology probes it eventually came to light that the difficulty was with the material-first approach that the primarily IoT-inspired technologies were employing. These technologies operated on the preconception that the core element of the activities were the common-denominator material objects, meaning the miniature models. However, while the miniatures are certainly a key part of the practice, it turns out that they are not the exclusive focal point of the record keeping and narrative making activities of the hobbyists.

This preconception is the main line of thinking employed by most of the technological approaches that aim to support these activities. Internet of Things research, products and services are mostly occupied with physical objects tracked by distributed sensors networks and embedded technology. But what the practitioners most often do, both explicitly and implicitly, is tell stories about abstract things. Not material objects. Indeed, as we saw in earlier chapters, the hobbyists most often centred and recounted their stories around

characters and identifies, which were more often than not intangible entities instead of specific physical objects. Yet it is also true that the stories were often caused by material objects, whether by the act of their craft, or by the perceived actions during gameplay, but most often the case was that narratives were created and perpetuated about characters, organisations and events, with the objects being mostly secondary in concern.

Of course, exceptions to this most certainly exist. Many miniature models were conceived and created purely to be the subject of a story – as was the case with the vignette of *Inquisitor Terry*. Conversely others managed to 'gain' notice and from that point on rise from 'mundane object' to a 'thing of note and worth', while some other miniatures served as physical proxies for a string of ever-changing identities – situations which both happened to the *Green Marine* from the 3rd Vignette. Meanwhile the majority of the miniatures are never individually noticed, serving under blanket collective identity such as most of the models in participant George's *Raptor* Army.

The common theme throughout these findings was the prevalence of the "Identity" as the focal point of the told stories and narratives, and the records that supported these. The identities were shown to be both singular, referring to a particular character or singular physical objects, and collective, representing groups and organisations, or collections of physical objects. The construction and use of these Identities are instrumental to how the wargaming community creates and communicates *Meaning* about activities, and demonstrably leads to some objects becoming personally meaningful to members in ways that vary from person to person. Through the shared understanding of the context that Meaning is also communicated to other members, with evident examples of the community understanding and appreciating the efforts of its members. Meaningfulness was formed and maintained through the Identities, and therefore it was deemed vital to clearly comprehend what they are, how they come about, how they persist, how they are communicated and how they can relate to any records that may be kept by community members.

We saw all the above happen in the niche – but rich and diverse – microcosm of tabletop miniature wargaming. But these phenomena extend beyond this specific context of practice, and the difficulty of explaining, and thus understanding and making use of them, still applies.

6.2 Introducing the Meaningful Things Framework

With the above in mind this chapter introduces the **Meaningful Things Framework**, a conceptual framework that aims to aid the understanding of the ways by which communities of practice perceive and structure narratives from their activities and about their 'things'. And thus, how they attribute and organise records – whatever form those may take.

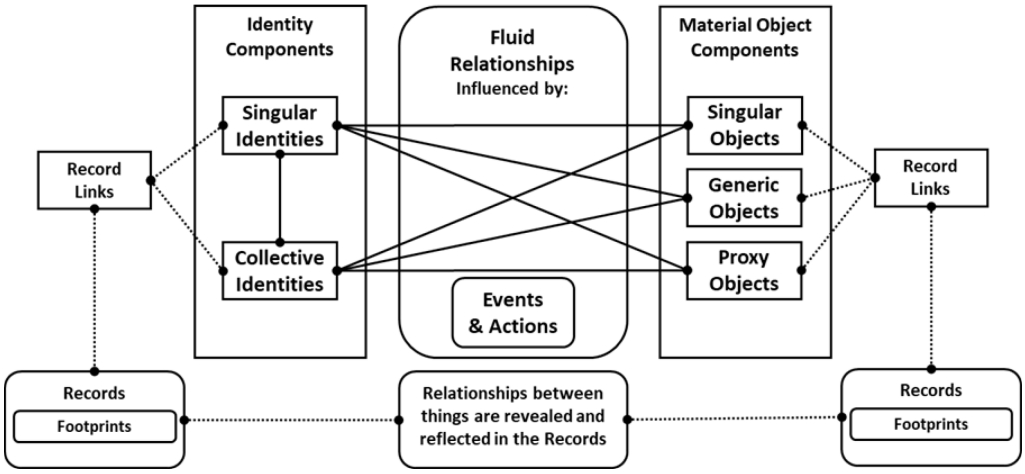


Figure 6.1. The Meaningful Things Framework.

The Meaningful Things Framework shown above in Figure 6.1 consists of two layers, or 'worlds', the **Identity** layer and the **Material** layer each of which contains several framework components. The **Identity** layer, contains the abstract Identity objects which are the intangible concepts that hobbyists and practitioners consider as things in their own right. The **Material** Layer contains the tangible Material Objects which may be things of note themselves, but can also be manifestations of the identities. The **Relationships** between these components, both within and across the Identity/Material divide are not

immutable and can fluidly form and dissolve over time, content and interactions. Finally, Identities and Objects can have **Links** between themselves and their respective Records, which can also change for the same reasons as the Relationships and often reflect them.

Briefly the key components of the framework are as follows:

- Material Objects
    - **Singular Objects**
        - These are specific material artefacts that can be uniquely identified among others.
    - **Generic Objects**
        - These are material artefacts that cannot be uniquely identified, or don't have to be, but they can still be interchangeably used or function for a purpose.
    - **Proxy Objects**
        - These are material artefacts that can temporarily represent or stand in for a Singular or Generic object, but do not necessarily bear any physical resemblance to it, or have the same functional purpose
- Identities or Abstract Objects
    - **Singular Identities**
        - These are the unique identities that refer to a single entity, such as a named character, a concept, or a specific thing of note.
    - **Collective Identities**
        - These are the identities that can be used to refer to a group of other things. In other words, several other identities, or objects can represent a collective identity
- **Relationships**
    - These are the context-specific relationships that form and dissolve between the things in a particular setting. In the framework, these can form between any of the abstract and material components. For example, a Singular Identity can belong to a wider Collective Identity, or a Singular Object can represent a specific Singular Identity while also belonging to a several Collective Identities.
- **Events and Actions**
    - These are wealth of possible occurrences that can happen within and without the activities of a practice and can trigger the creation or dissolution of a relationship between the things involved.
- **Records and Footprints**
    - A Record is the summary of the information and data content that refers to one or more abstract or material objects. Each object can have a Record. The Records are made up of Footprints, which describe contents such as text, audio, image and video content about the objects.

- **Record Links**
    - These are the technological links that connect a material or abstract object to its relevant digital Record. The links can range from simple name identifiers and RFID tags used to retrieve data from databases, all the way to embedded data capture and storage technologies.

In the following sections and subsections, the components and the relationships between them are described in detail and exemplified by revisiting the vignettes from the findings that were introduced in the previous chapters. We begin with the more straightforward Material Components, followed by the more complex concepts of the Identity components.

6.3 Material Components

This relatively large category encompasses all the tangible material objects and artefacts that are involved in the practice, whether they are crafted by the practitioners, or manufactured elsewhere and acquired or purchased. This also includes any object or artefact that could be used as a tool to facilitate or enable interactions in our lives and within a practice.

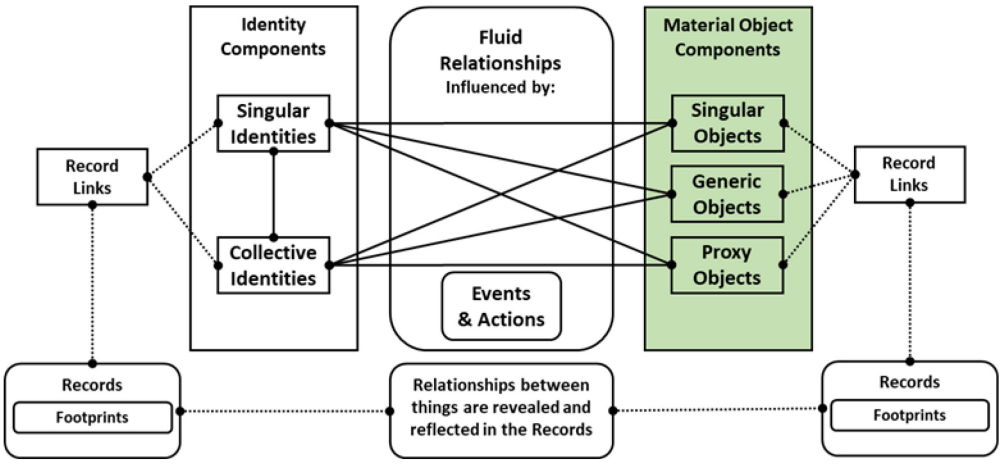


Figure 6.2. Focusing on the Material Objects of the Meaningful Things Framework.

As tangible physical artefacts, they have a distinct and intrinsic haecceity that often does not need to be communicated as it is afforded by their material properties and attributes. In the case of wargaming this naturally includes all the miniature models, but also the tables, scenery objects and any tokens and

artefacts, such as rules, dice, reference cards and even rulebooks that play a part in the practice. In short, it includes all the material 'things' that you build, use and handle in the activities of your pasttime. Furthermore, issues of granularity quickly emerge, as each object is almost never immutable, uniform or homogeneous. In other words, the object can change over time or they can be broken up into "Sub-things", which can also be further divided ad infinitum down to their constituent atoms. Conversely several objects can also be composited into one larger object.

Understandably, attempting to apply this line of thinking can quickly overwhelm the researcher or designer with issues of scale, depth and itemisation, which inevitably leads to the sort of pondering questions and theories we explored in chapter 2. There we briefly summarised the approaches of some of the schools of philosophical thought that pertain to the nature of Things and have struggled with these questions, as we saw with the paradox of Theseus's ship. Of their wide-ranging efforts, the pertinent ones to this work are their attempts to make sense of how and why, of all the material objects that surround us, do some of them 'come into focus' as notable things to us. Heidegger's notions of *Present-at-Hand* and *Ready-at-Hand* are key here, aiming to explain that distinction, which motivated Bill Brown to develop *Thing Theory* where he axiomatically defines 'objects' as 'stuff we don't notice', while 'things' are the objects that 'make us stop and consider them', either because of some metaphysical quality due to some special value or meaning that they have for us, or because our normal relationship with it changed or shattered for some reason – such as the object not functioning as expected or breaking entirely – thus transcending into a 'thing' of note – or frustration.

The Meaningful Things framework draws from the experience of these other disciplines and abstracts the nature of the objects involved into several loose categories - which while not necessarily exhaustive or mutually exclusive - aid in the comprehension of where those objects stand in the perception, and therefore the design needs of the practitioners.

First, the framework considers several recurring **properties** that each object may exhibit to a varying degree. The properties include:

- **Haecceity or Uniqueness**
  - Being uniquely identifiable among other physically similar objects.
  - E.g. A specific car with its unique licence plate.
  - E.g. A coffee mug with a scratch on it that I can distinguish from other similar cups.
- **Resemblance**
  - To have a physical similarity to the 'thing' that the object is supposed to 'be', or to afford some form recognition to another object or 'thing'.
  - E.g. A small scale model of a real car.
  - E.g. A picture of a coffee mug.
- **Functionality**
  - Having a functional purpose or use within, or independently of, a context.
  - E.g. A truck to move payloads with.
  - E.g. A disposable coffee cup.

In addition, these material components (or objects) can feature a distinct record of their own, or be the focus of a narrative, but don't necessarily have to.

The following subsections describe in detail the identified categories of objects that are considered as material components in the framework.

6.3.1 Singular Objects

The first category is that of **Singular objects**, or singular artefacts. These are the tangible material objects that, for varying reasons, are unique or stand out in some way. In other words, they are 'one of a kind'. Such objects are most often the key physical objects around which a practice is focused, either as the product of that practice or a necessary functional item or tool required for its activities.

In the case of miniature wargaming, this describes the miniature models that are in some way unique and identifiable. For practitioners of another domain, such as musicians for example, it may refer to their personal musical instruments and so on. In both examples, there are other objects involved in the practice as well, such as dice and rulebooks, or instrument cases and

scorebooks, but there are almost always objects that are considered more central to the experiences. And they are key, notable or standout in some way, either due to their nature, their inherent value, or some sort of association, or more pertinently in this case, some form of 'history', in other words a record. Thus, they exhibit all three of the aforementioned properties: they are unique, they resemble (or afford) what they are supposed to be, and they can serve the expected function.

Singular physical objects therefore describe components that are considered unique, even if they might be functionally identical to other similar objects. In other words, they are things of note. In philosophical terms, these would be the 'Things' in Thing Theory [19], meaning objects that became things, due to escaping their otherwise mundane or unnoticed existence.

Importantly they have a distinct record of their own as physical objects. This for example would include records of how they were made and their changes of status, such as location, ownership etc. Their record can also include information of their use and 'agency' within a context, although this sometimes coincides with the record of the singular identity they are representing – if any, as they don't necessarily have to always be representing a singular identity to be used – in fact, as mentioned previously, an object having a singular identity is a relative rarity – although it happens most often with singular objects, usually due to the specificity of their physical nature.

Many examples of objects that can be considered singular were seen in previous chapters. Among these are: The *Inquisitor with Fancy Hat* miniature model that was created to serve as a representation of *Inquisitor Terry*; all of *Lias Issodon's* various physical manifestations; each member of *Squad Tigris* from the exhibit; and the actual display board they were arranged on which represented the *Last Stand of the Argo* (and the remains of the *Argo* itself).

6.3.2 Generic Objects

A more common case is that of **Generic Objects.** These are those objects that are part of a practice's activities, but are not distinctly unique in any particular way. In addition, they are, relatively speaking, interchangeable as they have a similar functionality due to their material and physical properties.

This does not mean that these objects are just the anonymous 'mass-produced' items. They might still each be individually hand crafted, they simply don't have a standout uniqueness of their own – at least to begin with. They can attain such distinction in numerous ways through the activities of the practice. This might happen by them 'doing' something of note within the context of a practice, or simply by gaining some distinguishing feature that sets them apart. Here we see again the inspiration from Heidegger's work and Bill Brown's Thing Theory, with the object-to-thing transcendence. In addition, these generic objects are most commonly given some form of collective identity to refer to them. And thus, their 'activities' add to the record of that collective identity.

For example, in the context of wargaming, Generic Objects would be termed those miniature models that are not linked to any singular identity and are instead treated collectively as part of a group. More specifically, models which physically represent a common type of gameplay entity, such as a common rifleman, simply need to exhibit the appropriate physical attributes, such as an appropriate colour scheme and equipment. They are considered and treated as a collective group in most cases. We saw numerous examples of such miniatures in previous chapters, including the vignette George's *Green Marine*, who would adopt the necessary role as the needs of George's games dictated.

In these examples, the Generic Objects in question can become 'noted' and transition to singular objects. Each one of the nameless marines of Participant X's Raptor company can 'rise to prominence' during gameplay through some heroic – or hilarious – feat worth remembering. And a musician for example may acquire a brand-new instrument, and through use and experiences will imprint it with new associations that will elevate it from a commonplace tool to a cherished possession.

Therefore, *Generic Object* components are those artefacts that are of a similar 'type' and are functionally similar between themselves, thus making them interchangeable to fulfilling some role in the activities of a practice. They must have a resemblance to what they are supposed to be, and must serve the same functional purpose, but they do not necessarily have to be uniquely identifiable.

6.3.3 Proxy Objects

Proxy Objects are physical objects that can be a temporarily acceptable representation of another physical or non-physical thing, without actually providing the same functionality. In straightforward cases, these might effectively act as stand-ins during activities for objects that may not be currently available.

Within a practice, this may be a viable possibility to complete an activity. For example, hobbyists who don't have the correct model sometimes use other models or objects that are not at all similar to the object or identity they are trying to represent, such as using coins or drink glasses. This is different from using the 'Generic Objects' mentioned above, as the proxy objects are neither physically nor functionally similar to the physical object they represent. Furthermore, they are not necessarily meant to be the 'appropriate' or 'final' manifestation of an identity. In most cases, such as during a game, introducing a proxy requires explanation or prior negotiation with other hobbyists. Proxy Objects thus do not necessarily need to exhibit any of the properties that the Singular and Generic objects do.

When considering however the digital records that the suggested elements may possess, there are more interesting opportunities that may be pursued using proxy-like objects. Essentially, Proxy Objects can act as links or keys to the digital record of other objects or identities. A recent example of this was achieved with the use of guitar picks that featured machine readable Artcodes linking to the digital record of the unique Carolan Guitar which we saw in chapter 2. The guitar picks were distributed as gifts and tokens, and by scanning

them with the appropriate application, interested parties could gain access to parts of the digital record of the Carolan Guitar, without being in proximity to the Guitar itself, which had the same scan-able codes on its body.

Therefore, in the scope of the framework, Proxy objects are defined as those material objects that are temporarily and ephemerally 'standing in' another identity or object. They can be multiple Proxy Objects representing the same thing at any given time.

6.4 Abstract Identity components

We saw in previous chapters how wargaming hobbyists tended to construct their background narratives around specific characters or groups in their armies, or even about the army as a whole. This also held true when the narratives were explicitly about the crafting process of building and painting a miniature model, as it was often the case that these were being made to represent a character who had already been conceived in some way, such as in the background fiction of a hobbyist's army. So, hobbyists more often told stories about characters and abstract things such as groups, armies and organisations – instead of just about specific material objects such as miniatures. In doing so they gathered or created content and information footprints about them. Therefore, it was these abstract things – or identities - that were acquiring Records.

Understandably concepts such as characters are common elements of storytelling. This is promoted furthermore by the nature of the things involved in the tabletop wargaming setting, such as humanoid figures, which can very easily be anthropomorphised and related to, unlike other inanimate objects or the non-humanoid miniature models of a fictional setting. It's just as common for stories to be centred around groups and organisations, that are referred to collectively. In wargaming, hobbyists constantly captured and recounted stories of squads and armies, that often contained tens to hundreds of different miniature models. In other contexts, and practices, this still holds true, with stories being told of groups such as bands, organisations or even entire

cultures. In summary, people tell stories about things that are not tangible, but can be abstract notions, ideas and identities. And as discussed in earlier chapters, the philosophical thinking about abstract objects and how people talk about them is well trodden ground by many disciplines of thought. We saw numerous examples of seemingly material things transcending 'beyond the material realm' as they began to adopt or represent intangible things. From the Ship of Theseus to Japanese Shinto Temples (and Trigger's beloved broom) take on a haecceity or identity of their own which stands long after they are gone. And some others follow the opposite route, coming into being as symbols to represent an intangible concept or idea that someone wishes to communicate in material form.

The reality of the prominence that abstract things have in human activities has however not been acknowledged in the technological and design approaches that aim to permeate and support communities of practice, as was discussed in Chapter 2. The Internet of Things, driven particularly by its commercial motivators, focuses on augmenting the material aspects of any given setting – often disregarding whether doing so is practical and useful, or even appropriate. On the other hand, social networks do an altogether too good job of connecting people over the 'social objects' [51,88,155] of their common interests. Thus, they are the platforms that people most often employ or appropriate to perpetuate their storytelling activities. But in their current form these blogging and networking platforms rely entirely on the willingness and skills of the storyteller to richly and accurately weave their stories, as all they usually offer is a blank canvas.

Through the work described in the previous chapters it became clear that there was a need to consider the existence and importance of the abstract elements such as characters; groups; organisations; events and ideas, as 'Things in their own right'. Furthermore, it was also clear that these things could themselves acquire digital records and form the basis of narratives. By extension this requires that they are uniquely distinguishable in some way, which requires some form of unique identification.

Therefore, by considering the nature of the abstract things, that emerged most frequently, the term “Identity” is appropriated, and introduced to describe all those abstract things that, while not material in nature, nevertheless have their own particularly distinct record and footprints, and within a practice tend to be the focal point of the constructed and disseminated narratives.

