

Hidden Between Craft and Industry: Engineering Patternmakers' Design Knowledge

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Craft is currently experiencing an academic and popular revival, as evidenced by increasing interest in 'makers' and artisanal practices, both within and beyond design history. Yet, in this moment of craft's resurgence, some aspects are regularly overlooked. Industrial craft in manufacturing, for instance, is a field ripe for closer analysis. Engineering patternmaking is an industrial craft that remains almost invisible in design history, despite the design-related nature of patternmaking, and its centrality to many industrial manufacturing processes. Drawing on oral histories with Australian patternmakers, this article emphasizes that patternmaking is both a manual *and* intellectual practice that requires thorough knowledge of drawing, materials, geometry, three-dimensional visuality and manufacturing processes planning. Accordingly, I argue that patternmakers possess and enact a specific type of *design knowledge*, a form of expertise that has thus far been undervalued in both design and craft histories. Making use of Nigel Cross' influential theorization of 'designerly ways of knowing', this article explores the connections and divergences between design and patternmaking knowledge sets, reminding us that the making of manufactured objects is deeply collaborative across professional and class formations. In doing so, I highlight the significance of industrial craft knowledge in the actualization of design. This example has broader historical implications for how design history frames and values the knowledge, skills and influence of those engaged in industrial production.

Keywords: crafts—design knowledge—engineering patternmaking—manufacture—oral history—skill

Prologue

At the core of that was patternmaking, where an idea grew legs, *literally* grew legs. An idea from, y'know, an engineer's or a designer's mind, made it onto paper in two dimensions, and then, through the skill of the patternmaker, it gained a third dimension and became real. And that *really* had me, I mean I *wanted* to be a part of that.

Peter Williams, engineering patternmaker and teacher¹

Three years ago, the only 'patternmaker' I had heard of belonged to textiles production. All this was to change in winter 2015, when I was conducting fieldwork at a steel foundry in the state of Victoria, in regional Australia. I was there as part of a research team, exploring the intricacies of a family-owned steel foundry which had no desire to offshore to Asia.² We undertook fast-paced social-science-style interviews in an icy meeting room. I was nine weeks' pregnant, ravenously hungry, freezing cold, and somewhat consumed by all of these conditions. But on the final day of fieldwork, a couple of interviews stood out in my memory. We met with two engineering

patternmakers from the foundry's patternshop. I will call them Sam and Frank.³ When asked to describe his job, Frank explained:

I'm a patternmaker by trade. I've been [a patternmaker for] 47 years or something. It *has* changed ... Mainly it's a lot of machine work now ... We make patterns, sort of, but it's a lot of assembly now. It's either [3D] printed or cut on the CNC [Computer Numerically Controlled] machine, and we just put it all together. But occasionally we do make the old-style wooden patterns, but that's only occasionally.⁴

I was struck by his demeanour: defeated, but accepting.

Engineering patternmaking, I was soon to learn, emerged as a distinct trade in industrializing economies in the mid-nineteenth century; it was a specialized off-shoot from the 'all-round' role of the millwright.⁵ Put very simply, a patternmakers used engineering or design drawings to construct a three-dimensional form (a pattern) as accurately as possible.⁶ The pattern—usually a positive form—was used to produce a cavity for production processes involving moulding and casting [1].⁷ From producing large-scale patterns for steel castings [2], to the intricate forms for tiny glucose candy 'jubes' [3], a patternmaker was responsible for the original three-dimensional form used to produce the final, replicable product. Traditionally, patterns were made out of timber, and patternmakers were renowned for their precision skills in woodworking.⁸

I was not alone in my ignorance of patternmaking; historically it has remained on the fringes. In 1904, an anonymous patternmaker complained that it is 'seldom that we hear very much about' patternmakers, despite the fact that they are:

... necessary for the production of ordinary lamp posts, piano frames, fire grates, any kind of brackets, all sorts of machinery, locomotive, turbine and marine engines, or any other article which must be moulded and cast in brass, iron, steel or other metal.⁹

The lesser-known status of patternmaking can be partly explained by the very nature of industrial moulding and casting processes: patternmaking occurs after the design and prototyping stages, but before the final product comes into fruition. In this sense, patternmakers are intermediaries, working in the shadows of design. While their labour is crucial for the actualization of design objects requiring moulding and/or casting, patternmakers' hands tend not to touch the final produced object. This disconnection from the 'real thing' is one of the reasons—according to the anonymous patternmaker above—that patternmakers were regularly underpaid, undervalued and misunderstood.¹⁰ For design historians and curators, the implications of valuing not just the 'thing' itself, but its pre-production 'collateral' has fascinating potential for research.

Although I did not know it at the time, these initial interviews in 2015 were a moment of profound change in my understanding of the world of design and its relationship to industrial production. There are moments in the research process—as historians and designers will recognize—where it feels as if a cavernous space opens up in front of us, prompting a sense of both

Fig 1. Gear pattern (with resultant casting) by Peter White, Dolman Pattern & Model Makers, n.d., reproduced with permission.





Fig 2. Large pattern for a casting by Debra Schuckar, State Electricity Commission Victoria, 1988, personal album, reproduced with permission.

exceptional possibility, but also fear at the scope of the new terrain ahead. Three years later, I sit at home with my two-year-old child, holding one of their much-loved vintage die-cast cars, attempting to imagine the intricately hand-carved timber form that was once necessary to produce toys such as these. Running my hands over the rounded corners of a 4-cm die-cast Holden FJ, the disciplinary boundaries of what constitutes ‘design’, ‘craft’ and ‘engineering’ seem to recede. The overwhelming sense I felt during those first interviews owed to the fact that I could see the messy relations between design history, technology, labour and industrial production entangling in front of me. Appreciating this entanglement allows us to revalue the place patternmakers had within a broader network of design-related roles, activities and knowledge sets, as the Introduction will explain.

Introduction

It’s a bit of a black art. An integral part of the manufacturing process – but no one knows it’s there. They think that the design is made, and then all of a sudden out comes a part. And you just can’t explain it, it’s impossible to explain what I did for a living.¹¹

Engineering patternmaker Scott Murrells

This article makes a claim about a particular kind of *design knowledge* that is possessed by specialized non-designers who work in fields that are related to, but are not, strictly speaking, industrial design. It urges us to remember that deep understandings of the human-made world are not the mere purview of those with the privilege to call themselves professional designers, and a great deal can be learned from others, for example, industrial trades. While design history has, in recent years, come some way in appreciating the design contributions of amateurs, collectors and enthusiasts,¹² less has been said about the knowledge and practices of industrial craftspeople, whose work is fundamentally linked to the production of designed things. Patternmaking is an industrial craft that remains almost invisible in design history, despite the design-oriented nature of patternmaking, and its former centrality to many manufacturing processes. In popular visions of mass-manufacturing, we tend to be quick to remember the industrial designer, and many may point to the harsh realities of labour on a production line, but it is the highly skilled, craft-based intermediate stages of production that receive far less attention, both within and beyond design history. Accordingly, this article focuses on what engineering patternmakers *know* through practice, and makes an argument about why this is important for designers and design historians to understand. Through their work, patternmakers harnessed in-depth understandings of design form, materials, geometry and manufacturing processes. More than merely being ‘process workers’ following orders on the shopfloor, patternmakers played a distinct and influential role in bringing things into being.

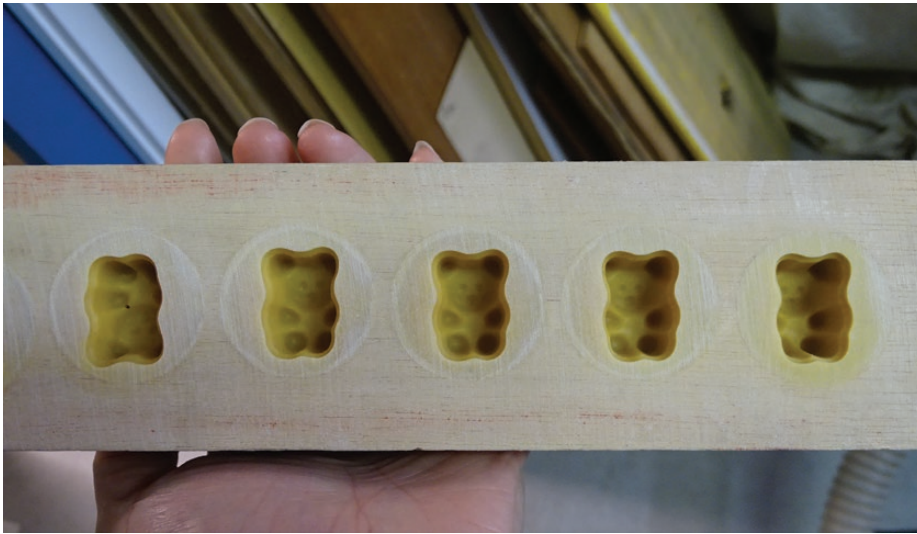


Fig 3. Negative mould for glucose jube forms by Paul Kay, W. G. Kay & Co., Sydney, reproduced with permission. Photograph by the author, 2018.