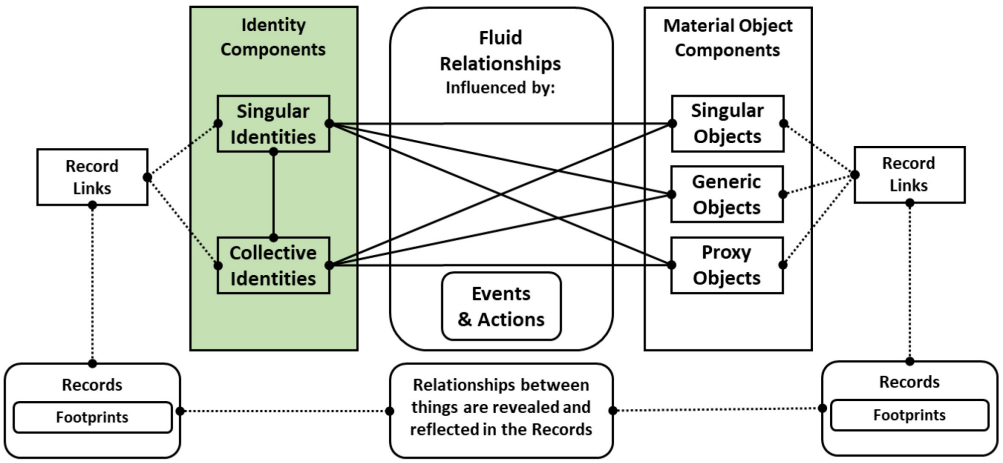


Figure 6.3. Focusing on the Abstract components of the Meaningful Things Framework.

The two following subsections detail the Singular and Collective Identity components of the framework.

6.4.1 Singular Identities

Singular Identities, or Characters describe, as the name implies, a specific distinct identity that is either created by a practitioner, adopted from the practice background or emerges by itself through the practice activities. In the case that the identity can be anthropomorphised to a degree, or describes a suitably rich entity, then it could also be described as a Character. However, this does not mean that all singular identities must describe such entities. The term can also be used to describe inanimate things or abstract concepts such as groups, organisations, factions, events, ideas or concepts. These begin to exist from the moment of their ‘conception’, which is usually a mental exercise.

It is relatively straightforward to imagine these singular identities acquiring a distinct digital record from the point of their creation onwards. From the

moment that any piece of information – a 'footprint' - is committed from thought to a tangible or digital form, it is a matter of record. This can be a bit of text, such as the biography of a character, or a concept art sketch of what they might look like for example. As time goes on, and depending on the context within which this identity exists and potentially acts, the record will grow and cross paths with the records of other identities and objects.

For wargaming, this type of entity is quite common. Hobbyists conceive and create characters and organisations, or appropriate them from the existing background lore of the setting, and then usually proceed to endow them with physical representations in the form of one or more miniature models. We saw this characteristically in the vignette of *Inquisitor Terry* whose identity, personality, abilities, description etc. were conceived prior to his "physical manifestation" in the form of a miniature model. In his case, the miniature was painted to represent him and him alone. When participant James created the character and then the model, he intended the two to be permanently linked, with the miniature – referred to as the model with the distinctive (or 'fancy') hat – would always ever represent the character of *Terry*. Thus, they would also share the same record as shown below in figure where the Singular Identity at the centre of the diagram shows the direction of the relationships and links.

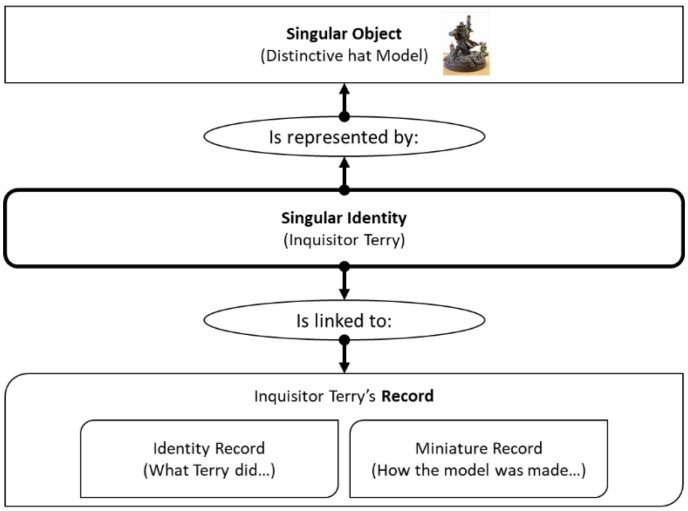


Figure 6.4. The Singular Identity of Inquisitor Terry related to the Singular Object that represents.

This is different from cases where characters were manifested by different miniatures at different times, which is a far more common case, thus lending credence to the idea that it is the abstract 'identity' that persists beyond the physical manifestation. Some of these characters may be represented by different models as the hobbyists upgrade or replace the old ones. Or they might have a pool of models to represent the character with a variety of equipment or at different points in their own 'timeline' of the character, as the natural immutability of the miniature models is a constant factor. We saw this occur in the second vignette, with the case of *Lias Issodon* and the many different miniature models that represented him at different times. In effect, these models are Generic Objects as defined previously, as each of them can serve the same functional purpose. In such a case *Lias Issodon* retains his own Record, which at times is linked to that of those models. The models in turn have their own distinct records, which link with *Lias Issodon's* when they take on his identity, as illustrated below in figure.

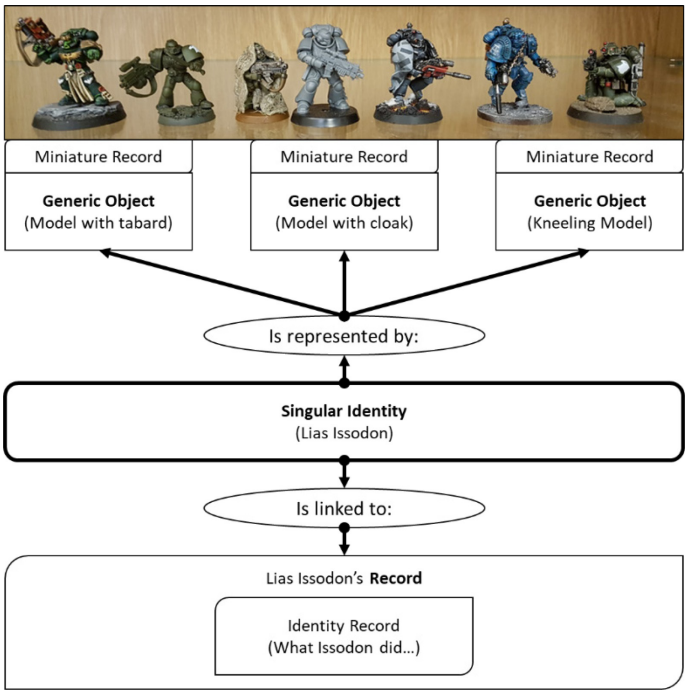


Figure 6.5. The Singular Identity of Lias Issodon and the representative relationship it has with several miniatures which constitute Generic objects.

In both cases the central element is the abstract Identity of the character in question, rather than the material objects that represent them. The miniature models may indeed still be objects of value and note, and have distinct and detailed records of their own as singular objects, but the narratives are primarily attributed to the character identity and persist beyond the presence or existence of the material objects.

This phenomenon can also be easily observed in other contexts outside of wargaming, especially in those involving storytelling or gameplay in some way. A pertinent example is that of a player's RPG character, or a gamer's character profile as seen below in Figure 6.6. Tracking everything a character has done has always been a main mechanic of games, which then use the resultant record for a variety of purposes, including gameplay mechanics, narrative support and straightforward gamification.

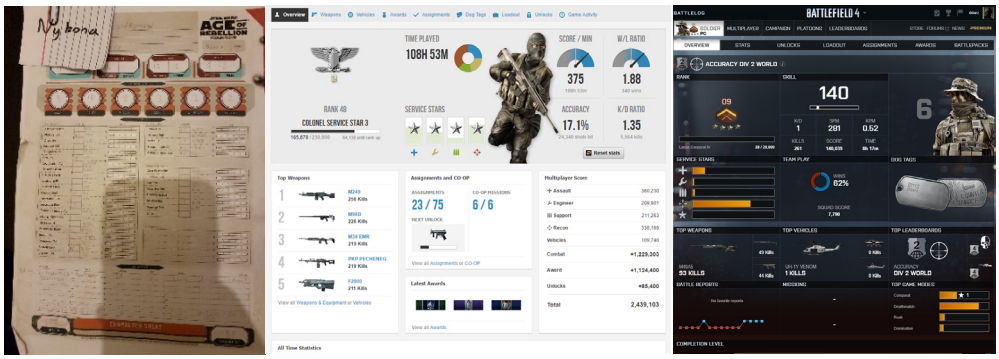


Figure 6.6.Examples of detailed record keeping in pen & paper RPG's and modern digital games.

6.4.2 Collective Identities

Collective Identities describe identities that can be assigned and attributed to groups of physical objects or even groups of other identities, whether collective or singular. It is one of the most commonly observed mechanisms with which practitioners simplify the capture of records and the resulting narratives, as it is naturally easier to manage a single collective record rather than numerous individual ones, especially as these can number in the hundreds or even more, depending on the context.

However, this does not mean that collective identities are only used due to necessity and the vagaries of information management and overload. It is very often the case that collective identities are a natural part of the practice and thus aid in clarifying and enriching the distinctness of the identity itself as well as its resulting records and eventual narratives.

For example, wargaming hobbyists tend to describe and discuss their collections in terms of armies, themselves comprised of units and characters. This is born not only out of practicality, but also due to the structure of the background lore and narratives that frame the practice, and the organisational structures (and sometimes limitations) imposed by the gameplay mechanics, which are sometimes based around units or groups of miniatures that operate as a single gameplay entity. It is the Armies of the players that participate in the games, and the Units and Characters therein that act, succeed or fail. And it is these that have stories told about them most often.

It is there often the case that the practitioners perceive and treat each of these groups as a distinct single thing, referring to them (essentially assigning them) a collective identity, that stands on its own and creates, through the practice, its footprints that build up its own distinct record. It is also understood that the collective identities can be nested within each other and are not necessarily mutually exclusive. To illustrate this, we again revisit the vignettes of George's Raptors army and the story of *Squad Tigris* that was told in the *Last Stand of the Argo* exhibit.

In the former case, all of George's Raptor Army consisted of hundreds of models, including those shown previously that were used as physical manifestations of *Lias Issodon*. As all the models in his army (and the characters they may represent) are a part of that army, they essentially adopt and represent the Collective Identity of the Raptor Army. It is under that name that George refers to them when recounting stories of their exploits and performance from games he used them in. As illustrated below in Figure 6.7, the Collective Identity of the Raptors Army is the central element in this case, but it contains numerous other Identities and Objects that can also be the

focus, as seen earlier when illustrated from the perspective of the Singular Identity of *Lias Issodon*.

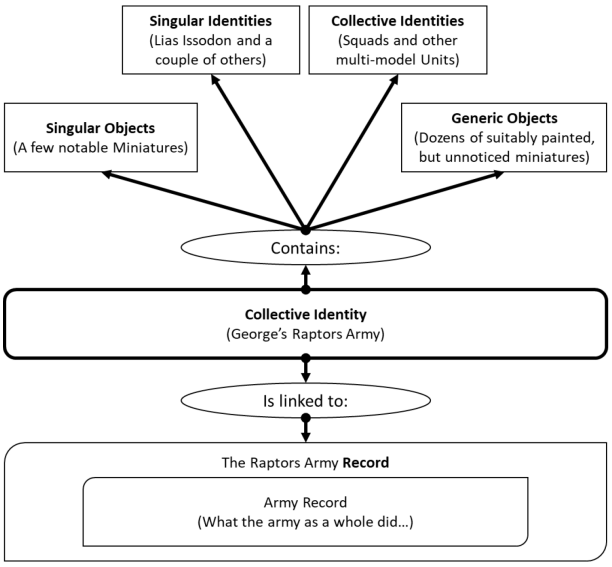


Figure 6.7. The Collective Identity of the Raptors, showing the various other Identities and Material Objects that it contains.

On a finer scale, we have the example of *Squad Tigris* from the 4th vignette, which demonstrates the case of a comparatively smaller Collective Identity of a single squad, which is made up of several Singular Identities, each of which is represented by a Singular Object.

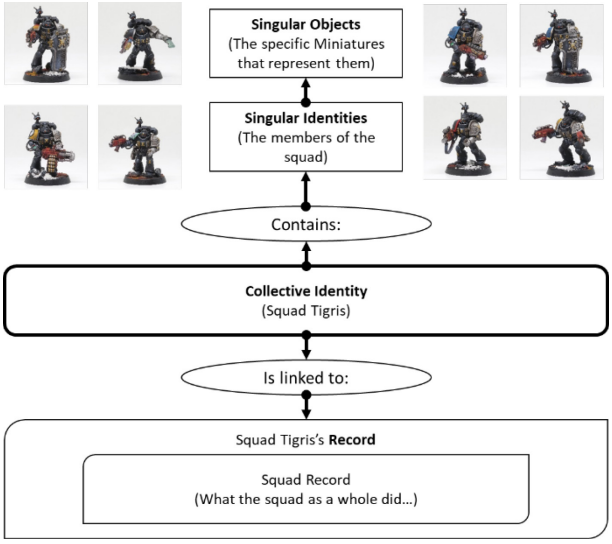


Figure 6.8. The Collective Identity of Squad Tigris, which contains several Singular Identities.

6.5 Fluid Relationships, Records and Links

Having laid out the components of the framework, the following section will detail the nature of the relationships between the abstract identities and the material objects that can appear and dissolve between them through events, and the links they can have with their records. We begin by elaborating on the relationships between identities and objects, followed by detailing the links between they can have with their records. Finally, we discuss how these can fluidly change over the course of temporal events.

6.5.1 Thing-to-Thing relationships

The 'things' that can be considered as part of the framework, whether as material objects or intangible identities, invariably have some form of relationship with other similar things. It is rare for anything to exist in a vacuum devoid of any contact or interaction with any other object or observer.

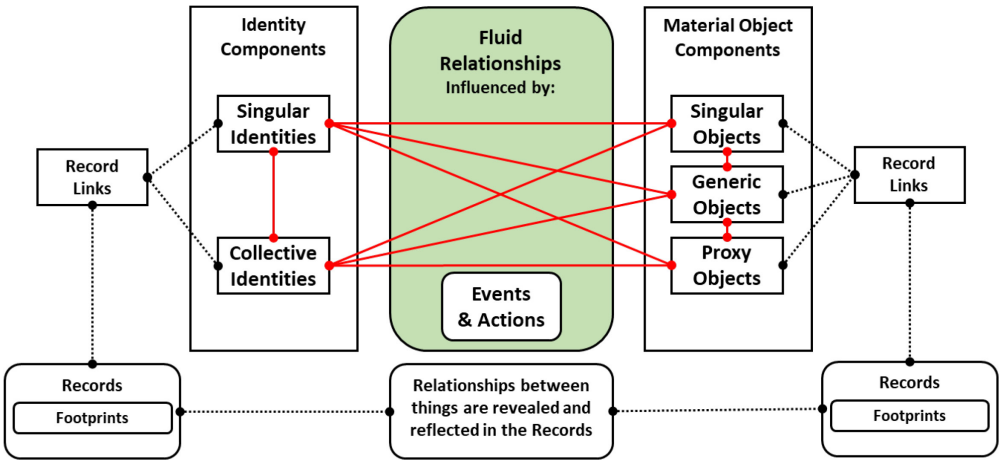


Figure 6.9. Focusing on the Relationships in the Meaningful Things Framework

Importantly, these relationships are heavily dependent on the context, setting and perspective of the observer. Throughout the previous chapters, we have seen wargaming practitioners refer to their miniatures, armies and collections – which are all 'things' that can be situated within the framework – with a variety of context specific terms. Examples have included:

- Miniatures that are “members of” squads and units
- Units are “part of an army”
- Miniatures that were built and painted together
- Characters that were designed for a particular group or event
- Miniatures and Characters that have directly interacted (Fought, duelled, killed, etc.)
- Miniatures and Characters that have something in common (particular battle, army list, etc.)
- Miniatures that are stored in the same case
- Miniatures that have the same general colour scheme
- Miniatures of the same ‘type’ (in gameplay terms)
- Used miniatures that were bought in the same lot

As can be seen from these examples, the nature of the relationships varies substantially, even within this one context. Some of the relationships are purely based on physical characteristics, such as their type, their paint scheme, their spatial positioning etc. Other are more nuanced – and context specific – in that they relate to interactions and connections that exist in the scope of the fictional setting of the practice, or in the cognitive way the observer perceives and makes sense of the things involved.

In addition, many of the relationships are ephemeral, existing only for a short period of time, usually for the duration of some sort of event, while persist for longer periods.

The above list of relationships is not exhaustive and depends heavily on the context, the level of detail of any records and the extent to which the observers and participants are motivated to develop it. In addition, it can be seen that relationships are not restricted to one-to-one relationships, but can also be one-to-many and many-to-many.

For example, specific miniatures can have a recurring one-to-one relationship with an identity that they are assigned to during games. The same model may at times be assigned to different identities and roles, meaning a one-to-many relationship over time. Similarly, a player’s army has a one-to-many relationship with the models and identities it contains, just as it has the same relationship with the squads and units it is made up of. By extension, squads have a one-to-many relationship with their members, and the members have

one-to-one relationships with each other. Members that can be assigned to different squads, for example between games, create many-to-many relationships.

It quickly becomes evident that classifying and reducing the nature of the relationships is a difficult task due to their variety and rich nature. Furthermore, it is reasonable to say that this nature will change dramatically from setting to setting. The framework relationships can therefore be loosely defined as the links and associations between element of the framework, both lasting and ephemeral, which communicate setting-specific context about the nature, organisation, relation and use of the 'things' involved. These relationships are often the product of setting interactions, and thus are an important part of the thing's record.

Supporting the capturing of the relationships for the Record, is best done on a setting by setting basis, in the same natural language and terminology that is innate to the setting and the practice. For storytelling activities, this is a relatively natural approach, seeing as how the perspective of the narratives would be told thematically or even 'in-character' for a constructed narrative, or from peer-to-peer with similar domain knowledge if shared within the community as a description of events.

6.5.2 Relationship & Link Fluidity through Events & Actions

The next concept of the framework is the fluid and mutable nature of the relationships and links, and the Events & Actions that enable these changes.

Events & Actions is the term used in the framework to describe various interactions, activities and happenings that occur either momentarily, or temporally for a period within the practice. The events can be planned and specified by the practitioners, as part of their normal activities, decisions or plans. Or they might be spontaneous and unexpected, caused by random or uncontrollable actions, inside and outside of the scope of the practice.

For example, a hobbyist crafting a miniature is an event. Deciding to use that miniature to represent a specific character that he has created, is also an event. As is him coming up with a backstory for his army that includes further fictional 'events'. When two or more miniatures, characters, units or entire armies interact in dozens of context-specific ways, these are also actions and events. These are the moments when relationships are made and broken between the entities described by the framework. Using a model to represent a character during a single game, creates a representational relationship between that model and that identity for the duration of that game. One character duelling another creates a relationship – adversarial in this case- between them, which is now part of both their records. Similarly, the links between objects and identities, and their records can also shift with events.

But notably, the events themselves can also have a distinct record that persists and can be queried to form the focus of a narrative. Events can also 'contain' other events. Their main differences, compared to the abstract and material components of identities and things, is that the events are temporal in nature, as they describe a specific period of time. However, their record and its effects may be far more persistent.

In the case of wargaming, such events can describe gameplay events, such as single games and matches, but also campaigns that feature a string of games played sequentially – or in parallel. Each battle has participants, which are the players, their armies, the units within, and the miniature models that make them up. Each of these have extended their own record by participating, and most probably 'acting' in some way. But it is also the battle itself that has a distinct record. It has footprints such as the time and date it took place. It has a setting and theme, potentially even a backstory. It has a winner and a loser. Smaller narratives may have emerged during the battle, and these are connected to both it and any models and identities that participated in them. But it also usually has tangible manifestations of its own, such as the table the game took place on, and the individual bits of modelled scenery that were used – as well as their arrangement at the time.

6.5.3 Records and Footprints

Records and Footprints are a relatively straightforward component of the framework. In keeping with the discussion of Records and their contained footprints throughout the research, the term *Records* continues to refer to the sum total of data and information that pertain to a certain thing. That thing may be a particular object or group of objects, or it may be the singular identity of an entirely fictional character or organisation. The term Footprints refers to the individual bits of content within that Record, and they can be in any from, both digital and analog.

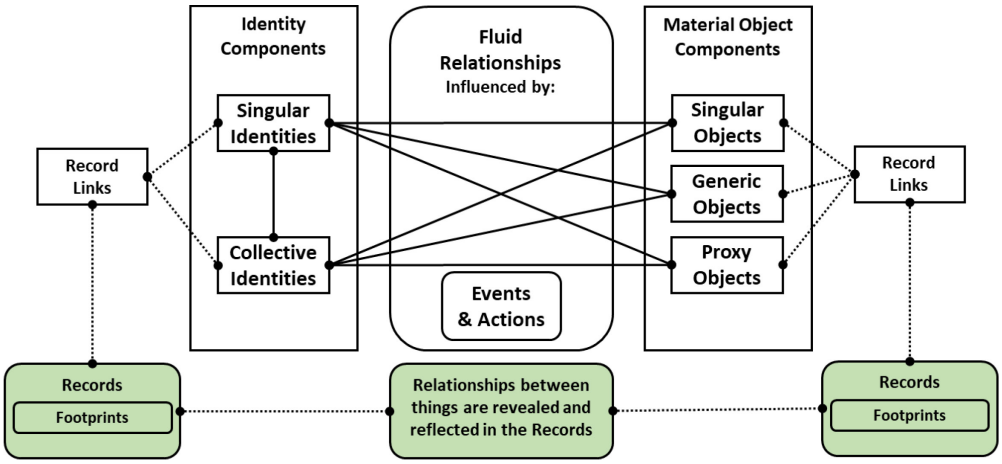


Figure 6.10. Focusing on the Records of the Meaningful Things Framework and their contained Footprints.

From the vignettes, we saw numerous examples of such records. *Inquisitor Terry's* tabletop exploits are captured during games on James's camera phone. Each picture is a rich footprint that is now part of the Inquisitor's Record. George would often make Facebook posts during the game with the images and a suitable caption (often with in-character expletives). These captions are also textual footprints of the Record, as are the paint scheme and fictional biography. Finally, *Inquisitor Terry's* Record also includes a 'Next-Generation' Footprint in the form of a 3D model created using the 3D scanner booth as seen in Figure 6.11 below

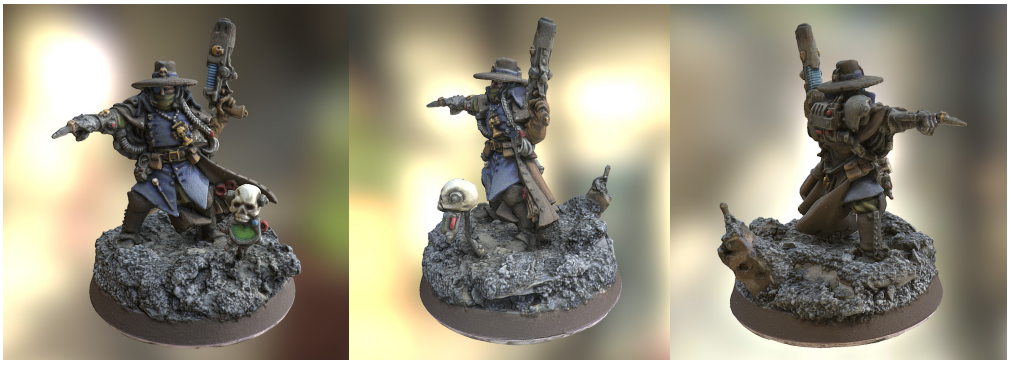


Figure 6.11. The 3D model footprint that is part of Inquisitor Terry's Digital Record.

While straightforward, it should be reiterated that the Records pertaining to the 'Things of a Practice' are probably the most valuable and persistent aspect of the Framework. In essence, they are the proof of the existence of these things, especially in the case of the intangible abstract Identities, which would otherwise only exist in the minds of their creators.

6.5.4 Record Links

The Records discussed above are often created and stored in digital form. The Digital Records are essentially the coherent and consolidated sum of the digital information and data which are relevant to an object or identity. The Digital Records are made up of Digital Footprints, which are the bits and pieces of data, such as text snippets, narratives, images, videos, 3D models, data points, etc. The Record Links are the connections between the 'things' described by the framework, and their Digital Records. Specifically, a 'Link' is the technological mechanism, by which an object or identity is connected to its Digital Record in such a way that it can be digitally accessed or retrieved.

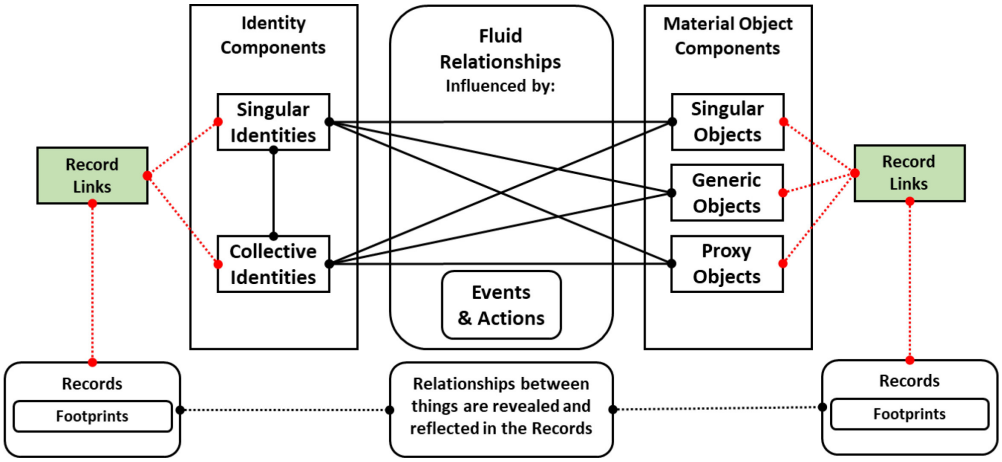


Figure 6.12. Focusing on the Record Links of the Meaningful Things Framework.

The links between the material objects, and their individual digital records, are facilitated relatively straightforwardly, through IoT-like techniques such as tags and embedded technology. They are primarily a matter of attributing – or connecting - the record content to the object, similar to the examples we saw in chapter 2 of the TOTEM project's tagging approach which used QR codes on stickers, or the Carolan Guitar project which embedded ArtCodes in the design and construction of the Guitar itself. In the former case, the objects where linked via the QR code to a single webpage, containing images and a text description authored by the owner and tagger of the object. In the majority of cases this rarely exceeded a single image and a few lines of text. In the latter case, the Carolan Guitar was supported by a bespoke website and content stream, and the various Artcodes embedded on its body would link to different parts of the website, and in some cases, would change or update the mapping. The exact nature of the links will vary greatly, depending on the practice and the context at hand. But in terms of the framework, Record Links are the connections of another framework component, whether a tangible object, or an intangible identity, to a Digital Record.

6.6 Applying the Framework

With the components and mechanisms of the framework described in detail above, the following section will demonstrate the framework in action by applying it first to the examined wargaming context, by revisiting the running vignettes we have become familiar with, and then by applying it to different contexts, such as the Carolan Guitar, and the TOTeM and Significant Objects projects, as well as the handicraft world of knitting through the online Ravelry community.

6.6.1 Applying the framework to Tabletop Miniature Wargaming

First, we return to the diagram of the framework, and appropriate it for the context of wargaming. As seen in the example in Figure 6.13 below, the various components of the framework are mapped to the phenomena that were identified to occur in the practice.

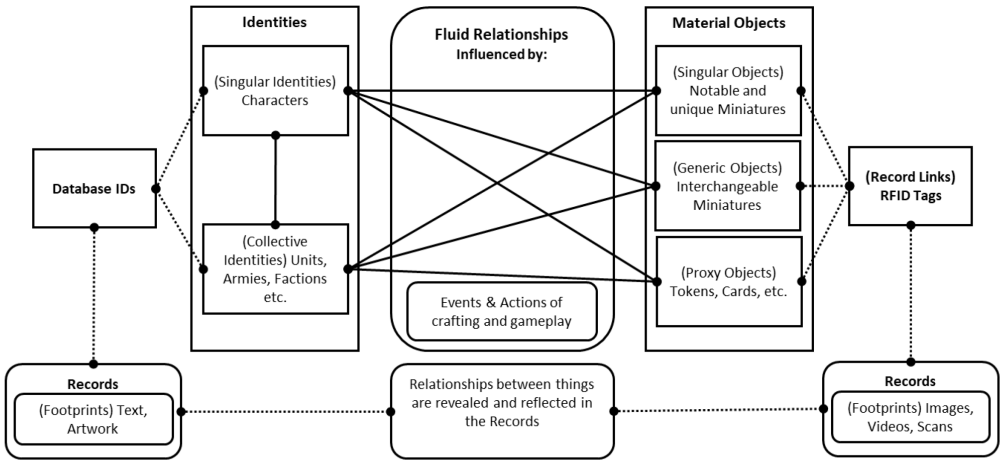


Figure 6.13. The Framework as it applies to the practice of Tabletop Miniature Wargaming.

The use of the framework can be further detailed by again employing the running vignettes, this time however as seen through the lens of the framework, specifically:

- *Inquisitor Terry*
  - A unique miniature made for a specific character identity
- *Lias Issodon*
  - An identity represented by various miniatures at different times

- The *Green Marine*
    - A unique model representing different identities at various occasions
- Squad *Tigris*
    - A collective identity, consisting of various character identities and miniatures.

Each vignette will be illustrated by two diagrams, one as a snapshot of the object or identity and its immediate relationships as described within the framework, and one in the form of a timeline which will demonstrate how the entity forms and breaks relationships over time with other entities.

Inquisitor Terry

We've seen many times by now how throughout the creation and existence of *Inquisitor Terry* – and his model, there is a practically unbroken connection between the character of *Terry* and the miniature made to represent him. In terms of the framework, this is the most straightforward situation, where a singular physical object and a singular identity have been created practically as one thing, and proceed to 'exist' effectively in tandem. We have the **Singular Identity** of *Inquisitor Terry*, and the **Singular Object** of the model of *Inquisitor Terry*, explicitly described as the "Blue Robed Inquisitor Model with the Distinctive Fancy Hat" – but as the identity and object are perceived and treated as one when it comes to contextual activities, it is rarely referred to in this way. Except by those who know the Identity. Observers who are not familiar with it will probably refer to the material object (Blue Robe…Fancy Hat). In addition, Inquisitor Terry "belongs" to the Collective Identity of "The inquisition", James's army.

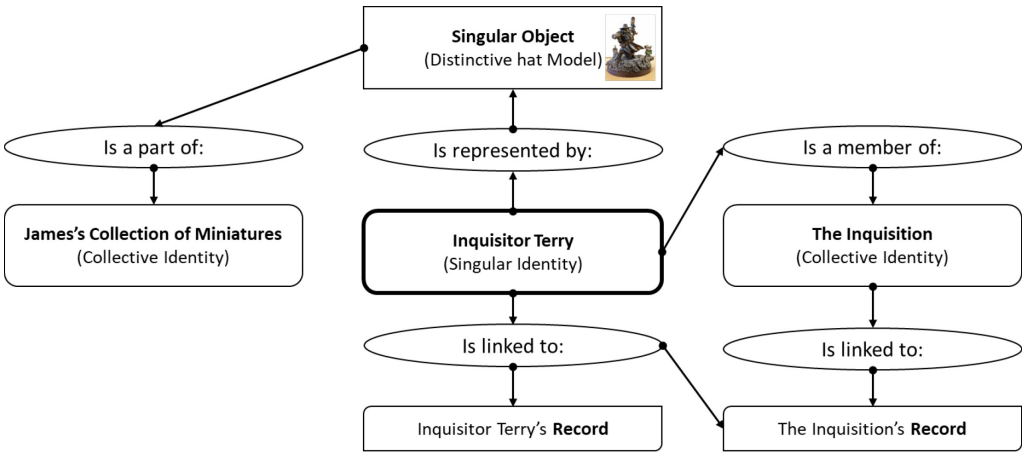


Figure 6.14. Snapshot of some of the relationships that the Singular Identity of Terry exhibits.

A snapshot of these relationships is visualised above in Figure 6.14, from the point of view of the *Inquisitor Terry* Identity. There we see the focal entity that is the Singular Identity which is *Linked* to its Record, but also to the wider Record of the Collective Identity that it belongs to which is expressed as a membership *Relationship*. We also see the representative Relationship between the Identity of *Terry* and the Singular Object of the Distinctive Hat Model, which is itself a part of the Collective Identity of the collection of miniatures that James owns, and which he will refer to as such both verbally and in written accounts.

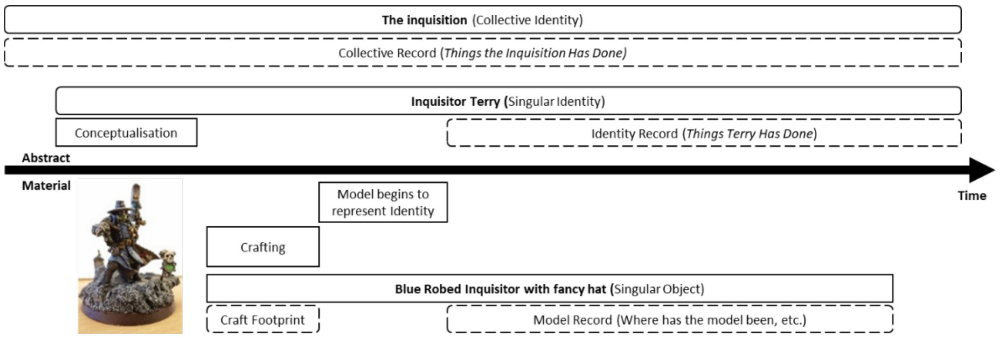


Figure 6.15. A timeline of the 'existence' of Terry split along the Abstract and Material aspects of the Meaningful Things Framework.

Similarly, above in Figure 6.15, we see what a timeline of *Inquisitor Terry* lifetime might look like when considered using the Meaningful Things Framework. Split vertically along an Abstract/Material divide, we see how the

existence of the identity of the character slightly precedes the creation of the physical model, which contains a digital record of the crafting process itself. From that point, onwards both the Identity and the Model have distinct records, but by having an unbroken identity-to-thing relationship the model always represents the identity. The two Records expand in tandem and can be practically considered as one Record. What may be different in some cases are the kinds of Footprints that are contained within the two Records, such as stories and narratives about the identity, and images and other media about the miniature, as well as utilitarian information such as its location and condition. This timeline would also include the various Events that would be the milestones in the Record, as we shall see in the following application of the framework.

Lias Issodon

Next, we revisit the character of *Lias Issodon*. In Chapter 4 we saw how the character of *Lias Issodon* was appropriated from the fictional background of Warhammer 40,000 as participant George had chosen to make a Space Marine Army of the Raptors Chapter, and this was one of their signature characters. Although he did not have an official model George wanted to have *Issodon* leading his army in every game – both for the narrative and for his powerful rules.

George's ultimate plan was to make a high-quality model conversion at some point, but at the time of the interview he had not got around to it. Thus, as he was lacking a model to represent *Issodon*, he used various different models as stand-ins during games. But importantly, as far as he was concerned, *Lias Issodon* was "present in each of his games and regardless of model was always that same character" – or Singular Identity in Framework terms. Furthermore, it did not unduly concern him that the character existed in the background and was not his own creation. The way he saw it, this was "*His Lias",* and any happenings on the table where part of *his Lias's* story – regardless of what model he was using to represent Lias Issodon at the time.

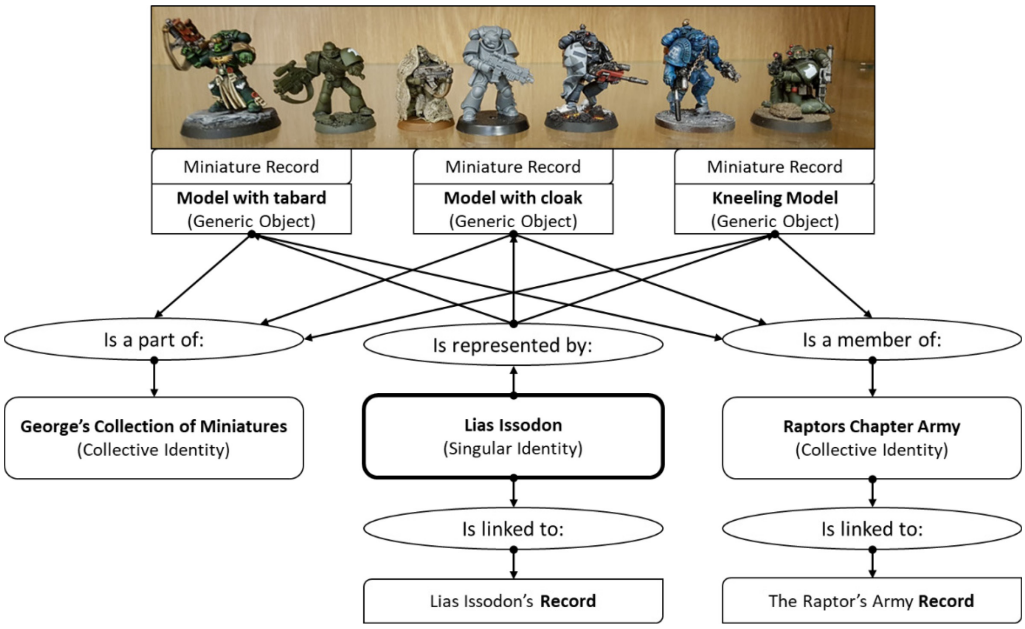


Figure 6.16. Snapshot of Lias Issodon's Framework-derived Relationships.

Just as with *Inquisitor Terry* previously, Figure 6.16 above shows a snapshot of the Framework Relationships that the Singular Identity of *Lias Issodon* exhibits at any given time. It is a much more complicated situation than with *Terry's* tandem relationship between Singular Identity and Singular Object. In *Issodon's* case he is represented by many more different material objects, some Singular – in that they themselves are objects of note. And many more Generic – meaning they are not particularly notable or distinctive but served the purpose of representing *Issodon* for a game or two. Furthermore, each of these miniatures is a part of George's collection and are thus connected to that identity. At the same time, since they are all painted with the appropriate colour scheme, they are also members of George's Raptors Army, which is yet another Collective Identity. Notably, the Singular Identity of *Issodon* maintains its own record, regardless of whether it has a material object to represent it at all times.

This therefore is the critical and common case where an abstract object, in this instance a characterful Identity, has a distinct Record of its own. It can grow via Footprints, which can be just textual narratives made by the hobbyists, but they

can also be gained during gameplay when the character is represented by a miniature. The miniature in question can have its own separate record, which also grows with footprints such as for example images or a crafting log. And the same footprints apply to the Character in the cases where they were made while the Miniature and the Character were associated, such as during a game. This applies to all the miniatures that may represent that character, as was the case with George's *Lias Issodon* character.

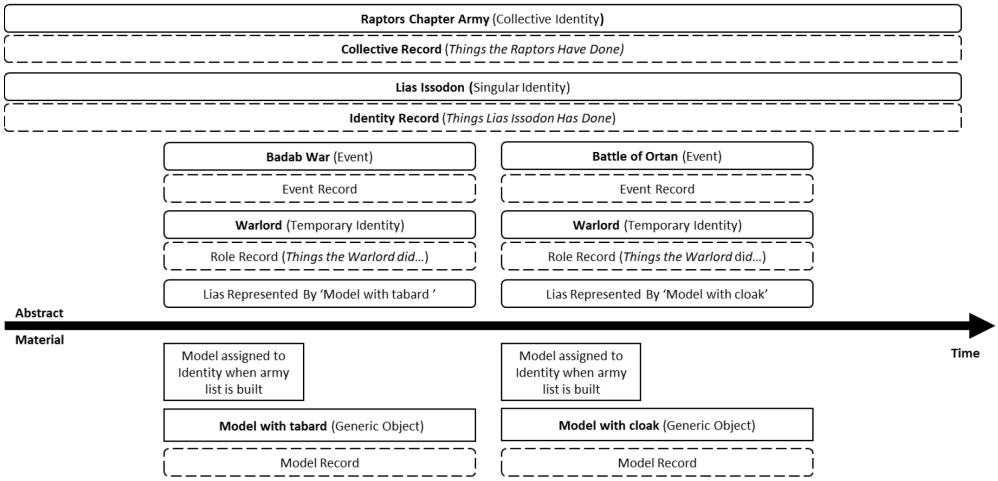


Figure 6.17. TimeLine of Lias Issodon's existence over two game events.