My use of the term ‘design knowledge’ is drawn playfully from Nigel Cross’ influential theorization of *Designery Ways of Knowing*, which, while the subject of ongoing debate, seems to be consistently returned to as a pedagogical anchor for defining design knowledge.¹³ In brief, Cross delineates design as a ‘third area’ of knowledge (humanities and sciences being the other two arenas). He explained:

Designery ways of knowing rest on the manipulation of non-verbal codes in the material culture; these codes translate ‘messages’ either way between concrete objects and abstract requirements; they facilitate the constructive, solution-focused thinking ... they are probably the most effective means of tackling the characteristically ill-defined problems of planning, designing and inventing new things.¹⁴

As I will outline, many of these aspects of design knowledge—with the exception of the final category (tackling ill-defined problems)—can also be understood in relation to the expertise of engineering patternmakers. In comparing Cross’ conceptualization of design knowledge with my research into patternmakers’ knowledge through practice, I demonstrate the interconnectedness between some of the conceptual and practical arenas of design and patternmaking. Presented this way, design and patternmaking operate on a *spectrum of practice*, rather than within bounded, polarized limits, which might be strictly delineated and labelled by some as ‘craft’ and ‘design’. (I have not forgotten ‘craft’ in this discussion, it is addressed at some length further on.)

I want to be careful about what I am claiming here: I am not arguing that patternmakers *are* designers—in the authorial, creative sense—but rather, that they are design-affiliated professionals who thoroughly understand many aspects of design, and, historically and even today, their expertise has been of great value to designers. Patternmakers are not generally involved in the original authorship of a new design, but their vital role in pre-production for many manufacturing processes often results in collaborative design changes, so as to ensure production is possible. Such changes may not be particularly obvious, but they are often essential for ensuring a successful end result. In this way, I argue that patternmakers’ accumulated understandings of form, materials literacy, problem-solving and three-dimensional visualization constitute

a form of design knowledge, which extends well beyond the oversimplified notion of a technician or craftsperson who is 'good with their hands'.

Accordingly, this article explores how patternmakers' design knowledge manifests as a practice in the nitty-gritty specificity of their labour activities. This focus provides a subtle but important challenge to design history's (and design studies') sometimes designer-centric framing of industrial design and manufacturing. Here, I am responding to calls by design theorist Lucy Kimbell for an understanding of design that 'de-centres the designer as the main agent in designing', and acknowledges design as 'involving diverse and multiple actors'.¹⁵ This has broader historical implications for how design history frames and values the knowledge, skills and influence of those engaged in industrial production.

As I hinted earlier, in this study I am deliberately eschewing strict disciplinary distinctions. I am not concerned, for instance, with the need to draw a clear division between what is 'craft', and what is 'design'. My own observations of industrial design and patternmaking practices suggest that this line is much blurrier in practice than in theory and pedagogy.¹⁶ As argued by design theorist Tony Fry, design history risks being 'historically dislocated' and restricted by its focus on disciplinary boundaries.¹⁷ It is imperative, Fry argues, that new forms of design history engage with the

huge complexity of the 'world-within-the-world' of human fabrication, wherein everything within this world has been created by design: as such, it is often invisible, mostly anonymous.¹⁸

This means that it is possible to say, for instance, that patternmakers practice a craft, *as well as* possessing specialized understandings of design form, material literacy and manufacturability. In this view, design knowledge and craft practice need not be seen as mutually exclusive categories.

The structure of this article is as follows: first, the methods and sources for this study are introduced, and a background historical context—relevant to Australian patternmakers—is outlined. From there, the discussion is situated within the context of the growing discourse about industrial craft, both within and beyond design history. Oral history evidence is then drawn upon in order to outline the process of making a pattern. A close engagement with these processes opens up possibilities for paralleling Cross' conceptualization of 'designerly ways of knowing' with patternmaking practice. The final section provides a brief discussion about patternmakers' relative freedom to make changes to a design. I conclude by briefly reflecting on the continuing value of trades knowledge in the context of emerging digital fabrication technologies.

Sources: hearing stories, finding patterns

One of the challenges for industrial design and manufacturing histories is sourcing evidence about production methods and worker experience. For craft theorist Ezra Shales, it is the voices of workers that can open up our empathic understanding of industrial labour practices, revealing links between past and present, and demonstrating the interconnectedness of craft, design and industry. Shales states that oral histories enable us to 'decipher everyday life, not necessarily praxis as it stands in the design academy'.¹⁹ Similarly, I have drawn upon oral history interviews with engineering patternmakers, as a way of (literally) opening up dialogue between design and manufacturing, both past and present. The example explored here is a small group of Australian patternmakers

with manufacturing experience spanning the 1940s to the present. I make use of two separate but related interview projects. The first project, as mentioned at the start of this article, involved observational fieldwork and interviews at an Australian steel foundry in 2015.²⁰ The second, more in-depth project—the *Reshaping Australian Manufacturing*—is conducted in partnership with the National Library of Australia.²¹

Space precludes me from providing a highly detailed background into the methodological complexities of handling oral history interviews and content analysis. It is important to note, however, that there are long-established social history methods of using oral history to understand working life and working-class experience.²² Verbal accounts provide insights into socially inscribed labour relations, tacit knowledge, unofficial practices and sensory experiences. It is now broadly established that oral histories do not, generally speaking, uncover ‘what happened’ on a purely factual basis. Rather, oral testimony helps us understand how people construct narratives about the past.²³ In this sense, the content generated conveys nuances of meaning, memory, perception and politics. Oral histories also provide a way to understand material culture, changing practices and perceptions of skill in social context, opening up paths to understanding the embodied experience of work.²⁴ In a similar manner to Giovanni Contini’s interviews with Italian miners and quarry workers,²⁵ my interviews with patternmakers demonstrate how craftworkers understand and situate their own knowledge and skill, how they articulate their material engagement and how they perceive their role in bringing things into being.²⁶

Background: engineering patternmakers in Australia

In the Australian technical training system—largely inherited from the United Kingdom—to formally qualify as an engineering patternmaker, an apprentice is indentured for four (formerly five) years with an employer, as well as completing studies at a technical institute. In Australia, nineteenth-century patternmakers tended to work within metal foundries or in discrete small businesses known as ‘patternshops’. With the growth of plastics manufacturing in the twentieth century, patternmakers adapted to embrace more precise, smaller forms of patternmaking, in the service of toolmaking for plastics production, and also in association with automotive manufacturing. This has meant that the practices of patternmakers, toolmakers and industrial modelmakers are closely allied and often overlap.²⁷

At first glance, the connection between plastics production and highly refined woodwork might seem obscure.²⁸ But throughout much of the twentieth century, dimensionally stable timbers such as Huon Pine and Mahogany were seen as ideal materials for making intricate models for toolmaking and plastics production. For instance, patternmaker Bryan Poynton recalled, ‘One time I had to make – out of Huon Pine – a very fine cup and saucer which was a model to be approved of for Ansett Airways’.²⁹ While the verbatim transcription may not communicate this, there is a certain delight that patternmakers get in their voice when they talk of using Huon Pine to make models and patterns.³⁰

In the second half of the twentieth century, patternmakers expanded their materials repertoire well beyond timber, working more with Epoxy resins, silicone, polyester filler (known in Australia as ‘bog filler’), high-density polyurethane, fibreglass, polystyrene, among other materials.³¹ In this sense, patternmakers were the initial beneficiaries of technological change in the twentieth century, as booming plastics production led to

further demand for their services. This also resulted in the emergence of further specializations within the patternmaking trade, with some patternmakers, for example, collaborating with toolmakers, using a pantographic machine to reproduce patterns in metal. Other patternmakers focused on resin patterns and mouldings for food manufacturing [3], or patterns for vacuum formed plastics. Another group of patternmakers focused their skills on patterns for metal casting foundries. Master patterns for castings were typically made out of timbers such as Sugar Pine and Jelutong, and the end-product castings were often for mining and agricultural equipment, railways, shipping industries and other industrial machinery [4].