The idea of a Singular Identity adopting – or being represented – by different objects over time is better illustrated in the timeline diagram above in Figure 6.17. Here we see how for the duration of two different events, games in this case, the Character of *Lias Issodon* was represented by different miniatures. In the first event, the "Badab War", *Lias Issodon* was represented on the table by a model described only as the "Model with Tabard" by George. As he did not deem the miniature of particular importance, it would be in this case a **Generic Object**. During the next event, *Lias Issodon* was represented by an entirely different model, the "Model with Cloak". George, despite valuing it more due to its "nicer paintjob", still did not consider it particularly important to him as he had bought it second hand, so it too is a **Generic Object** as far as the framework is concerned. As seen in the diagram, the Record of *Lias Issodon*

remains essentially unbroken, with his actions during each event (as actually perpetrated by the miniatures) being attributed to him. In addition, we see how the Record of the Raptor Army that Lias is part of also grows, as it is the **Collective Identity** that he and the other character and miniatures are members of.

The Green Marine

Next, we consider the case of the *Green Marine* miniature, sometimes known as *Sergeant Bob*. Like the previous 3 vignettes, we first saw the *Green Marine*, in chapter 4, where he was introduced as one of George's models. A plastic miniature from Games Workshop's Space Marine model line, the *Green Marine* was picked out by the participant as a talking point, due to the way the model would continuously shift between recognition and anonymity. Physically, the model is not of any particular note, not having a complex build, nor a high-quality paintjob. George mentioned that its only distinguishing feature is its "reloading pose", which allows him to tell it apart from its "brothers". Because of its green paint scheme, the model is always a part of George's, by now familiar, Raptors Army, a faction within the Warhammer universe which uses this particular colour scheme – as such it usually cannot be used in another army. Due to its type - a Space Marine - and modelled equipment, it is limited to those Army roles that can be equipped in such a way, dictated by the Warhammer game rules. As such, George mostly uses him as a normal Marine in a Tactical Marine Squad unit. These are archetypes defined by the game rules, with a Tactical Marine being the equivalent of a basic trooper.

However, sometimes George would assign him as a "Squad Sergeant" – another rules-defined archetype - in smaller games. Squad sergeants are nominally the leaders of squads, and each squad has one. As permitted by the rules, they can choose to carry better equipment from a bigger selection, assuming the player has enough points to 'buy' that equipment as part of his army list, something that was discussed in chapter 3. This also means that there are more modelling opportunities, and most sergeant models are therefore

quite distinct from the troopers. George would use the plainer *Green Marine* as a sergeant in some smaller games mainly because the lower points restrictions of these games would not allow him to equip the squad's sergeant with better gear, and his usual sergeant model could therefore not be used as it was modelled with points-expensive equipment. The *Green Marine* was given the role because he could be distinguished from the other marines due to his pose. When this was the case, George would refer to him as *Sergeant Bob*, who was effectively a recurring character in his army – and therefore an identity with its own distinct record. This **Singular Identity** would always be a part of his army, but was never tied to a particular model, nor was it as fleshed out as the examples of *Inquisitor Terry* or *Lias Issodon*.

The complex situation above is partially illustrated in the snapshot in Figure 6.18 below, using the Framework to paint the picture of an object who, while normally of little notice, would occasionally rise to prominence for a short period of time. In addition, a number of relationships are described with other objects and identities, which also shift and changed through the model's existence.

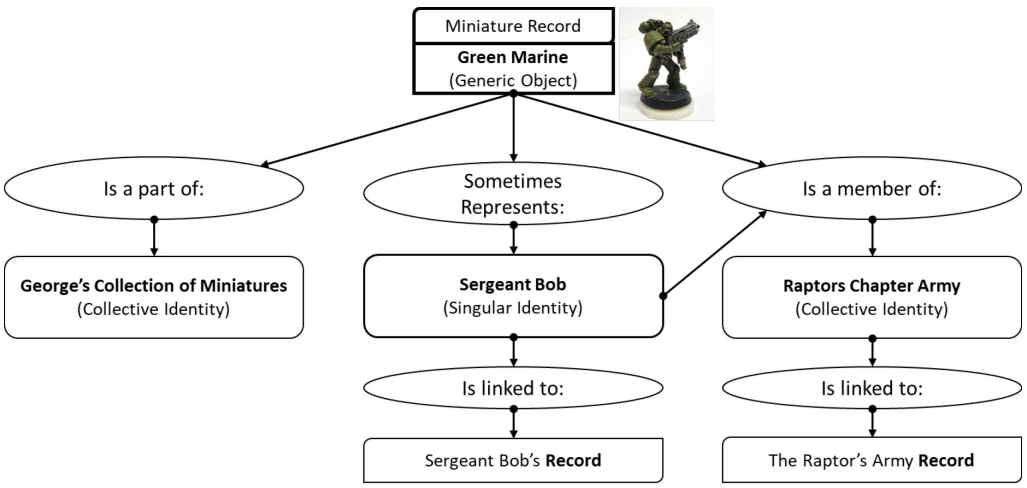


Figure 6.18. Snapshot of the Green Marine as seen through the Framework.

As can be seen in the figure, the *Green Marine* has several relationships with other entities that can be described by components of the framework – some

permanent and some ephemeral. Similarly, to the examples seen earlier, most of the time the *Green Marine* model has the following relationships:

- Part of Participant X's Collection
    - Due to ownership of the physical miniature
- Part of the Raptor Army
    - Due to colour scheme associating it with the Collective Identity of the Raptor Army)

Sometimes it develops the following relationships:

- Part of an Army
    - For the duration of a game or tournament and made part of the Roster
- Member of a Tactical Squad
    - Due to type and equipment the model would be used in tactical squads with other similar models
- Sergeant of the Tactical Squad
    - In some smaller games where the usual sergeant model could not be used.
- Gameplay Interactions with other models and identities which cause relationships:
    - Nemesis, Adversary, Duels, etc.

As a material Generic object, the *Green Marine* tends to have a more 'busy' existence as in practice it gets used more often and thus gets to 'act' more. The timeline diagram below in Figure 6.19 helps illustrate how these relationships occur and dissolve over time. The miniature model itself, even as a Generic Object, can retain its own distinct Record which would contain footprints such as images of the model, its craft information, etc. During – or due to – various events, in this case two different games, it forms and dissolves a number of relationships.

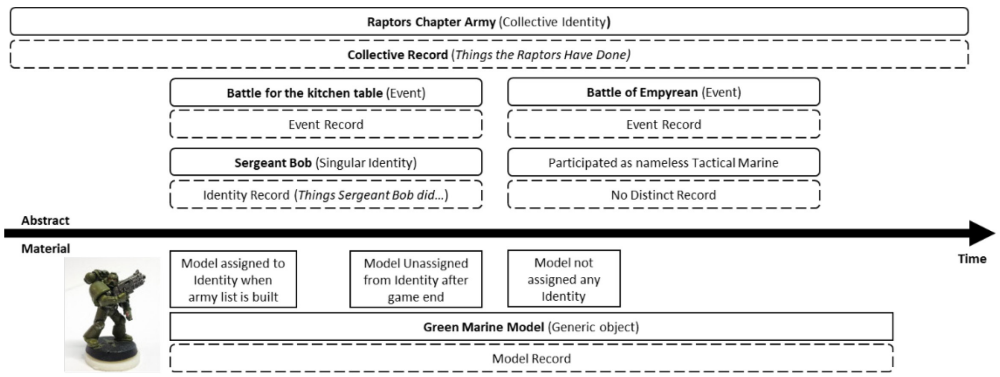


Figure 6.19. A timeline example of the existence of the Green Marine miniature.

First, during the “Battle for the Kitchen table”, the model was associated with Singular Identity of *Sergeant Bob*, as the game is smaller and the normal sergeant model cannot be used. For the duration of that event, the *Green marine* miniature was representing *Sergeant Bob*, thus any gameplay ‘actions’ build up the record of both the miniature and the identity. After the game ends, the relationship is dissolved. For the second event, the *Green Marine* is used as a standard Tactical Marine in a Tactical Squad. For this event, it does not represent any Singular Identity. It does however have a relationship with the **Collective Identity** of the Raptor Army – which it did in the previous game as well. It also has a relationship with the identity of *Sergeant Bob*, as the squad the *Green marine* is a member of is led by him – albeit while represented by his normal sergeant miniature model.

Squad Tigris

Finally, we re-examine the 4th running vignette, *Squad Tigris* from the Mixed Reality Storytelling project. Describing a multiple member unit, *Squad Tigris* is evidently a Collective Identity. One that is itself contained within the larger Collective Identity of the *Adeptus Astartes*, the faction of which they are members. Furthermore, the ten members of *Squad Tigris* are all individual Singular Identities of characters – each of which corresponded to a specific Singular Object in the form of a miniature crafted to represent each one of them. Similarly, to the previous examples, the snapshot diagram below in Figure 6.20 aims to illustrate the situation using the Meaningful Things Framework. *Squad Tigris* has ten members, each a named individual character. The Figure shows them in a loose arrangement starting on the Left with *Veteran Asmocar* and ending on the Right with *Veteran Kothos*. Each of the members is a Singular Identity, and each one of them have a membership relationship with the Collective Identity of *Squad Tigris* which both in gameplay and in narratives is treated as a single unit. By extension the individual members are also associated with the squad’s Record and each of their actions and Footprints add to that Record.

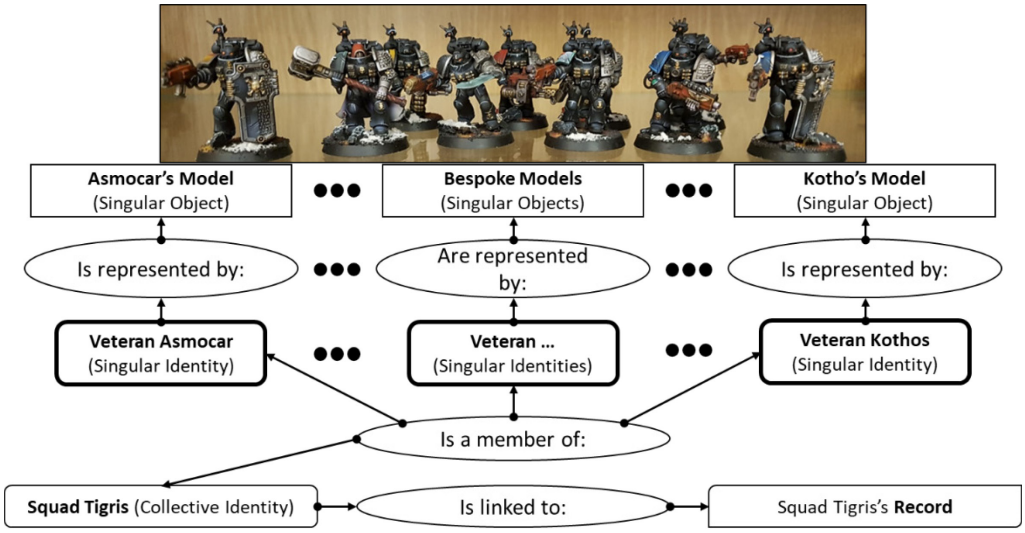


Figure 6.20. Squad Tigris and its ten members as seen through the Framework.

In addition to this they each have their own individual Records, which can grow independently of the Collective Identity's Record, for example by having one of them being scanned by the 3D scanner to create a 3D model footprint as seen for *Veteran Kothos* in Figure 6.21 below. Importantly each of this Similar Identities are very reminiscent of *Inquisitor Terry,* as each one of them had a bespoke miniature crafted to represent them, each of which is a Singular Object in their own right. Thus, just like in the case of *Terry*, the Records of the Singular Object Miniatures and the Singular Identity Characters are paired and are treated in tandem.

Figure 6.21. The 3D model Footprint of Veteran Kothos.

6.6.2 Applying the Framework to the Carolan Guitar

The *Meaningful Things Framework* is designed to be generally applicable and can be further adapted and extended to suit the context of other practices and settings. Beyond the context of tabletop wargaming, another example, still in the context of a creative practice (instead of for example a cultural practice), is that of music making. Most musicians would tell you that their instruments are dear to them. Experienced musicians pick their instruments based on several highly personal factors, and over time attain large collections of them. If asked, they can usually point out (if not name) each instrument individually and elaborate on their particular characteristics and peculiarities. This, combined with their innate haecceity as creative and aesthetical material objects, make them very good examples of singular objects, that often gain a distinct singular identity that transcends their material ownership or even existence.

Figure 6.22. (Left) The Red Special (Right) The Carolan. Both examples of unique-by-design artefacts

This can be observed in cases of famous guitars such, such as Bryan May's "Red Special", which like the case of *Inquisitor Terry*, exhibits a distinct Singular Identity in tandem with a unique Singular Object that has a well-documented history of its design, construction and use as an artefact of wide interest. However here we shall focus on the previously mentioned Carolan Guitar which was designed from the ground-up as an "Accountable Artefact" incorporating IoT inspired technologies, including as we saw back in Chapter 2 multiple ArtCode tags and (removable) embedded sensors, which help build and link to its substantial digital Record.

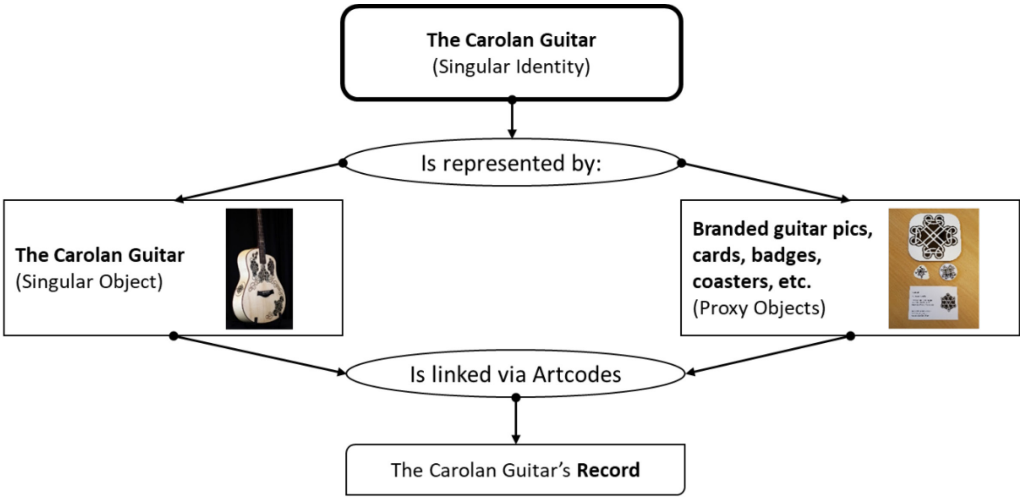


Figure 6.23. The Carolan Guitar as seen through the Framework.

Above Figure 6.23 illustrates how the Carolan Guitar fits into the framework as the by now familiar matchup of a Singular Identity paired with a Singular Object. One might ask why the Carolan Guitar is a Singular Identity, instead of just a Singular Object. This is a valid concern, seeing as unlike the previous vignettes were the distinction was easier due to the anthropomorphised nature of the objects and their 'life' beyond the material. For Carolan the difference is not as clear, however it is worth nothing that the Carolan began to accumulate a Record and presence before the actual artefact was even created. Just like with *Inquisitor Terry*, there was a substantial period of intangible conceptualisation prior to the guitar's creation. The content created by this process is part of the Carolan Identity's record. Of particular interest are the various promotional artefacts, including guitar picks, badges, coasters and business cards, that were created to publicise the project and serve as mementos for those who came into contact with the guitar. These artefacts bore scannable ArtCode patterns on them that linked to Carolan's online digital Record, exactly like the patterns on the actual artefact. In essence, they represent the Identity of the Carolan Guitar, but do not serve the same functional purpose as the actual artefact, in other words they cannot be used to create music. Therefore, these artefacts fit the framework's definition of a proxy object, serving as tangible link to the Record that may otherwise be inaccessible without the real artefact to scan.

6.6.3 Applying the framework to the TOTeM and Significant Objects Projects

In Chapter 2 we also saw two other related projects, the object-tagging *Tales of Things* (TOTeM) project and the Narrative driven *Significant Objects* project. Re-examining both of these different and unrelated projects through the lens of the Framework reveals both how relatively disparate elements and approaches are accounted for, and where there are issues that can be addressed.

To recap, the *TOTeM* project used an online form where users save 'Tales' about their objects. In practice, they could upload an image and a short description of an object, which was essentially a blogpost. They could then generate a printable QR code containing the URL for that post, that they could attach to the object, which in theory would allow anyone to access the online 'Tale' of the object. Below in Figure 6.24 is illustrated the case of the "Smiths Pocket Watch" [231] which is a very straightforward case of a specific object – therefore a Singular Object – being linked via a QR code sticker to a digital Record containing two small content footprints of an image and a text description.

Figure 6.24. The straightforward QR code enabled links between the TOTeM objects and their Records.

Conversely, the *Significant Objects* project, which acquired a selection of specific objects, endowed them with fictional stories and sold them at a much higher value, did not use any particular form of Record Link in order to connect the material objects to the stories – which essentially are their record.

Figure 6.25. The lack of Links between the Significant Objects artefacts and their respective Records.

Figure 6.25 above illustrates the case of the Hawk Ashtray [232] - which had been given a story authored by William Gibson - expressed in terms of the Framework. The objects themselves were never technologically 'connected' to these stories in any tangible way, meaning there were no machine-readable tags or any sort of link back to the digital content. The stories were used as the descriptions for the auctions that resold the objects on eBay, which created an ephemeral and intangible link, which is actually the most common situation between material objects and the various content about them that can exist in everything from written notes, website content, old camera film rolls or just memories. This shows how there are in fact 'Records', or at least Footprints and content about objects in existence, but without some form of linkage it is usually beyond management, curation and sharing and most importantly prone to erosion and loss.

6.6.4 Digitally supported crafting – The Ravelry Community

To be robust and useful the framework must be generalisable and applicable to other settings, contexts and practices where HCI meets existing community activities revolving around objects and storytelling. We saw in chapter 2 how even the most basic or tangential technological support led to entire communities, practices and phenomena to take form, such as in the case of *Where's George* and *BookCrossing*, which consisted purely of human-driven databases. In addition, *TOTeM* and *Carolan* showed how IoT-inspired approaches can link stories and provenances to objects through organised digital Records, while the *Significant Objects* project demonstrated the power of those stories to influence meaning and perceived value.

By design, the framework takes into account that not all aspects of such practices revolve solely around physical objects. Thus, beyond the focused case of miniature wargaming, the framework can be applied to contexts where the apparent focus of the activities is on other elements, such as ideas, characters, designs and cultures. Technology has already been applied to support such communities and contexts, some more successfully than others. One such

context that we shall examine further is that of craft activities such as knitting, which while seemingly very different from the gameplay and hobby focused pastime of miniature wargaming, actually share many underlying similarities, something that the framework helps to make more apparent.

Specifically, the framework was tested by applying it to the successful online crafting community known as Ravelry [35,70,114]. Ravelry was launched in 2007 as a social network for "Fibre Arts and Artists", meaning all activities revolving around fibre crafting such as Knitting, Weaving, Crocheting, Spinning, etc. While officially in beta until 2010, the network's website continues to have features added as suggested by the community, which is a crucial point as the design and feature set has been heavily influenced by the needs, desires and activities of the community members. Thus, with over 1,500,000 users it has evolved into a network, organisational tool and repository of knowledge that is lauded as a particularly successful case of technology integration. This has led it to become the focus of numerous studies and research efforts both in the subjects of technology integration and effective social networking [86] and for e-commerce and patenting [75,76].

In practice, the platform gives users the expected functionality of a social network, including user profiles, groups, forums, media uploads, private messaging, etc. However, where it begins to quickly differ is by providing tools and functionality that are tailored for the community. Examples include databases of commercial patterns and yarns, complete with cross indexes and support for sharing custom patterns and new designs. It provides users with their own project pages, complete with progress tracking, a blog-like update interface, inventory tracking for tools and materials such as needles and yarns, pattern design spaces and transaction mechanisms.

There are detailed ethnographies of this specific community [84,134,148] but there are some key stakeholders, practices and elements that stand out:

- First are the users, these can be people who simply wish to belong to the community to get access to the patterns and tools, and discuss the practice.