Two significant shifts in the late twentieth century spelled the end of Australian patternmakers' security: shifting national economic policy and technological change. Given patternmakers do not produce a 'final product', they are entirely reliant on other manufacturing industries for survival. This is why an explanation of the broader story of Australian manufacturing is necessary. As a consequence of the Australian Labor Government's Accord with Australian Council of Trade Unions (ACTU) between 1983 and 1997, Australia retained a centralized wage fixing system, but floated the Australian dollar and gradually dismantled the tariff protection system in favour of 'free trade', among other policy shifts.³² As a result, Australian manufacturing firms—many of which were typically small- to medium-size businesses—were thrust into global competition. Their overseas competitors often had access to looser regulatory structures, lower wage requirements, larger markets, geographical advantages and cheaper supplies.

The diminishing political support for manufacturing in Australia was further entrenched in the first two decades of the twenty-first century, both by Liberal-National and Labor governments. During this period, local manufacturers faced the challenges of a high Australian dollar, the Global Financial Crisis, and a political preference for minerals extraction over manufacturing.³³ Ultimately, this led to the exit of all large-scale automotive manufacturing from Australia in 2017 (which has had cascading impacts in many other sectors, including patternmaking).³⁴ Evidently, the story of manufacturing decline is by no means exclusive to Australia; patternmakers are a declining profession elsewhere (particularly in the Global North),³⁵ owing to a confluence of economic and technological factors.

The most significant *technological* reason for patternmaking's decline is the widespread uptake of CNC (Computer Numerically Controlled) milling machines [5],

CADD software, and, to a lesser extent, 3D printing, from the 1990s onwards. The introduction of CNC meant that patternmakers began to do far less 'hands-on' pattern production, and their manual connection to the work was increasingly reduced to finishing and painting. Essentially, a patternmaker's role became more of a machine-attendant, a hand-finisher, and/or a production planner and CADD technician.³⁶ With CNC, the practice of patternmaking—in its fully exercised sense—is now on the cusp of disappearance, gradually moving, as it were, into full technological redundancy.

Patternmaking is now something of an endangered species within the fragile ecology that makes up the

Fig 4. Master pattern for a bearing cover by Peter White, Dolman Pattern & Model Makers, n.d., Jelutong timber, 400 mm diameter, later moulded in Epoxy resin for production, reproduced with permission.

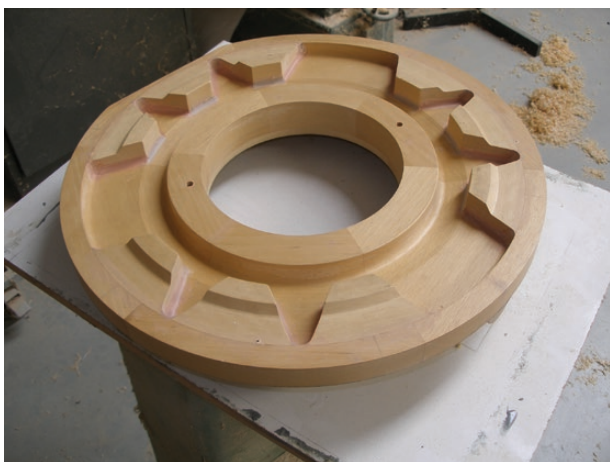




Fig 5. Haas CNC machining centre, access granted by G. and D. Tyrrell, Kimbeny Pty. Ltd., Sydney. Photograph by the author, 2018.

remnants of Australian manufacturing.³⁷ The second patternmaker I ever met, Sam (mentioned in the Prologue), explained:

Patternmaking is a very small trade, especially the way I was taught to do it ... a customer comes in with a requirement, and we just build anything, any shape, any form. It was all traditional patternmaking too, a lot of woodworking, hand tools ... Down on the floor here we've got young Stuart. He's just finished his apprenticeship last year. He'll be the last Victorian patternmaker ever.³⁸

With the benefit of hindsight, I can now say that this is a good example of the way many patternmakers talk. When asked to explain their trade, they invariably commence by stating that they make three-dimensional forms, and end with a statement about how patternmaking is 'on the way out', 'over' or the trade is 'dead'. They are not being melodramatic. At the time of writing (2018), there remain only seven currently enrolled engineering patternmaking apprentices in Australia.³⁹ While approximately 2,200 patternmakers are still recorded as working in Australia,⁴⁰ most who were indentured in this trade have retrained in other fields, or taken early retirement. Of the group I interviewed, almost none envisage a long-term future in patternmaking. Yet, perhaps unexpectedly, manufacturing employers in Australia today still seek qualified patternmakers and claim that it is hard to find them.⁴¹ What they seek, therefore, is not just the patternmakers' manual labour at the patternshop bench, but their specialist *knowledge*—their in-depth and practiced understanding of design form, surface, materials and manufacturing processes. But many Australian patternmakers—bored by what technology has done to their skilled labour, and understandably anxious about the long-term economic prospects of local manufacturing—have decided to move on to something else, or retire. This devaluation (and revaluation) of industrial craft is explored in the following section, with specific reference to how design history has handled the matter.

Design histories of industrial craft

Where once 'craft' was understood as the antithesis of industrial factory production, in recent years, historians of design and craft have shifted beyond this dichotomy.⁴² We are no longer subject to the long-standing assumption that craft practices and industrial production are at opposing ends of a polarized binary, a notion that can be traced from John Ruskin and the Arts & Craft Movement's reaction against the industrial revolution.⁴³ There is a growing understanding of the interconnectedness of design, production and craft, both past and present. As argued by design and craft theorist Glenn Adamson, it is now possible to understand craft not as an 'eternal' tradition rooted in the distant past, but as a 'modern invention' that emerged in constant relation to industrial design and factory production.⁴⁴

Craft—in its many guises—is now experiencing a revival in terms of popular consumption and academic analysis, across humanities disciplines.⁴⁵ Recent years have seen a burgeoning study of craft not only in design history and modern craft studies,⁴⁶ but also in anthropology, sociology and human geography.⁴⁷ This has broadened the scope of our analysis, and challenged narrower notions of craft as regional, colonized, nostalgia-laden, gendered and/or amateur.⁴⁸ Fashionable craft practices such as beer brewing, surfboard making and hair-dressing have recently received academic attention as skilled activities worthy of serious analysis.⁴⁹ It is fair to say that we are moving in the direction of a more comprehensive understanding of the historical and contemporary complexity of craft.

There remain some blind-spots, however. Craft still tends to be more readily identified in the realm of the artisanal hand crafter, and the unglamorous, grubbier and more apparently working-class practices remain less recognized.⁵⁰ This may be an uncomfortable thing to suggest, but it is worth asking whether design history replicates social class structures, in our choice of topics for investigation. Craft's role in heavy industrial production remains relatively uncharted territory for design historians and social scientists alike. Reyner Banham hinted at this, in his somewhat eccentric polemic, 'Sparks from a Plastic Anvil' in 2008:

A craftsman to most literate people is the man who stands under the spreading chestnut tree doing all those groovy things with his muscles, but where is he now? Quite a lot of them are doing quite well, thank you, in the post-horse era ... What I am getting to is that the craftsman, as is normally understood, has far from disappeared. He has found a number of very important niches within the structure of manufacturing industry. We do not get his products directly, but nevertheless we do get his products.⁵¹

The indirect nature of this encounter speaks very appropriately to a lay experience of patternmaking. There are, of course, some exceptions, and the work of Shales is one example.⁵² As Shales has argued, we must move past the perception that industrial manufacturing is a realm almost exclusively dominated by machines and unskilled labourers.⁵³ The *idea* of heavy industrial manufacturing still generally invites mental images that are seemingly craft's antithesis: conveyor-belt production lines in some far-away low-wage nation, or fully mechanized robotic factories. Shales challenges this, directing our attention to the skilled craft production that is *ongoing* in factories, noting that 'most of us still live within an hour's drive of factories, even if we might conceptually define our society as "post-industrial"'.⁵⁴ What might we find if we look to the 'extraordinariness of an "ordinary" hand', he asks.⁵⁵ That is evidently where my

research has taken me: into small industrial patternshops, workshops and foundries in suburban and regional Australia.

At this point, it is important to acknowledge that ‘production’ has a long and contested past within design history, as outlined in Grace Lees-Maffei’s historiography.⁵⁶ In design history’s earlier years, ‘production’ was often used as a term to describe the *design* stages, with less attention given to the actual factory processes enacted to bring a thing into being.⁵⁷ More recently, craft theorist and curator Marilyn Zapf—in her analysis of engineering training in the UK—called for an expansion of design history’s understanding of ‘production’, to encompass labour and training well beyond the ‘well researched area of the star-designer, manufacturer, or object’.⁵⁸ Zapf’s approach coheres with my own inclusion of industrial craft labour as an area suitable for design history analysis.