- Designers are users who create and contribute designer patterns. Some are creative individuals, some own their own business, and some are proxies for related companies.
- Designs are self-contained sets of instructions – written in a codified language – which can be followed by knitters to make their own "instance" of the design.
- Projects describe the entire process of a Ravelry user making an "" of a pattern. While they are unfinished, the "instances" are referred to by users as a 'UFO', an unfinished object. After they complete they are referred to as an 'FO', a finished object.
- Ravelry users can choose a design from the library, then begin a project to keep track of their progress and share updates such as work-in-progress narratives and images until the object is complete. Following completion, they share images of the completed object. Sometimes they will share images and stories about the completed object well after the crafting process is complete, such as pictures of events or trips where the object was worn.
- Like the other elements, Yarns are a top-level element of the practice. This is due to their importance in the crafting process, as their extremely diverse nature often dictates the project they can be used in, and building a collection and inventory of yarn is a key aspect of the knitting practice – referred to by knitters as a 'Stash'. Ravelry has dedicated tools for 'stash management', which cross indexes all known suppliers and yarn types with their applicable designs'

Therefore, the underlying phenomena, activities and mechanisms of the Knitting practices that the Ravelry community supports are just as complex as those of wargaming. The application of Meaningful Things framework was shown to be useful in revealing and illustrating this.

Some elements quickly began to stand out: First are the Designs, which while intangible in nature, exist as a clearly defined idea, that has a design process and information about it, which are effectively footprints, digital in Ravelry's case, which can make up a Footprint. In terms of the framework, **the design is akin to a Singular Identity**. In addition, the design is almost always represented by a 'master' physical 'instance' of it. For example, it would be the 'make' that the designer knitted and whose images she uses to illustrate the design. This could be considered a **Singular Object**, at least to the designer. The instruction sets that describe how to make the design are also crucial elements and they could be described by the framework as **Proxy Objects**. They represent the design, and can be used to create it, but they are in no way functionally similar.

The framework can also be used to describe the complex situation that forms when a knitter begins a project to make their own instance of a design. For that user, the object they are making is a **Singular Object** in most cases. It could also be a **Generic Object** if they were making multiple instances, something that is common with smaller projects. The process of crafting the object has a record comprised of footprints. These will be Work-in-Progress (WiP) pictures, accounts and progress updates. Through Ravelry these footprints do not have to be generated entirely by the crafting user. Other users may leave comments, or even share progress on their own instances of the design.

There may also make variations of the original. As such, the project itself can be a **Singular Identity**, albeit closely related to the singular object of the tangible item the knitter is creating. When the object is finished, it will also often have a record of use. That record may no longer be created and perpetuated by Ravelry though. The knitter may add to its record in other ways, such as by creating and sharing images on other social media platforms with the object used or worn. The object may also take on a **Singular Identity** over time as through its use, the associations and memories it is part of, will make it meaningful for its owner and those close to it. The other accoutrements of the practice such as the yarn and tools such as needles can be considered aptly **Generic Objects** since they are functional items which can relate to the patterns and projects. As was done earlier with Wargaming, Figure 6.26 below illustrates the familiar framework layout as it can apply to the Ravelry network and the practice of Knitting.

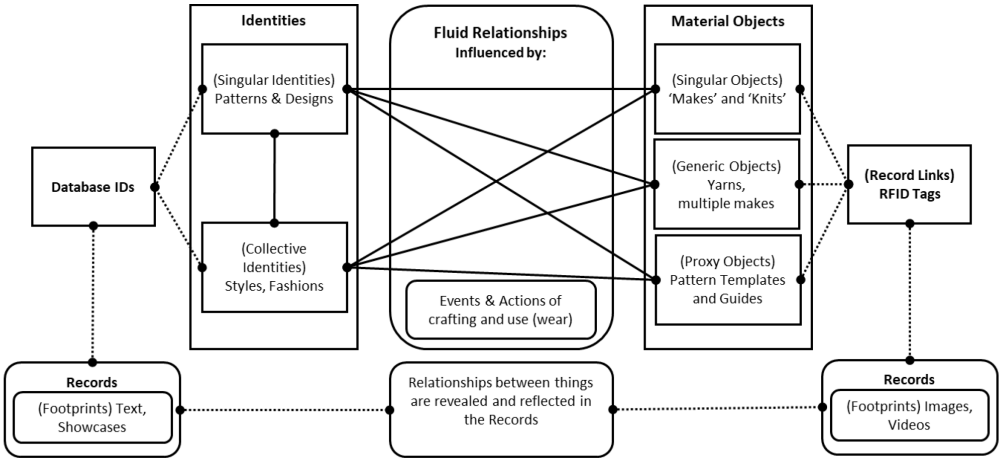


Figure 6.26. The Ravelry Network as seen through the Framework.

We see therefore how the framework can begin to unravel this complex picture and support the understanding of the complexities of community practices and guide designers and stakeholders in the development of supporting technologies.

6.7 Conclusions

This chapter served to present the Meaningful Things Framework which emerged as a way of understanding and communicating the complex ways by which people commonly perceive and treat the 'things' within their practices.

As emerged from the findings of the ethnography and probe workshops, the things that are involved in any practice, whether they are the product of the practice, such as in the case of crafts, or a functional artefact that is vital to the activity, such as a musical instrument in music-making or a knitting needle for knitting, is not always necessarily a material object – especially where after-the-fact narratives are concerned. The diverse past-time of tabletop wargaming, which encompasses both crafting activities and active use (through gameplay) helped demonstrate this by illustrating how wargamers more often than not created or appropriated identities for the characters and organisations that they employed in their activities. And sometimes these identities emerged spontaneously by themselves through the uncontrollable randomness of gameplay.

Such phenomena can be seen in other contexts as well, and in order to help communicate this, the Meaningful Things Framework was elaborated in order to illustrate some reoccurring archetypal elements. These were split among the material and abstract, with the former including Singular Objects, describing notably unique physical artefacts; Generic Objects describing interchangeable but still functioning objects, and Proxy Objects which describe stand-in objects that cannot function like the object they are representing, but can act as a reference to it. The second category of Abstract archetypes contains the pivotal Singular identities, which refer to unique entities such as characters and roles, and collective identities which are similar to singular identities but are wider in scope and can contain other identities or objects. All these elements are connected via fluid context-specific relationships, which occur and dissolve based on the events and actions that take place in the context of the setting and practice.

Finally, and importantly, each of these elements can exhibit a distinct record of its own, containing footprints of data and information that pertain to it and aid in later narrative creation. The Framework was applied to the examined context of wargaming, being used to reimagine the telling vignettes that were observed during the fieldwork. However, the Framework is designed to be generalizable to other settings. The following chapter will discuss the outcomes of the framework and its uses and potential future work that can be done to expand it.

7 Conclusions

Following a summary of the thesis, this concluding chapter outlines the potential contributions and implications of the Meaningful Things Framework. This is then followed by a brief discussion on the potential users of the framework and the likely beneficiaries. Finally, a speculative conversation is struck on the possible next steps and future work that could follow on from the framework and the supporting research.

7.1 Summary

The growing role of ubiquitous technology and persistent digital records on an ever-increasing number of aspects of our daily lives has set the stage for several line of enquiry. This thesis set out to take a closer look at how Internet-of-Things inspired technologies are influencing the relationship between people and their cherished and meaningful material creations and possessions when considering the oncoming reality of persistent records of their traced lifetime. In other words: How would we feel about and treat traced objects that we could potentially know anything about?

The approach of taking a in-depth look at the practice of tabletop wargaming, which involves acknowledged meaningful objects, led to the realisation that the substance of the practice was substantially more complex than it appears on the surface. In particular, it came to light that despite the apparent focus on the intricately crafted material objects that the practice is known for, the practitioners found equal or more meaning and fulfilment in the intangible things of the practice. And more importantly, these things acquired records just as rich and meaningful as the material objects, if not more in the narrative-centred activities of the practice. This contrasted with the predominantly material object - focussed approaches of most Internet of Things - inspired solutions.

Further investigation driven by a series of Technology Probes, Workshops and a public exhibit, led to the formulation of the initial findings into insights that

provided the bedrock for the creation of the Meaningful Things Framework, a conceptual framework aimed at disambiguating the complex and hard-to-give-voice-to innate activities and aspects of creative communities of practice. Offered as a tool in the arsenal of designers, developers and members of communities of practice, the framework aspires to provide a common language and flexible terminology to assist in participatory and multidisciplinary development of solutions that can support and expand the activities of communities of practice without compromising the nature of the practice.

The following subsections reiterate the work described throughout the thesis.

7.1.1 Related work and Theoretical Framing

The first section of the thesis outlines related work covering first the current state of the Internet of Things and importantly its trends and research and commercial focuses. The literature and work of the IoT is predominantly concerned with the technological challenges of addressing and accessing the anticipated vast numbers of distributed sensors that are the current vision of the IoT and how the unwieldy amount of captured data will be managed and made use of, if not necessarily made sense of. This leads to the description of the current state of the IoT as one that is better likened to an "Internet of Sensors and Data" as the 'things' in the IoT are mostly distributed and embedded sensors contributing to silos of data whose main purposes range between utilitarian to commercial.

In response to this, the thesis then presents research and related projects with a more creative and human focus, which have either been inspired by the approaches of IoT, or sprung independently from creative use (and misuse) of the Record tracing capabilities of such technologies. Most of these works show a deep interest in the power of tracing the records and provenances of things, that can elicit meaningful experiences, inspire creativity and influence the personal and monetary value of things.

Finally, this section takes a brief transdisciplinary foray into the fields of thought that have occupied themselves with the nature of objects and things, what differentiates them, how they come about and why some of them become meaningful. Considering the prevalence and importance of the intangible things of the investigated practices, thought is given to how these philosophical deliberations treat the distinction between abstract and concrete objects, and how these tend to emerge and be considered in practice.

7.1.2 Ethnographical Investigation of Tabletop Wargaming

The next major section presents the ethnographical investigation of Tabletop Wargaming. Starting with a brief history, the section moves on to describe the increasingly complex array and interplay of activities that make up the practice. Stating initially with the overtly observable and defining aspect of the hobby, the intricacies of the crafting activities are detailed, revealing how wargaming hobbyists are inspired from fictional and historical settings to build and paint miniatures over hundreds of hours of labour, focusing especially on the records that they keep and share.

This is followed by the next most salient aspect, which is the gameplay. There is detailed how the miniatures transcend their material form to take upon characterful identities, and capabilities within the context of the rules of the game. The ways by which hobbyists organise their models into units and armies, seeing them as groups and collectives, and how they perceive and document the unpredictable emergent events on the tabletop battlefield. It rapidly became apparent how, considering the individual miniatures models as the key common-denominator 'actant' of the activities, and therefore the centre of the documented Records and recipient of any technological intervention, was not a suitable approach to the reality of the practice.

Finally, and most importantly, the ethnographical fieldwork revealed the ways by which wargaming hobbyists collected, documented, curated and shared the records of their activities, and how they shared them with the rest of the

community in ways ranging from technocratic performance reviews to thematic point-of-view narratives, and how these existed beyond the material objects themselves and gave birth to persistent character and larger identities.

7.1.3 Technology Probes

Following the findings above, the next chapter details a series of technology probes and workshops. These aimed to take a much closer look at some of the identified activities and provoke reflection and discussion from a group of experienced wargamers. The technology probes attempted to support and expand the existing ways and techniques of the wargaming communities and expose them to potential technologies.

The probes consisted of: Several NFC tagged miniature bases, that were used to bring the miniatures they were placed upon into the IoT and enable unique identification and tagging of content with their identifier to create a persistent digital Record for each one; A web portal that participants could use to manage, curate and share content about their tagged miniatures; A photobooth that rapidly and seamlessly captured 360 view images of miniatures that were placed inside it and uploaded them the web portal with the appropriate tags; and a “Toolbox” that consisted of a variety of technologies and techniques that participants could use to both document their activities, such as wearable cameras and embeddable sensors, and present their Records and Narratives, such as Augmented Reality enabled display cases.

The probes and the workshops delivered a set of telling vignettes which illustrated key examples of complex activities and shed light on the ways that the participants actually perceived and treated their miniatures, and how they created the identities that drove their sense making, their Record organisation and the eventual narratives and things they found meaningful.

7.1.4 The Mixed Reality Storytelling exhibit

Following the above, an interactive public exhibit was developed and deployed in the National Videogame Arcade featuring refined versions of some of the probes to engage a wider audience of wargamers and the general public.

The first component of the two-part exhibit consisted of an interactive augmented reality display, inspired by the Army Display Boards used by the community to thematically showcase their assembled armies at competitions and events. The display featured a multi-layered narrative interleaving actual miniatures and character and group identities, each with their distinct record that was accessible through a mobile device-based Augmented Reality experience.

The second part was an evolution of the photobooth in the form of a 3D scanner which captured high fidelity images and processed them into detailed 3D models using a photogrammetry process. The aim was to demonstrate what a future digital footprint of an objects record might look like. Visitors were invited to bring in objects they wished to have scanned. The resulting 3D models were compiled into an online gallery and could be shared individually though social media and personal blogs, and can be used in virtual worlds.

The exhibit was very well received with visitors stating that the engaging interaction method and the Identity-focused experience was particularly engaging even for those with no knowledge or experience of the wargaming context. The 3D scanner was considerably successful, with several hundred visitors contributing objects that they described as meaningful and that they wanted to both preserve in some way and share with others.

7.1.5 The Framework

The next chapter describes in detail the design and composition of the Meaningful Things Framework and applies it to the vignettes that were previously introduced and several other contexts beyond wargaming.

The Framework outlines two major types of components, the *Material Objects*, and the intangible *Identities*. The former is made up of unique, identifiable and notable *Singular Objects*, the functional but otherwise interchangeable and ordinary *Generic Objects,* and the non-functioning but representative *Proxy Objects.* The former are divided between the Singular Identities which represent unique characters and things, and the *Collective Identities,* which can describe, contain or represent several other objects or Identities, both singular and collective. Each of these components can form contextual *Relationships* between each other that fluidly shift, form and dissolve over time through the activities of the practice. Finally, some of the components are linked to *Records* via technological *Record Links* such as RFID tags and computer vision techniques.

Once elucidated, the framework was applied to the working content of wargaming by revisiting the vignettes that emerged from the probes and were discussed in depth previously. These familiar cases were illustrated as momentary snapshots and over longer timelines to demonstrate in the operation of the framework. Moving beyond the wargaming context the framework was applied to settings such as the TOTeM and Carolan Guitar projects mentioned in earlier chapters, and the Ravelry knitting network which stands as a successful case of technology supporting a community of practice, whose way of working can be disambiguated using the framework.

7.2 Contributions and Implications

The following subsections outline the contributions of the research to the understanding of communities of practice and implications for the technologies which are called upon to meet the challenges that have been posed.

7.2.1 Understanding Practices

The research and resulting framework take a step further in aiding researchers to better understand communities of practice and their activities.

The framework helps disambiguate the complex ways of thinking and doing in a practice, that are the result of multiple factors, both social and personal.

Depending on the context almost all communities of practice tend to develop abstruse ways of communication and thinking that inform, guide and permeate their activities. Penetrating these layers in order to apply an analytical point of view to the actuality of the practice more often than not requires thorough and lengthy familiarisation with the context, something that is not always straightforward or even possible. This is further complicated by the highly personal and constructivistic ways by which individuals in the practice come about to successively become aware, attain proficiency, membership and eventually expertise in some – if not all – aspects of a practice. Each individual's journey through a practice is different, and thus each account that a researcher may rely and draw on is also subject to these unique points of view.

Moreover, the findings of the present research clearly demonstrated that framing an investigation around the tangible – and more visible – aspects of the practice, such as the miniatures, was often insufficient. The intangible – and thus more subtle and difficult to define – 'things', such as Identities, were more meaningful to the practitioners.

In the context of a seemingly crafting oriented practice like tabletop wargaming, the understandable focus on material objects had the consequence of missing out on a wealth of meaningful creative thought and

activity that practitioners valued enough to record and share. Attempting to alleviate this by pursuing and pointing out only tangible material evidence of creative activities, such as written accounts, artwork or narrations, while a step in the right direction, still tends to miss the underlying processes that are at work. Furthermore, the findings from such observations are highly subject to influence by the creative tendencies of the given practitioners. In other words, while the tangible output of a practice activity may appear the same or similar, the practitioners did not necessarily arrive at that point by following the same route.

With the above in mind, the Meaningful Things framework aims to add to the researcher's available arsenal of tools for looking at the doings and workings of a community of practice and its activities. It does this by drawing on the considerable experience of philosophical argument, to give a name the "unknown and intangible" aspects and elements of a practice that are so often difficult to articulate but are to the practitioners the meaningful essence of their activities. By doing so it provides a flexible language to promote a common understanding between researchers and practitioners. The framework provides a structure and ontology to rally around and begin discussion and disambiguation, while remaining permeable enough to not constrain the analysis with over- formalisation. Thus, after seeding, it can be adapted, expanded and modified to suit the requirements of a given context.

7.2.2 Implications for Technology

The finding of research has numerous implications for the technologies that are currently tasked with augmenting and enhancing the material world.

A key requirement for achieving this is being able to accurately, reliably and robustly link digital content to physical objects. This however is an ongoing technological challenge whose mandate evolves constantly due to a shifting landscape of social, commercial, technological and practical forces. This requirement is composed of multiple sub-tasks, each with their own inherent

challenges. One of these sub-tasks is being able to uniquely identify and track physical objects, which stems from the current approaches of the IoT. However, another, which originates from the not-inconsequential task of managing the ever-increasing amounts of digital content of the Information Age, is also further compounded by the findings of the research highlighting the importance of intangible things as the focus of digital records. Specifically, this task involves being able to link digital content to the relevant contextual 'thing' – or Identity in framework terms, is a similar fashion to the earlier challenge of linking material objects to their relevant content.

The nature of the material objects, and the activities in which they play a part within various practices is what practically dictates the feasibility of the technological approaches. While the Spimes vision described objects that would be tracked from cradle to grave (and to the cradle again by virtue of recycling the raw materials), the current reality does not really live up to such expectations. Size, cost, power consumption other issues dictate that embedded tracking technologies are currently not a feasible option for identifying and tracking most everyday objects, especially those that have not been designed or manufactured with this possibility in mind. Tagging objects with passive technology, such as QR codes, Artcodes and RFID tags is indeed a possibility, however the tags themselves can become obsolete, damaged or be accidentally or forcibly removed from the object. Visual recognition for unique identification is also not currently a realistic option, despite advancements in computer vision and machine learning, as technology has issues telling apart visually identical objects, just like a human would if they relied entirely upon their vision to identify between several near identical items. Either way, these technologies do not currently provide the futurist vision of a material world that is in step with our increasingly digital existences. The vision of our increasingly ambient and context-aware computing being able to make sense of our material world in the same way that we do – and to act as a beneficial channel for meaningful interaction is still unfulfilled. However, developments

in computer vision, sensor-rich environments and embedded technology have brought in closer than it has ever been before.

As for linking digital content to the intangible contextual things of a context, especially those meaningful ones that will be associated with rich and highly personalised information, the challenge is somewhat different. Firstly one must contend with the defining intangibility of these meaningful things, putting aside the Platonist versus nominalist debate about whether such abstract things actually exist, it would suffice to say that the things practitioners find meaningful enough to create, talk about and create footprints of, are extant enough for them, and therefore should be taken into account when trying to technologically support that community of practice. Next there is the practical assumption, that the abstract thing of interest somewhat 'takes form' through the collected bits of information about it, whatever form they may take. The framework terms these as the Footprints that make up the Record. This therefore moves the issue on to the practical question of storing, managing and curating that collected Record in such a way that the contextual meaning is maintained and ideally communicable to others. This expands the issue into the territories of other disciplines such as Information Science and research areas such as Database Systems.

Another major issue is being able to automatically capture relevant and accurate data and content about the object – which has also led to the 'Internet of Sensors' situation described in chapter 2. The current technological limitations that apply to identification and tracking technology also apply to data capture, and are often more difficult to overcome. This is because they are inherently more complex tasks requiring more sophisticated hardware that incurs further limitations of size and power, but more importantly it is also because the question of "What" should be capture does not have a clear-cut answer. Depending on the setting, context and users the desirable and appropriate data that should be recorded may vary greatly – which is why the definition of what makes up the Footprints of a Record is correspondingly open-ended.

Furthermore, the quality and quantity of the potential Digital Footprints that may make up the Digital Record of an object are both increasing exponentially, fast outpacing the power, processing and storage capabilities of any current and near future embedded technologies. Therefore, the burden of storage and processing currently falls to offsite datacentres. This necessitates connectivity of the object – or more appropriately, connectivity of the medium by which the object's record is accessed, be it a desktop, mobile device, or some as yet unknown technology. It also implies the existence of appropriately designed systems and databases capable of handling any queries, management and curation.

This last point in itself opens a related and equally long line of inquiry. Finding a common way of recording data and information about billions of heterogeneous objects has been a main concern of IoT research. When considering that the objects may be completely subjective practice-specific objects that defy easy categorisation, it may be beneficial to draw inspiration from cultural archival practices that consider carefully the requirements of each case, rather than treating all such things as homogeneous entities.

In addition, there are still the concerns of privacy and security to consider. As we saw in the case of the Significant Objects project, even explicitly artificial records can influence the perceived value of objects. It most certainly holds true for items of actual provenance, as seen in the example of Bryan May's "Red Special" guitar, or for that matter any item of historical or cultural significance. As previously discussed, in the domains of art and antiquities, verifying whether the stated provenance of an object is genuine is a core concern. This holds true for many other settings as well and while it could be envisioned that some form of Internet of Things – enabled lifetime tracking of objects would be the answer to this, there are considerable concerns about how this might be accomplished and how easy it might be to defeat or manipulate with malicious intent. Tangential to this are the concerns of what the recorded data within an object's Digital Footprint may have to say about things other than the object itself. When that record could contain information

about the object's owners and users, and how it was used, then concerns about privacy, and unethical use of that data quickly arise.

To further complicate the picture, we must also consider again the less easy to grasp implications of non-tangible identities and their own distinct Digital Records. While such things do not have to necessarily contend with the practical linkage problems that the physical objects face, such as reliable tagging and embedded technology concerns, they do share the same issues with regards to storage, management and security of the Digital Records. The process of linking a Digital Record, and the contained Digital Footprints, to a single and unique digital identity is a delicate proposition. A main problem is fragmentation. A footprint can be an image from a mobile phone, a post on a social media platform, or even a verbal comment during a game. This implies innumerable different types and formats of records which cannot be easily reconciled into a single platform or tool for effective curation and management. Perhaps lessons can be learned from how social networks attempt to connect users to common nodes, such as hashtags.

7.3 Potential Users and Beneficiaries beyond Research

The outcomes of the research, particularly in the form of the working version of the Meaningful Things Framework, aim to be of real-world use to several user parties and stakeholders, beyond aiding in the research of communities of practice.

7.3.1 Designers

A naturally desirable audience for the research is the Design community. The increasing remit of Design routinely takes on the challenge of attempting to discover, and even anticipate, the issues and requirements of communities, and create solutions that are feasible, effective, and sustainable in the long term.

For Designers, the Meaningful Things framework operates firstly as a sensitising lens to be used in the initial stages of a project as a way of reconnoitring the problem space and gaining a more detailed – if not clearer – picture of the actual situation that they are aiming to intervene in. This sensitising process is crucial for the eventual design of an effective intervention that will be met with positive reaction, adoption and long-term retention by the practicing community. As seen throughout the research, correctly gauging what the practitioners actually find meaningful and care about in their activities, is challenging, especially as those meaningful things are not always so easily articulated, explained or even pointed out – especially in the case of non-tangible abstract things. Not all practitioners are so willing or able as wargamers to talk about their practice and the activities and things therein, therefore the Framework can help hone the awareness of Designers to the existence of such unseen things of meaning.

Secondly the Framework can provide Designers with a high-level guideline to anticipate the practical aspects of a design intervention by pointing out the interplay and relationships between the abstract and material meaningful and meaningless things, and their linkage options to records. It can thus help shape the basis of eventual bespoke, powerful and well-articulated solutions that meets a community's needs and anticipates those it didn't even know it had.

7.3.2 Developers

While the Meaningful Things Framework came about through a coming together of multiple disciplines, theoretical framing and practical fieldwork, the end result can be practically applied to short term projects and quick iteration development without the immediate need to delve deeper into the theoretical grounding.

When applied to a context, the Framework can be used by software developers as a rapid orienteering tool, that quickly highlights the points of interest that they focus on and some the possible points of friction or failure that they must

anticipate. Furthermore, it can serve practically as the basis for software developers to develop the information model that they would require building an effective application or platform aimed at supporting the particular activities of a practice.

To illustrate this, we can return to two of the previous cases. First, the Mixed Reality exhibit which utilised an early version of the framework was a short-term development that nevertheless required a careful handling of the numerous “things of interest”, which spanned the material-digital divide by including artefacts as well as stories and characters that had to be cohesively organised and displayed. Using the framework as a guide to loosely classify these, it was then relatively straightforward to determine the technology needs and come up with appropriate solutions – in this case using Augmented Reality to facilitate both the Record Links, and the Record presentations. ‘Under the hood’ the Framework facilitated the creation of the Information Model that the final application was based on.

The second case is the Ravelry platform, which neatly spans the space between Design-led forethought and Developer-driven application. While the Framework itself was of course not used in the development of Ravelry, it was inspired to emulate its success. As described in depth earlier, the Ravelry platform is acknowledged as a success, driven in no small part by the close interplay between the community and its tight-knit Designer/Developer team. Compared to the short-term and fast-paced development of the Mixed Reality Storytelling exhibit, the Ravelry platform gradually evolved with a continual iterative feedback/development cycle which was instrumental to its effectiveness.

Here the Framework can be of help, by being applied is such a way so as to create a similar level of understanding between developers and recipients. It can do so by providing the aforementioned common ground of terminology to help practitioners point out their interests and requirements to the developers, and for the developers to identity the most appropriate form of technological intervention to apply. While this may seem obvious at first, we can recall from

earlier chapters the various examples of failure where faith was misplaced in straightforward application of material object-focused IoT-inspired interventions. In other words, developers, even in cooperation with practitioners, applied solutions to the most immediately apparent elements of various practices, such as the miniature models in the case of wargaming, while not being aware of the nuances of the community practice to the point of being able to identify the most meaningful things involved. This led not only to commercial failures, but also to public disillusionment with the consumer-level visions of Internet of Things.

7.3.3 Communities of Practice

Finally, the research is of direct benefit to the communities of practice themselves. As mentioned the research and resulting framework give the members of communities a way to self-reflect and identify the aspects of their practice that may be hard to otherwise give voice to. While this has the benefit of improving the relationship and cooperation between the practitioners and Designers and Developers who are aiming to create an intervention for them, it also helps the communities directly.

Many of the successful technological interventions and developments have come from within the community, usually by active and capable members making small interventions that were successful and in some cases, were commercially exploited. Examples range from cases of army list and roster drafting applications for desktop and mobile devices as we saw in chapter 3, all the way to modelling techniques and tools. Furthermore, the combination of the increasing popularity of small scale manufacturing using 3D printers, “Kickstarter” type funding mechanisms and social media-based promotion often can transform such hobbyist interventions into full scale products with wider distribution and acceptance - often leading to competition and commercial licencing - and essentially becoming part of the practice.

More subtle interventions are seen in the way the communities organised their social media and technology based 'communal spaces' – essentially the way they organise their forums and social media groups. As seen in chapter 3, wargaming forums for example have more forum sections to discuss character creation, storytelling and battle reporting than they have for modelling and painting. This self-knowledge based organisation is normally the result of years of accumulated practice knowledge and input from thousands of members.

However, most communities of practice need to rely on existing frameworks and platforms to create their online communities. Heavily customised solutions such as Ravelry are not nearly as common as community forums or social media groups that have conformed to the generic ontology of a platform such as WordPress, Reddit or Facebook Group pages. Many communities find a way to work around these limitations however. In a wider context, the Framework can sensitise these popular platforms to the mutable, malleable and often intangible nature of the actual meaningful things of practice, while considering the need for robust methods to link Records to the Things at hand.

7.4 Future Work

Several avenues for further inquiry have been identified, which span several disciplines and domains.

7.4.1 Disambiguating the Record

Much has been said of the 'Record' of a thing. While it has been relatively well-defined as the collection of information and data Footprints that pertain about a particular thing, there is substantial room to explore the nature of the Records and their far-reaching implications.

While it is fair to say that the eventual persistent form of a Record is likely to be in digital form – primarily owning to the popularity and convenience of the medium for creation, storage and sharing – it is but one facet of what a Record might be. A Record of a thing may very well exist only in written form or even

only in one's mind. Having a clearer understanding of the range of forms that a Record may exist in will be vital going forwards. Inspiration could be taken here from the 'Way of Conflation' that were discussed earlier in chapter 2, where the sum total of the objects with a similar property are what make an abstract thing – likewise it could be said that a Record exists only insofar as the Footprints that compose exist in some form. This may be true to a certain extent, in that if each Footprint (or Fragment) of a Record is erased – including from living memory – then that Record ceases to exist as well.

However, it is probably safe to say that the Record is more than the sum of its Footprints. The subjective meaning that the Record may elicit in a viewer may very well be more deep, complex and expansive that what may be immediately apparent to an objective eye. Such a response would of course be subject to the constructivistic experiences of each viewer. In other words, the foreknowledge of the subject of the Record will probably heavily influence the outcome of the experiencing that Record and evoke different results depending on the person involved. Furthermore, different natures and combinations of the Footprints in a Record may also have a large impact on the resulting outcome, and in this case, it may supersede – to a point – the subjectivity of the viewer. For example, a detailed narrated video, describing the history and value of a particular thing, say a cultural monument, is by Design meant to be a powerful medium to convey meaning about that thing. Conversely a single unlabelled photograph of an old family car may leave some viewers indifferent without any further content.

Further investigation is therefore warranted into gaining a deep understanding into the nature of the Record. Such an investigation would need to draw upon an impressively diverse range of disciplines including Archival Sciences, Archaeology, Semantics, Provenance Standards, and others.

7.4.2 Documenting the Record

Following on from the above, a particularly difficult challenge that has yet to be met is that of the documentation, or capture of the Record. Or in other words how does one populate a thing's Record with large amounts of accurate, insightful and detailed Footprints of data and content in a practical and cost-effective way? And how does one store, mange, curate and present it? And how are the Record Links between thing and Record maintained or changed as needed?

Whether talking about material artefacts or intangible things the challenge is primarily technological in nature. While data capture is a fixture of current research and commercial endeavours, it still remains an issue that is highly particular to the content at hand and subjective to the observer. In general, the content of a Record could possibly be divided between quantitative 'Hard Data' and qualitative subjective 'Soft Information'. The Hard Data would describe the data capture by environment and embedded sensors which would contain raw and utilitarian data depending on the thing at hand, such as accelerometer, temperature and position sensors. It also describers any non-annotated imagery or other media relating to a thing. Such data has the benefit of being relatively straightforward to capture and store, and is generally objective but must be interpreted to derive any useful conclusions or meaning. Conversely the Soft Data is a much wider (and tougher) proposition. These are all the snippets and fragments of subjective information and content about some thing. It can very well be a detailed written account or biography of a character, cross referenced with all the other things he has interacted with, but in most cases, it will be the spoken word and memories of the creator, owner or custodian of a thing that have to be somehow documented, coded and stored in such a way as to retain its context, while making it open to meaning and interpretation by others too.

Meeting this challenge would require the thorough understanding of the Record itself as described previously, but also entails complex technological challenges that must be tailored to the setting at hand.

7.4.3 Querying and using the Record

Assuming the existence of the persistent and detailed Records described above, it then becomes pertinent to consider what to do with that information. It is clear that the extent of such Records, as well as their amount, could quickly render them cumbersome and unwieldy, and not just for the matters of storage described above.

Essentially the Records could be quite useless if there is no way to intuitively and fruitfully browse them and form queries relevant to the questions we wish to seek answers for. The vision of Spimes contested that one of the converging technology that underpinned it was that of a search engine flexible and smart enough to understand the context of a given query and respond with the relevant answer. The wide-ranging power – and respectable effectiveness - of Search Engines is probably undisputable at this point. Their continuing rise can be attributed largely to their uncontested access to data – not just the content upon which a search is made – but also the queries that are made, the corrections to those queries, the location they are made from, the profiles and search histories of the user, their browsing habits, their emails, their purchase, their credit history, and so on.

Large data-sets are what the machine learning engines feed on, and few things – other than a global population willing to continually contribute information – are a larger potentially source of data than an internet of distributed sensors, all continuously capturing information, as described by the "Internet of Sensors and Data" analogy in Chapter 2. Adding to this an "Internet of Meaningful and Interesting Things", containing contextual information on the real-world usage of such things can provide a resource just as rich, and probably more evocative for human-centric users. This harkens to the almost science fiction level vision of being able to interrogate any object about its lifetime of use and existence – something that in some settings in not necessarily that farfetched.

The challenge however is more grounded. Given the existences of such vast amounts of content and information, however well organised, tagged and cross-indexed, there still needs to be a way of making sense of it – or asking questions of it. Inspiration can be taken from the innumerable wiki reference websites that emerge surrounding many specialised as well as mainstream subjects. Whether the fictional setting of a game or TV series, or such a niche and contrived Social Object such as character and media stereotypes, there is a crowd-sourced wiki website containing detailed interlinked pages upon pages of information on that specific topic often available. The hypertext structure of wikis has been shown to be immensely popular as the reference system of choice for online communities wanting to create a repository of knowledge about a particular topic. For wargaming we saw this in chapter 3 with the prevalence of reference sites such as the *Lexicanum* and the *WH40K Wiki*. It is possible that such a structure will be a good starting point to illustrate the complex interleaved Records of the Things in a practice, but more investigation would be needed to examine options and methods of querying the records for meaningful answers and conclusions.

7.4.4 Matters of Concern – Security, Privacy and Social Change

Before continuing further with the vision of detailed and searchable records for all things tangible and intangible, it would be appropriate to mention the numerous concerns that such a situation gives rise to. There are still open questions to what risks such tracked, traced and interrogatable things may create for their users, owners, custodians and others in proximity. Social Media networks opened a Pandora's box of phenomena that are still not fully understood, and the Internet of Things has already introduced untold vulnerabilities. These are not just the already experienced concerns of criminal hacking, but are also matters of negative influences and changes to personal and social life.

People's concerns are quickly raised about traced meaningful things. The provenance of Artefacts is a key way of determining the monetary value of an

object. When technology becomes a key part of how the provenance of an object is documented, then that introduces additional points of vulnerability. The provenance of a valuable object can be potentially replicated to create illegitimate duplicates. Or an otherwise normal object may have its digital provenance Record altered to inflate its value for example. These are obvious cases, and already within the realm of possibility.

The intimate personal details of our lives that we make available to all (knowingly or not) on social media are creating previously unthinkable Records of our day to day actions and expressed opinions. The pitfalls are many, as has been discovered by unfortunates whose momentary lapse of judgement has become a cautionary tale for younger generations. Beyond embarrassment, there are serious repercussions. Individuals have incriminated themselves by posting content that was used as evidence against them. Publicly posted opinions have cost people their careers later in life; and more worryingly entities such as data service, credit check, advertising, insurance and other companies are now actively commodifying, hoarding and parsing this data for their own business intelligence. Unthinkingly adding to this the records about our meaningful things could have similarly unpleasant consequences.

Fortunately, society has become more aware of the potential misuse of data. This is timely, as our meaningful things, whether material or abstract, inevitably begin to acquire persistent Digital Records.

Figures

References

1. Douglas Adams and Mark Carwardine. 2009. *Last Chance To See*. Arrow, London.

2. Charu C. Aggarwal, Naveen Ashish, and Amit Sheth. 2013. *The Internet of Things: A Survey from the Data-Centric Perspective, Managing and Mining Sensor Data*.

3. Ahmed Ahmed, Steve Benford, and Andy Crabtree. 2012. Digging in the Crates: An Ethnographic Study of DJs' Work. In *Proc. of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12), 1805–1814. https://doi.org/10.1145/2207676.2208314

4. Thomas Ainsworth. 2016. Form vs. Matter. In *The Stanford Encyclopedia of Philosophy* (Spring 2016), Edward N. Zalta (ed.). Metaphysics Research Lab, Stanford University. Retrieved September 21, 2017 from https://plato.stanford.edu/archives/spr2016/entries/form-matter/

5. Flora Amato, Angelo Chianese, Vincenzo Moscato, Antonio Picariello, and Giancarlo Sperli. 2012. SNOPS: A Smart Environment for Cultural Heritage Applications. In *Proceedings of the Twelfth International Workshop on Web Information and Data Management* (WIDM '12), 49–56. https://doi.org/10.1145/2389936.2389947

6. David J. Anderson and Edward N. Zalta. 2004. Frege, Boolos, and Logical Objects. *Journal of Philosophical Logic* 33, 1: 1–26. https://doi.org/10.1023/B:LOGI.0000019236.64896.fd

7. Kevin Ashton. 2009. That 'Internet of Things' Thing. *RFiD Journal* 22: 97–114.

8. Luigi Atzori, Antonio Iera, and Giacomo Morabito. 2010. The Internet of Things: A survey. *Computer Networks* 54, 15: 2787–2805. https://doi.org/10.1016/j.comnet.2010.05.010

9. Emmanuel P. Baltsavias. 1999. A comparison between photogrammetry and laser scanning. *ISPRS Journal of Photogrammetry and Remote Sensing* 54, 2: 83–94. https://doi.org/10.1016/S0924-2716(99)00014-3

10. Estelle Barrett and Barbara Bolt. 2013. *Carnal Knowledge: Towards a "New Materialism" Through the Arts*. I.B.Tauris.

11. Valérie Bauwens and Patrick Genoud. 2014. Online Ethnography. *interactions* 21, 5: 60–65. https://doi.org/10.1145/2642749

12. Steve Benford, Adrian Hazzard, Alan Chamberlain, Kevin Glover, Chris Greenhalgh, Liming Xu, Michaela Hoare, and Dimitrios Darzentas. 2016. Accountable Artefacts: The Case of the Carolan Guitar. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16), 1163–1175. https://doi.org/10.1145/2858036.2858306

13. Steve Benford, Adrian Hazzard, Alan Chamberlain, and Liming Xu. 2015. Augmenting a guitar with its digital footprint. 303–306. Retrieved September 21, 2017 from https://nime2015.lsu.edu/proceedings/264/0264-paper.pdf

14. Steve Benford, Adrian Hazzard, and Liming Xu. 2015. The Carolan Guitar: A Thing That Tells Its Own Life Story. *interactions* 22, 3: 64–66. https://doi.org/10.1145/2745960

15. Steve Benford, Boriana Koleva, Anthony Quinn, Emily-Clare Thorn, Kevin Glover, William Preston, Adrian Hazzard, Stefan Rennick-Egglestone, Chris Greenhalgh, and Richard Mortier. 2017. Crafting Interactive Decoration. *ACM Trans. Comput.-Hum. Interact.* 24, 4: 26:1–26:39. https://doi.org/10.1145/3058552

16. Steve Benford, Peter Tolmie, Ahmed Y. Ahmed, Andy Crabtree, and Tom Rodden. 2012. Supporting traditional music-making: designing for situated discretion. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*, 127–136. https://doi.org/10.1145/2145204.2145227

17. Michael Bieber and Joonhee Yoo. 1999. Hypermedia: A Design Philosophy. *ACM Comput. Surv.* 31, 4es. https://doi.org/10.1145/345966.346028

18. William Blattner. 2006. *Heidegger's "Being and Time."* Continuum, London ; New York.

19. Bill Brown. 2001. Thing Theory. *Critical Inquiry* 28, 1: 1–22.

20. Nicholas Bunnin and Jiyuan Yu (eds.). 2004. *The Blackwell Dictionary of Western Philosophy*. Blackwell Publishing Ltd, Oxford, UK. https://doi.org/10.1111/b.9781405106795.2004.x

21. M. Carter, M. Gibbs, and M. Harrop. 2014. Drafting an Army: The Playful Pastime of Warhammer 40,000. *Games and Culture*. https://doi.org/10.1177/1555412013513349

22. Marcus Carter, Mitchell Harrop, and Martin Gibbs. 2014. The Roll of the Dice in Warhammer 40,000. *Transactions of the Digital Games Research Association* 1, 3. https://doi.org/10.26503/todigra.v1i3.20

23. Hakima Chaouchi. 2013. *The Internet of Things: Connecting Objects*. John Wiley & Sons.

24. Angelo Chianese and Francesco Piccialli. 2014. Designing a Smart Museum: When Cultural Heritage Joins IoT. In *Proceedings of the 2014 Eighth International Conference on Next Generation Mobile Apps, Services and Technologies* (NGMAST '14), 300–306. https://doi.org/10.1109/NGMAST.2014.21

25. Michelle M. Christovich. 2016. Why Should We Care What Fitbit Shares - A Proposed Statutroy Solution to Protect Sensative Personal Fitness Information. *Hastings Communications and Entertainment Law Journal* 38: 91.

26. S. Claisse, M. Morel, and W. B. Ormsby. 2010. Enhanced SISMARIS: (Syst #x00E8;me d'information et de surveillance MARitime etendu pour l'identification des comportements suspects): Enhanced maritime surveillance and information

system for abnormal behaviour identification. In *2010 International WaterSide Security Conference*, 1–5. https://doi.org/10.1109/WSSC.2010.5730234

27. Computerphile. *Augmented Reality & Wargaming - Computerphile*. Retrieved September 22, 2017 from https://www.youtube.com/watch?v=BW7S8H3Zi-g

28. Computerphile. *3D Scanning - Computerphile - Computerphile*. Retrieved September 22, 2017 from https://www.youtube.com/watch?v=f266wim8Ylc

29. Computerphile. *Google Tango - Computerphile*. Retrieved September 22, 2017 from https://www.youtube.com/watch?v=z1gMRZiM9RY

30. Computerphile. *Microsoft Hololens - Computerphile*. Retrieved September 22, 2017 from https://www.youtube.com/watch?v=gp8UiYOw8Fc

31. William E. Connolly. 2013. The 'New Materialism' and the Fragility of Things. *Millennium - Journal of International Studies* 41, 3: 399–412. https://doi.org/10.1177/0305829813486849

32. Diana Coole, Samantha Frost, Jane Bennett, Pheng Cheah, Melissa A. Orlie, and Elizabeth Grosz. 2010. *New Materialisms: Ontology, Agency, and Politics*. Duke University Press Books.

33. Tim Coughlan, Michael Brown, Robert Houghton, and Glyn Lawson. 2012. Exploring new connections between the physical and digital for future heritage interpretations. Retrieved September 8, 2016 from http://dl.dropbox.com/u/2327496/camera-ready/Coughlan_Brown_Houghton_Lawson.pdf

34. Andy Crabtree, Steve Benford, Chris Greenhalgh, Paul Tennent, Matthew Chalmers, and Barry Brown. 2006. Supporting Ethnographic Studies of Ubiquitous Computing in the Wild. In *Proceedings of the 6th Conference on Designing Interactive Systems* (DIS '06), 60–69. https://doi.org/10.1145/1142405.1142417

35. Michelle Craig, Sarah Petersen, and Andrew Petersen. 2012. Following a Thread: Knitting Patterns and Program Tracing. In *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education* (SIGCSE '12), 233–238. https://doi.org/10.1145/2157136.2157204

36. Mihaly Csikszentmihalyi and Eugene Halton. 1981. *The Meaning of Things: Domestic Symbols and the Self*. Cambridge University Press, Cambridge Eng. ; New York.

37. Eleanor Dallaway. 2017. #INFOSEC17: Ransomware and IoT. *Infosecurity Magazine*. Retrieved September 21, 2017 from https://www.infosecurity-magazine.com/news/infosec17-ransomware-and-iot/

38. Matteo Corciolani Daniele Dalli. 2014. Gift-giving, sharing and commodity exchange at Bookcrossing.com. New insights from a qualitative analysis. *Management Decision* 52, 4.

39. Dimitrios Paris Darzentas, Michael A. Brown, Martin Flintham, and Steve Benford. 2015. The Data Driven Lives of Wargaming Miniatures. In *Proceedings of the*

33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15), 2427–2436. https://doi.org/10.1145/2702123.2702377

40. Ozgur Dedehayir and Martin Steinert. 2016. The hype cycle model: A review and future directions. *Technological Forecasting and Social Change* 108, Supplement C: 28–41. https://doi.org/10.1016/j.techfore.2016.04.005

41. Pieter Desmet, Kees Overbeeke, and Stefan Tax. 2001. Designing Products with Added Emotional Value: Development and Appllcation of an Approach for Research through Design. *The Design Journal* 4, 1: 32–47. https://doi.org/10.2752/146069201789378496

42. Steve Diller, Nathan Shedroff, and Darrel Rhea. 2005. *Making Meaning: How Successful Businesses Deliver Meaningful Customer Experiences*. New Riders Press, Berkeley, Calif.

43. Alan Dix. 2007. Designing for appropriation. In *Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI... but not as we know it-Volume 2*, 27–30. Retrieved September 21, 2017 from http://dl.acm.org/citation.cfm?id=1531415

44. Paul Dourish. 2004. *Where the Action Is: The Foundations of Embodied Interaction*. The MIT Press, Cambridge, Mass.

45. Hubert L. Dreyfus. 1991. *Being in the World: Commentary on Heidegger's "Being and Time", Division 1*. MIT Press, Cambridge, Mass.

46. Abigail Durrant, Alex S. Taylor, David Frohlich, Abigail Sellen, and David Uzzell. 2009. Photo Displays and Intergenerational Relationships in the Family Home. In *Proceedings of the 23rd British HCI Group Annual Conference on People and Computers: Celebrating People and Technology* (BCS-HCI '09), 10–19. Retrieved September 21, 2017 from http://dl.acm.org/citation.cfm?id=1671011.1671013

47. Raphael Eidenbenz, Li Yu, and Roger Wattenhofer. 2013. Reading Up on Bookcrossing. *The International Journal of the Book* 10, 2: 11–26.

48. Pedro Ferreira, Ricardo Martinho, and Dulce Domingos. 2010. IoT-aware business processes for logistics: limitations of current approaches. In *INForum*, 611–622. Retrieved September 21, 2017 from http://inforum.org.pt/INForum2010/papers/internet-das-coisas-e-servicos/Paper099.pdf

49. Flightradar24. Flightradar24.com - Live flight tracker! *Flightradar24*. Retrieved September 21, 2017 from https://www.flightradar24.com/

50. Gottlob Frege. 1948. Sense and Reference. *The Philosophical Review* 57, 3: 209–230. https://doi.org/10.2307/2181485

51. Wynona Smutz Garretson. 1962. The Consensual Definition of Social Objects. *Sociological Quarterly* 3, 2: 107–114. https://doi.org/10.1111/j.1533-8525.1962.tb01550.x

52. Doménique van Gennip, Elise van den Hoven, and Panos Markopoulos. 2015. Things That Make Us Reminisce: Everyday Memory Cues As Opportunities for

Interaction Design. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15), 3443–3452. https://doi.org/10.1145/2702123.2702460

53. Alexandra Georgakopoulou. 1997. *Narrative Performances: A study of Modern Greek storytelling*. John Benjamins Publishing.

54. Eleanor J. Gibson and Arlene S. Walker. 1984. Development of Knowledge of Visual-Tactual Affordances of Substance. *Child Development* 55, 2: 453–460. https://doi.org/10.2307/1129956

55. James J. Gibson. 2014. *The Ecological Approach to Visual Perception: Classic Edition*. Psychology Press.

56. William Gibson. 2015. *Neuromancer*. Harper Voyager, London.

57. Etienne Gilson. 1955. *History of Christian philosophy in the Middle Ages*. London : Sheed and Ward. Retrieved September 21, 2017 from http://trove.nla.gov.au/work/10555317

58. Joshua Glenn and Carol Hayes. 2007. *Taking Things Seriously: 75 Objects with Unexpected Significance*. Princeton Architectural Press, New York.

59. Joshua Glenn and Rob Walker. 2012. *Significant Objects*. FANTAGRAPHICS, Seattle, WA.

60. Carles Gomez, Joaquim Oller, and Josep Paradells. 2012. Overview and Evaluation of Bluetooth Low Energy: An Emerging Low-Power Wireless Technology. *Sensors* 12, 9: 11734–11753. https://doi.org/10.3390/s120911734

61. Elizabeth Goodman. 2014. Design and Ethics in the Era of Big Data. *interactions* 21, 3: 22–24. https://doi.org/10.1145/2598902

62. Pascalle CM Govers and Ruth Mugge. 2004. I love my Jeep, because its tough like me ': The effect of product-personality congruence on product attachment. In *Proceedings of the fourth international conference on design and emotion. Ankara, Turkey*. Retrieved September 19, 2017 from http://www.pascallegovers.nl/uploads/1/2/3/9/12391484/govers_and_mugge_de2004.pdf

63. Abe Greenberg. 1981. An Outline of Wargaming. *Naval War College Review* 34: 93–97.

64. Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, and Marimuthu Palaniswami. 2013. Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems* 29, 7: 1645–1660. https://doi.org/10.1016/j.future.2013.01.010

65. Charlie Hall. 2017. How a mature board game became the biggest Kickstarter game ever (update). *Polygon*. Retrieved September 22, 2017 from https://www.polygon.com/2017/1/4/14153916/kingdom-death-monster-biggest-kickstarter-game-ever-most-funded

66. Joss Hands. From Cultural to New Materialism and Back: The Enduring Legacy of Raymond Williams. *Culture, Theory and Critique* 0, 0: 1–16. https://doi.org/10.1080/14735784.2014.931782

67. Mitchell Harrop, Martin Gibbs, and Marcus Carter. 2013. Everyone's a Winner at Warhammer 40K (or, at least not a loser). Retrieved July 14, 2014 from http://marcuscarter.com/wp-content/uploads/2013/08/harrop-warhammer.pdf

68. Martin Heidegger. 1951. *Das Ding*.

69. Martin Heidegger. 1987. *Die Frage nach dem Ding: Zu Kants Lehre von den transzendentalen Grundsätzen*. De Gruyter, Tübingen.

70. Maria Hellstrom. 2013. Knitting Ourselves Into Being: the Case of Labour and Hip Domesticity on the Social Network Ravelry.com. Retrieved May 30, 2017 from http://researcharchive.vuw.ac.nz/handle/10063/2780

71. S. Hinske, M. Lampe, N. Yuill, S. Price, and M. Langheinrich. 2010. Let the play set come alive: Supporting playful learning through the digital augmentation of a traditional toy environment. In *2010 8th IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops)*, 280–285. https://doi.org/10.1109/PERCOMW.2010.5470654

72. Steve Hinske and Marc Langheinrich. 2009. W41K: digitally augmenting traditional game environments. In *Proceedings of the 3rd International Conference on Tangible and Embedded Interaction* (TEI '09), 99–106. https://doi.org/10.1145/1517664.1517691

73. Ian Hodder (ed.). 2004. *The meanings of things: material culture and symbolic expression*. Routledge, London.

74. Lars Erik Holmquist, Magnus Helander, and Steve Dixon. Every Object Tells a Story: Physical Interfaces for Digital Storytelling.

75. Sal Humphreys. 2008. The Challenges of Intellectual Property for Users of Social Networking Sites: A Case Study of Ravelry. In *Proceedings of the 12th International Conference on Entertainment and Media in the Ubiquitous Era* (MindTrek '08), 125–130. https://doi.org/10.1145/1457199.1457227

76. Sal Humphreys. 2009. The economies within an online social network market : A case study of Ravelry. In *ARC Centre of Excellence for Creative Industries and Innovation; Creative Industries Faculty*. Retrieved May 30, 2017 from http://www.anzca.net/documents/2009-conf-papers/34-the-economies-within-an-online-social-network-market-a-case-study-of-ravelry-1.html

77. Hilary Hutchinson, Wendy Mackay, Bo Westerlund, Benjamin B. Bederson, Allison Druin, Catherine Plaisant, Michel Beaudouin-Lafon, Stéphane Conversy, Helen Evans, Heiko Hansen, Nicolas Roussel, and Björn Eiderbäck. 2003. Technology Probes: Inspiring Design for and with Families. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '03), 17–24. https://doi.org/10.1145/642611.642616

78. Sabina Jeschke, Christian Brecher, Tobias Meisen, Denis Özdemir, and Tim Eschert. 2017. Industrial Internet of Things and Cyber Manufacturing Systems. In *Industrial Internet of Things*, Sabina Jeschke, Christian Brecher, Houbing Song and Danda B. Rawat (eds.). Springer International Publishing, 3–19. https://doi.org/10.1007/978-3-319-42559-7_1

79. Martin L. de Jode, Ralph Barthel, and Andrew Hudson-Smith. 2011. Tales of Things: The Story So Far. In *Proceedings of the 2011 International Workshop on Networking and Object Memories for the Internet of Things* (NoME-IoT '11), 19–20. https://doi.org/10.1145/2029932.2029940

80. Felice Armenio Johnson Johnson, Mark Harrison, Bernie Hogan GS US, Jin Mitsugi, Josef Preishuber, Oleg Ryaboy CVS, and K. K. Suen. 2005. The epcglobal architecture framework. Retrieved September 21, 2017 from https://www.gs1.org/docs/architecture/architecture_1_3-framework-20090319.pdf

81. Dan Jolin. 2016. The rise and rise of tabletop gaming. *The Observer*. Retrieved September 22, 2017 from http://www.theguardian.com/technology/2016/sep/25/board-games-back-tabletop-gaming-boom-pandemic-flash-point

82. Donald G. McNeil Jr. 2009. Predicting Flu With the Aid of (George) Washington. *The New York Times*. Retrieved September 21, 2017 from https://www.nytimes.com/2009/05/04/health/04model.html

83. Amir Kavousian, Ram Rajagopal, and Martin Fischer. 2013. Determinants of residential electricity consumption: Using smart meter data to examine the effect of climate, building characteristics, appliance stock, and occupants' behavior. *Energy* 55: 184–194. https://doi.org/10.1016/j.energy.2013.03.086

84. Maura Kelly. 2014. Knitting as a feminist project? *Women's Studies International Forum* 44, Supplement C: 133–144. https://doi.org/10.1016/j.wsif.2013.10.011

85. N. Koshizuka and K. Sakamura. 2010. Ubiquitous ID: Standards for Ubiquitous Computing and the Internet of Things. *IEEE Pervasive Computing* 9, 4: 98–101. https://doi.org/10.1109/MPRV.2010.87

86. Robert E. Kraut, Paul Resnick, Sara Kiesler, Moira Burke, Yan Chen, Niki Kittur, Joseph Konstan, Yuqing Ren, and John Riedl. 2012. *Building Successful Online Communities: Evidence-Based Social Design*. MIT Press.

87. Bruno Latour. 2004. Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern. *Critical Inquiry* 30, 2: 225–248. https://doi.org/10.1086/421123

88. Bruno Latour. 2007. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press, USA, Oxford.

89. Dave Lee. 2017. Global ransomware attack causes turmoil. *BBC News*. Retrieved September 21, 2017 from http://www.bbc.co.uk/news/technology-40416611

90. David Lewis. 2001. *On the Plurality of Worlds*. Wiley-Blackwell, Malden, Mass.

91. Shancang Li, Li Da Xu, and Shanshan Zhao. 2014. The internet of things: a survey. *Information Systems Frontiers* 17, 2: 243–259. https://doi.org/10.1007/s10796-014-9492-7

92. Saara Liinamaa. 2005. Of Treasures and Trash: BookCrossing, Mark Dion's Tate Thames Dig and the (lost) objects of urban intervention. *Public* 0, 32. Retrieved September 19, 2014 from http://pi.library.yorku.ca/ojs/index.php/public/article/view/30060

93. Siân E. Lindley, Catherine C. Marshall, Richard Banks, Abigail Sellen, and Tim Regan. 2013. Rethinking the Web As a Personal Archive. In *Proceedings of the 22Nd International Conference on World Wide Web* (WWW '13), 749–760. Retrieved July 14, 2014 from http://dl.acm.org/citation.cfm?id=2488388.2488454

94. Francis J. McHugh, Naval War College Press, and David A. DellaVolpe. 2012. *The Fundamentals of War Gaming*. Dept. of the Navy, Newport, R.I.

95. Harvey J. Miller. 2010. The Data Avalanche Is Here. Shouldn't We Be Digging? *Journal of Regional Science* 50, 1: 181–201. https://doi.org/10.1111/j.1467-9787.2009.00641.x

96. Luke Mintz. 2017. How Games Workshop turned plastic figurines into solid gold. *The Telegraph*. Retrieved September 22, 2017 from http://www.telegraph.co.uk/business/2017/09/09/games-workshop-turned-plastic-figurines-solid-gold/

97. T. Miyashita, P. Meier, T. Tachikawa, S. Orlic, T. Eble, V. Scholz, A. Gapel, O. Gerl, S. Arnaudov, and S. Lieberknecht. 2008. An Augmented Reality Museum Guide. In *Proceedings of the 7th IEEE/ACM International Symposium on Mixed and Augmented Reality* (ISMAR '08), 103–106. https://doi.org/10.1109/ISMAR.2008.4637334

98. Nicholas Negroponte. 1996. *Being Digital*. Coronet Books, Rydalmere, N.S.W.

99. Trond Nilsen and Julian Looser. 2005. Tankwar-Tabletop war gaming in augmented reality. In *2nd International Workshop on Pervasive Gaming Applications, PerGames*. Retrieved September 22, 2017 from https://pdfs.semanticscholar.org/49d0/27d5967de11486345f3656e7761902587191.pdf#page=87

100. Donald A. Norman. 2013. *The Design of Everyday Things, revised and expanded edition*. MIT Press, Massachusetts.

101. William Odom, John Zimmerman, and Jodi Forlizzi. 2011. Teenagers and Their Virtual Possessions: Design Opportunities and Issues. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '11), 1491–1500. https://doi.org/10.1145/1978942.1979161

102. Jeff Z. Pan, Shonali Krishnaswamy, Yuan-Fang Li, Manfred Hauswirth, and Hai H. Nguyen. 2014. The Ubiquitous Semantic Web: Promises, Progress and Challenges. *Int. J. Semant. Web Inf. Syst.* 10, 4: 1–16. https://doi.org/10.4018/ijswis.2014100101

103. David Parlett. 1999. *The Oxford History of Board Games*. Oxford University Press, Oxford ; New York.

104. H. Kupwade Patil and R. Seshadri. 2014. Big Data Security and Privacy Issues in Healthcare. In *2014 IEEE International Congress on Big Data*, 762–765. https://doi.org/10.1109/BigData.Congress.2014.112

105. Dragan Peraković, Marko Periša, and Ivan Cvitić. 2015. Analysis of the IoT impact on volume of DDoS attacks. In *33rd Symposium on New Technologies in Postal and Telecommunication Traffic (PosTel 2015)*, 295–304. Retrieved September 21, 2017 from http://www.academia.edu/download/41030230/Postel2015-Perakovic_Perisa_Cvitic_eng_02112015.pdf

106. Virginia Pilloni, Luigi Atzori, and Matteo Mallus. 2017. Dynamic Involvement of Real World Objects in the IoT: A Consensus-Based Cooperation Approach. *Sensors* 17, 3: 484.

107. John Plotz. 2006. Can the Sofa Speak? A Look at Thing Theory. *Criticism* 47, 1: 109–118. https://doi.org/10.1353/crt.2006.0006

108. T. Qu, S. P. Lei, Z. Z. Wang, D. X. Nie, X. Chen, and George Q. Huang. 2016. IoT-based real-time production logistics synchronization system under smart cloud manufacturing. *The International Journal of Advanced Manufacturing Technology* 84, 1–4: 147–164. https://doi.org/10.1007/s00170-015-7220-1

109. Ragunathan (Raj) Rajkumar, Insup Lee, Lui Sha, and John Stankovic. 2010. Cyber-physical Systems: The Next Computing Revolution. In *Proceedings of the 47th Design Automation Conference* (DAC '10), 731–736. https://doi.org/10.1145/1837274.1837461

110. Devina Ramduny-Ellis, Alan Dix, Martyn Evans, Jo Hare, and Steve Gill. 2010. Physicality in Design: An Exploration. *The Design Journal* 13, 1: 48–76. https://doi.org/10.2752/146069210X12580336766365

111. Ammar Rayes and Samer Salam. 2017. Internet of Things (IoT) Overview. In *Internet of Things From Hype to Reality*. Springer, 1–34. Retrieved September 21, 2017 from http://link.springer.com/chapter/10.1007/978-3-319-44860-2_1

112. Ammar Rayes and Samer Salam. 2017. Internet of Things (IoT) Overview. In *Internet of Things From Hype to Reality*. Springer, 1–34. Retrieved September 21, 2017 from http://link.springer.com/chapter/10.1007/978-3-319-44860-2_1

113. Daniela K. Rosner. 2011. Tracing Provenance. *interactions* 18, 5: 32–37. https://doi.org/10.1145/2008176.2008186

114. Daniela K. Rosner and Kimiko Ryokai. 2009. Reflections on craft: probing the creative process of everyday knitters. In *Proceedings of the seventh ACM conference on Creativity and cognition*, 195–204. Retrieved September 19, 2017 from http://dl.acm.org/citation.cfm?id=1640264

115. Daniela K. Rosner and Kimiko Ryokai. 2010. Spyn: Augmenting the Creative and Communicative Potential of Craft. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '10), 2407–2416. https://doi.org/10.1145/1753326.1753691

116. Aviva Rutkin. 2015. It's a Fitbit, Your Honour. *New Scientist* 225, 3002: 17. https://doi.org/10.1016/S0262-4079(15)60024-0

117. Frank Schalow and Alfred Denker. 2010. *Historical Dictionary of Heidegger's Philosophy*. Scarecrow Press.

118. Dieter Schmalstieg and Daniel Wagner. 2005. A handheld augmented reality museum guide. In *In Proc. IADIS International Conference on Mobile Learning*.

119. Armin Selbitschka. 2015. Miniature tomb figurines and models in pre-imperial and early imperial China: origins, development and significance. *World Archaeology* 47, 1: 20–44. https://doi.org/10.1080/00438243.2014.991801

120. Christopher Shields. 2016. Aristotle. In *The Stanford Encyclopedia of Philosophy* (Winter 2016), Edward N. Zalta (ed.). Metaphysics Research Lab, Stanford University. Retrieved September 21, 2017 from https://plato.stanford.edu/archives/win2016/entries/aristotle/

121. D. Shingleton. 2010. Pervasive Memory, Locative Narratives. *Research Education and Media Journal* 2, 2: 40–47.

122. Alison Margaret Smithson and Design Museum (London England). 2004. *Alison and Peter Smithson: From the House of the Future to a House of Today*. 010 Publishers.

123. Scott S. Snibbe and Hayes S. Raffle. 2009. Social Immersive Media: Pursuing Best Practices for Multi-user Interactive Camera/Projector Exhibits. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '09), 1447–1456. https://doi.org/10.1145/1518701.1518920

124. Krushang Sonar and Hardik Upadhyay. 2014. A survey: DDOS attack on Internet of Things. *International Journal of Engineering Research and Development* 10, 11: 58–63.

125. E. Spanò, L. Niccolini, S. D. Pascoli, and G. Iannacconeluca. 2015. Last-Meter Smart Grid Embedded in an Internet-of-Things Platform. *IEEE Transactions on Smart Grid* 6, 1: 468–476. https://doi.org/10.1109/TSG.2014.2342796

126. Chris Speed. 2010. An internet of old things. *Digital Creativity* 21, 4: 239–246. https://doi.org/10.1080/14626268.2010.555915

127. Chris Speed. 2011. A rolling stone gathers no moss and other consumer conspiracies. Retrieved July 14, 2014 from http://www.research.ed.ac.uk/portal/en/publications/a-rolling-stone-gathers-no-moss-and-other-consumer-conspiracies(0f903629-84cb-4fc5-9a68-b6e64a5ea523).html

128. Chris Speed and Arthi Kanchana Manohar. 2010. Storytelling Within an Internet of Things. In *Proceedings of the Third Joint Conference on Interactive Digital*

Storytelling (ICIDS'10), 295–296. Retrieved September 8, 2016 from http://dl.acm.org/citation.cfm?id=1926497.1926556

129. Chris Speed and Simone O'Callaghan. 2011. The Hidden Histories of Objects; Provenance, Storytelling and Tagging Technologies. In *International Symposium for Electronic Art*. Retrieved July 14, 2014 from http://www.research.ed.ac.uk/portal/en/publications/the-hidden-histories-of-objects-provenance-storytelling-and-tagging-technologies(e1755569-1ad6-4078-a0e1-84c08ccd1c51).html

130. Bruce Sterling. 2005. *Shaping Things*. MIT Press, Cambridge, Mass.

131. J. Tate. 1953. Review of Plato's Theory of Ideas. *The Classical Review* 3, 2: 91–94.

132. TheBeastsOfWar. *Weekender: HoloLens - Augmented Reality Tabletop Gaming?* Retrieved September 22, 2017 from https://www.youtube.com/watch?v=mw8xoK3Usnc

133. Trevor Timpson. 2013. How HG Wells created hobby war gaming. *BBC News*. Retrieved September 22, 2017 from http://www.bbc.co.uk/news/magazine-22777029

134. Cristen Torrey, Elizabeth F. Churchill, and David W. McDonald. 2009. Learning How: The Search for Craft Knowledge on the Internet. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '09), 1371–1380. https://doi.org/10.1145/1518701.1518908

135. Sun Tzu. 2009. *The Art of War*. Pax Librorum, Place of publication not identified.

136. Dieter Uckelmann, Mark Harrison, and Florian Michahelles. 2011. An Architectural Approach Towards the Future Internet of Things. In *Architecting the Internet of Things*. Springer, Berlin, Heidelberg, 1–24. https://doi.org/10.1007/978-3-642-19157-2_1

137. Lachlan Urquhart and Tom Rodden. 2016. *New Directions in Information Technology Law: Learning from Human Computer Interaction*. Social Science Research Network, Rochester, NY. Retrieved May 13, 2017 from https://papers.ssrn.com/abstract=2865842

138. David Vandervort. 2016. Medical Device Data Goes to Court. In *Proceedings of the 6th International Conference on Digital Health Conference* (DH '16), 23–27. https://doi.org/10.1145/2896338.2896341

139. J. P. Vasseur and A. Dunkels. 2008. Ip for smart objects. *IPSO Alliance, White paper* 1. Retrieved September 21, 2017 from http://www.dunkels.com/adam/dunkels08ipso.pdf

140. Peter-Paul Verbeek. 2005. *What Things Do: Philosophical Reflections on Technology, Agency, and Design*. Penn State University Press, University Park, Pa.

141. Wolfgang Wahlster. 2013. *SemProM: Foundations of Semantic Product Memories for the Internet of Things*. Springer.

142. Roy Want. 2011. Near Field Communication. *IEEE Pervasive Computing 10*, 4–7.

143. Mark Weiser. 1993. Some Computer Science Issues in Ubiquitous Computing. *Commun. ACM* 36, 7: 75–84. https://doi.org/10.1145/159544.159617

144. Mark Weiser. 1993. Hot topics-ubiquitous computing. *Computer* 26, 10: 71–72. https://doi.org/10.1109/2.237456

145. Mark Weiser. 1999. The Computer for the 21st Century. *SIGMOBILE Mob. Comput. Commun. Rev.* 3, 3: 3–11. https://doi.org/10.1145/329124.329126

146. H. G. (Herbert George) Wells. 2003. *Floor Games; a companion volume to "Little Wars."* Retrieved April 18, 2013 from http://www.gutenberg.org/ebooks/3690

147. H.G Wells. 2003. *Little Wars; a game for boys from twelve years of age to one hundred and fifty*. Gutenberg. Retrieved April 18, 2013 from http://www.gutenberg.org/ebooks/3691

148. Theresa Winge and Marybeth Stalp. 2014. Virtually Crafting Communities: An Exploration of Fiber and Textile Crafting Online Communities. *Textile Society of America Symposium Proceedings*. Retrieved from http://digitalcommons.unl.edu/tsaconf/889

149. Rafal Wojciechowski, Krzysztof Walczak, Martin White, and Wojciech Cellary. 2004. Building Virtual and Augmented Reality Museum Exhibitions. In *Proceedings of the Ninth International Conference on 3D Web Technology* (Web3D '04), 135–144. https://doi.org/10.1145/985040.985060

150. L. D. Xu, W. He, and S. Li. 2014. Internet of Things in Industries: A Survey. *IEEE Transactions on Industrial Informatics* 10, 4: 2233–2243. https://doi.org/10.1109/TII.2014.2300753

151. E. Zalta. 2012. *Abstract Objects: An Introduction to Axiomatic Metaphysics*. Springer Science & Business Media.

152. Zee. 2011. Fitbit users are unwittingly sharing details of their sex lives with the world. *The Next Web*. Retrieved May 15, 2017 from https://thenextweb.com/insider/2011/07/03/fitbit-users-are-inadvertently-sharing-details-of-their-sex-lives-with-the-world/

153. Congyingzi Zhang and Robert Green. 2015. Communication Security in Internet of Thing: Preventive Measure and Avoid DDoS Attack over IoT Network. In *Proceedings of the 18th Symposium on Communications & Networking* (CNS '15), 8–15. Retrieved September 21, 2017 from http://dl.acm.org/citation.cfm?id=2872550.2872552

154. Xuan Zhao, Niloufar Salehi, Sasha Naranjit, Sara Alwaalan, Stephen Voida, and Dan Cosley. 2013. The Many Faces of Facebook: Experiencing Social Media As Performance, Exhibition, and Personal Archive. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '13), 1–10. https://doi.org/10.1145/2470654.2470656

155. Zhongying Zhao, Shengzhong Feng, Qiang Wang, Joshua Zhexue Huang, Graham J. Williams, and Jianping Fan. 2012. Topic oriented community detection through social objects and link analysis in social networks. *Knowledge-Based Systems* 26: 164–173. https://doi.org/10.1016/j.knosys.2011.07.017

156. Annemarie Zijlema, Elise van den Hoven, and Berry Eggen. 2016. Companions: Objects Accruing Value and Memories by Being a Part of Our Lives. In *Proceedings of the 28th Australian Conference on Computer-Human Interaction* (OzCHI '16), 170–174. https://doi.org/10.1145/3010915.3010958

157. John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research Through Design As a Method for Interaction Design Research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '07), 493–502. https://doi.org/10.1145/1240624.1240704

158. John Zimmerman, Erik Stolterman, and Jodi Forlizzi. 2010. An Analysis and Critique of Research Through Design: Towards a Formalization of a Research Approach. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (DIS '10), 310–319. https://doi.org/10.1145/1858171.1858228

159. 1976. Problems from Locke - Oxford Scholarship. Retrieved September 19, 2017 from http://www.oxfordscholarship.com/view/10.1093/0198750366.001.0001/acprof-9780198750369

160. 1992. *The Tso Chuan*. Columbia University Press, New York.

161. 2017. Art Spotlight: Ravasch Cario. *Sketchfab Blog*. Retrieved September 22, 2017 from https://blog.sketchfab.com/art-spotlight-ravasch-cario/

162. 2017. WannaCry Aftermath: Is IoT Ransomware in Our Future? *IoT Institute*. Retrieved September 21, 2017 from http://www.ioti.com/security/wannacry-aftermath-iot-ransomware-our-future

163. Auto-ID Labs. Retrieved September 21, 2017 from https://autoidlabs.org/

164. The Internet of Things - Connecting the real world with the digital world. Retrieved September 21, 2017 from http://archive.eurescom.eu/message/messageSep2009/The-Internet-of-Thing%20-Connecting-the-real-world-with-the-digital-world.asp

165. NEST. *Nest*. Retrieved September 21, 2017 from https://www.nest.com/uk/

166. Bluetooth Tracker | Tile. Retrieved September 21, 2017 from https://www.thetileapp.com/en-gb/

167. Hue personal wireless lighting | Philips Lighting. *Philips*. Retrieved September 21, 2017 from https://www.philips.co.uk/c-m-li/hue

168. Amazon Echo - Alexa Voice Service. Retrieved September 21, 2017 from https://www.amazon.co.uk/dp/B01GAGVIE4/

169. Internet of Shit. *Internet of Shit*. Retrieved September 21, 2017 from https://internetofshit.net/

170. The Internet of Useless Things. *The Internet of Useless Things*. Retrieved September 21, 2017 from http://internetofuselessthings.io

171. Predicting Divorce | Science of Revenue. Retrieved May 15, 2017 from https://scienceofrevenue.com/tag/predicting-divorce/

172. Where's George? **"**Currency Tracking Project**"**. Retrieved September 21, 2017 from https://www.wheresgeorge.com/

173. Where's George?: The Trail Of $1 Bills Across The U.S. *NPR.org*. Retrieved September 21, 2017 from http://www.npr.org/2013/03/24/174966382/wheres-george-the-trail-of-1-bills-across-the-u-s

174. EuroBillTracker - Follow your Euro notes in their tracks. Retrieved September 21, 2017 from https://en.eurobilltracker.com/

175. Where's Willy? Track Your Dollar Bills. Retrieved September 21, 2017 from http://www.whereswilly.com/

176. Welcome to BookCrossing. Retrieved September 21, 2017 from https://www.bookcrossing.com/

177. Free AIS Ship Tracking of Marine Traffic - VesselFinder. Retrieved September 21, 2017 from https://www.vesselfinder.com

178. *Significant Objects | …and how they got that way*. Retrieved December 19, 2014 from http://significantobjects.com/

179. Tales of Things. Retrieved September 21, 2017 from https://talesofthings.com/

180. Artcodes Community - Try, explore & share Artcodes! *Artcodes Community*. Retrieved September 21, 2017 from https://www.artcodes.co.uk/

181. Carolan Guitar. *Carolan Guitar*. Retrieved September 21, 2017 from https://carolanguitar.com/

182. Addicted Toasters. Retrieved September 21, 2017 from http://www.addictedproducts.com/

183. object | Definition of object in English by Oxford Dictionaries. *Oxford Dictionaries | English*. Retrieved September 21, 2017 from https://en.oxforddictionaries.com/definition/object

184. thing | Definition of thing in English by Oxford Dictionaries. *Oxford Dictionaries | English*. Retrieved September 21, 2017 from https://en.oxforddictionaries.com/definition/thing

185. thing | Definition of a thing in English by Merriam-Webster. Retrieved September 21, 2017 from https://www.merriam-webster.com/dictionary/thing

186. Introducing Heidegger: A Graphic Guide (Introducing...) eBook: Jeff Collins, Howard Selina: Amazon.co.uk: Kindle Store. Retrieved September 21, 2017 from https://www.amazon.co.uk/Introducing-Heidegger-Graphic-Guide-

ebook/dp/B00URQVNK8/ref=sr_1_9?ie=UTF8&qid=1506029684&sr=8-9&keywords=heidegger

187. Heidegger: An Essential Guide For Complete Beginners eBook: Michael Watts: Amazon.co.uk: Kindle Store. Retrieved September 21, 2017 from https://www.amazon.co.uk/Heidegger-Essential-Guide-Complete-Beginners-ebook/dp/B00PWY4ZG4/ref=sr_1_2?ie=UTF8&qid=1506029684&sr=8-2&keywords=heidegger

188. Lives that Made Greek History. Retrieved September 21, 2017 from https://www.hackettpublishing.com/lives-that-made-greek-history

189. The Hitchhiker's Guide to the Galaxy: The Trilogy of Five eBook: Douglas Adams: Amazon.co.uk: Books. Retrieved September 21, 2017 from https://www.amazon.co.uk/Hitchhikers-Guide-Galaxy-Trilogy-Five-ebook/dp/B009OCBX38/ref=la_B000AQ2A84_1_1?s=books&ie=UTF8&qid=1506031984&sr=1-1

190. Science Without Numbers. *Princeton University Press*. Retrieved September 21, 2017 from http://press.princeton.edu/titles/528.html

191. The Meaning of Things. *Cambridge University Press*. Retrieved August 18, 2015 from http://www.cambridge.org/gb/academic/subjects/psychology/social-psychology/meaning-things-domestic-symbols-and-self

192. Warhammer 40,000. *Warhammer 40,000*. Retrieved September 22, 2017 from https://warhammer40000.com/

193. Role-Playing and Wargames Society. Retrieved September 22, 2017 from https://www.su.nottingham.ac.uk/societies/society/rpbsoc/

194. Warhammer World. *Warhammer World*. Retrieved September 22, 2017 from https://warhammerworld.games-workshop.com/

195. The Oxford Companion to Chess: Amazon.co.uk: David Hooper, Kenneth Whyld: 9780192800497: Books. Retrieved September 22, 2017 from https://www.amazon.co.uk/Oxford-Companion-Chess-David-Hooper/dp/0192800493

196. H.G. Wells Awards | Award | BoardGameGeek. Retrieved September 22, 2017 from https://boardgamegeek.com/award/22973/hg-wells-awards

197. Hobby Games Market Nearly $1.2 Billion. Retrieved September 22, 2017 from https://icv2.com/articles/news/view/35150/hobby-games-market-nearly-1-2-billion

198. How board games became a billion-dollar business. Retrieved September 22, 2017 from http://www.newstatesman.com/culture/games/2017/01/how-board-games-became-billion-dollar-business

199. Dawn of War (Series) - Lexicanum. Retrieved September 22, 2017 from http://wh40k.lexicanum.com/wiki/Dawn_of_War_(Series)

200. Dawn of War. *Dawn of War*. Retrieved September 22, 2017 from https://www.dawnofwar.com

201. Lexicanum. Retrieved September 22, 2017 from http://wh40k.lexicanum.com/wiki/Main_Page

202. Warhammer 40k Wiki. Retrieved September 22, 2017 from http://warhammer40k.wikia.com/wiki/Warhammer_40k_Wiki

203. CoolMiniOrNot - The Top 10. Retrieved September 22, 2017 from http://www.coolminiornot.com/top

204. Flickr.com. *Flickr*. Retrieved September 22, 2017 from https://www.flickr.com/

205. ArtStation. *ArtStation*. Retrieved September 22, 2017 from https://www.artstation.com/

206. DeviantArt - The Largest Online Art Gallery and Community. *DeviantArt*. Retrieved September 22, 2017 from https://www.deviantart.com

207. YouTube. Retrieved September 22, 2017 from https://www.youtube.com/

208. Kickstarter. Retrieved September 22, 2017 from https://www.kickstarter.com/

209. Best way for artists and creators to get sustainable income and connect with fans. *Patreon*. Retrieved September 22, 2017 from https://www.patreon.com/

210. Golden Demon. *Golden Demon*. Retrieved September 22, 2017 from https://golden-demon.com/

211. DakkaDakka - Wargaming and Warhammer 40k Forums, Articles and Gallery. Retrieved September 22, 2017 from https://www.dakkadakka.com/

212. VASSAL. Retrieved September 22, 2017 from http://www.vassalengine.org/

213. Remembrancer Service. *Remembrancer Service*. Retrieved September 22, 2017 from http://ddarz.wp.horizon.ac.uk/

214. Raspberry Pi - Teach, Learn, and Make with Raspberry Pi. *Raspberry Pi*. Retrieved September 22, 2017 from https://www.raspberrypi.org/

215. Arduino - Home. Retrieved September 22, 2017 from https://www.arduino.cc/

216. Mixed Reality Storytelling – Researching the Digital Footprints of Interesting Things. Retrieved September 19, 2017 from http://www.mixedrealitystorytelling.net/

217. National Videogame Arcade. *The National Videogame Arcade*. Retrieved September 22, 2017 from https://www.thenva.com/

218. Home. *Awaken Realms*. Retrieved September 22, 2017 from http://awakenrealms.com

219. Ex Illis. Retrieved September 22, 2017 from http://www.ex-illis.com/

220. Vuforia | Augmented Reality. Retrieved September 22, 2017 from https://www.vuforia.com/

221. Best Practices for Using Augmented Reality in Mobile Apps. Retrieved September 22, 2017 from https://www.gartner.com/doc/3803466/best-practices-using-augmented-reality

222. Best Practices. Retrieved September 22, 2017 from https://library.vuforia.com/best-practices

223. Agisoft PhotoScan. Retrieved September 22, 2017 from http://www.agisoft.com/

224. Sketchfab. *Sketchfab*. Retrieved September 22, 2017 from https://sketchfab.com/

225. NVFHome. *The National Videogame Foundation*. Retrieved September 22, 2017 from http://www.thenationalvideogamefoundation.org/

226. Uk Games Expo 2017 - Home Page. Retrieved September 22, 2017 from https://www.ukgamesexpo.co.uk/

227. Historicon® - Historical Miniatures Gaming Society, Inc. Retrieved September 22, 2017 from http://www.hmgs.org/general/custom.asp?page=HconHome

228. Partizan Wargaming Show :: Home. Retrieved September 22, 2017 from http://partizan.org.uk/

229. Wargames Events - Home. Retrieved September 22, 2017 from https://www.wargamesevents.co.uk/

230. Gav Thorpe: Author of Fantasy and Science Fiction, including Warhammer and Warhammer 40K. Retrieved September 22, 2017 from https://gavthorpe.co.uk/

231. Tales of Things - SMITHS POCKET WATCH. Retrieved September 23, 2017 from http://www.talesofthings.com/thing/34/

232. “Hawk” Ashtray by William Gibson | Significant Objects. Retrieved September 23, 2017 from http://significantobjects.com/2009/10/02/hawk-ashtray/