Why engineering patternmaking, in particular? As social historian Sarah Fayen Scarlett and Adamson have separately argued, patternmaking well exemplifies the significance of craft knowledge *within* industrial manufacturing.⁵⁹ As an industrial process, patternmaking reveals how deeply interconnected manual craft, design planning and automated production can be in practice. From Scarlett, we learn that patternmaking was perceived as a working-class trade that American furniture designer Charles Rohlf (1853–1936) wanted to hide from his personal history, so as to avoid his popular Arts & Craft designs being sullied by his trade background.⁶⁰ Adamson notes that patternmaking is ‘a good example of the way a mass production system can increase the importance of craft skill rather than diminishing it’.⁶¹ Further, Adamson states that the pattern itself is an unfamiliar object for a design or craft historian to analyse, as

patterns and prototypes are not copies, strictly speaking, but they are mimetic objects, in which craft skill is tested not on the basis of originality, but by its ability to approximate an external ideal.⁶²

In this way we can see how a pattern—as an object—can exceed the value of a single mass-produced thing, as it will, in part, dictate the quality of the ‘real thing’.⁶³ Adamson has identified ‘three areas of industrial craft – finishing, prototyping, and tooling’, and lamented, ‘among the greatest failings of modern craft historians has been their neglect of this vast terrain of second-order workmanship’.⁶⁴ While Robin Holt and Andrew Popp’s revisionist study of Wedgwood has helped challenge some of design history’s false dichotomies between ‘craft’ and ‘industry’, the craft-industry relationship has far more to offer for inquiring design historians.⁶⁵

My focus on patternmakers’ expertise, then, carries broader implications for how design history frames and values the knowledge, skills and influence of those engaged in industrial production. Phillip Pacey’s early suggestion for design history to emerge ‘in relation to a broader picture which encompasses the non-professional designing which preceded and has co-existed with professional design’ remains instructive here.⁶⁶ Patternmakers, I argue, fall within this ‘broader picture’, as their practices are fundamentally based in design actualization—transforming a paper or digital two-dimensional image into three-dimensional form. To ignore a patternmakers’ skill, knowledge and experience would be to overlook a significant and vastly under-appreciated form of craft practice that is very much engaged with questions of form, surface, materiality and process—all elements that are at the crux of how design comes into being in the world.

(Designerly ways of) patternmaking?

The following sub-sections hone in on the patternmaking process in detail, as a way of engaging with the design-oriented expertise that patternmakers possess, enact and narrativize as they speak. For the sake of simplicity, the rest of this section will refer to the patternmaking process for foundries, in a ‘traditional’ casting patternshop, in other words, the patternmaking process prior to the widespread introduction of CNC machines into patternshops in the 1990s and 2000s.

Patternmakers read and write in ‘object languages’

A patternmaker began a new ‘job’ by being handed a set of engineering or design drawings on paper, or on a stable material, such as mylar film [6]. After studying the drawings and specifications, a patternmaker then produced a ‘layout’, marking out their own drawing to scale, on Plywood (or, prior to the widespread use of Ply, a wooden board). The patternmaker mentioned at this article’s opening, Williams, explained:

One of the most exciting parts of my job, and I can remember it as an apprentice ... was going up ... the manager’s office, tapping on the door, and saying, ‘Dave, I need a job, whaddya you got for me next?’ and Dave would go to the plan file, and take out the next job, and we’d roll that drawing out onto the bench, and I’d look at it and go,

‘Yep, yep, righto,’ ... Sometimes we’d sit there and look at a drawing for two hours on a bench, and nut that out, and see it in our minds, and agree on things. And then I’d go away and get started. And that – I found that just *enthraling*. And then to go away and make it happen was ... making it happen was almost secondary to that initial excitement of reading a drawing, and seeing the thing in three dimensions in my own mind. ... to make a full-size layout – which is virtually another drawing – we would make that on a sheet of plywood ... we would use a scribe and dividers, and engineer’s marking out equipment, to inscribe that object.⁶⁷

The importance of reading a drawing, *re*-drawing and thus visualizing was key. Patternmakers often make much of the fact that being able to read a design or engineering drawing is a key skill that they possess (and often express surprise at design and manufacturing professionals who cannot understand technical drawings). Patternmaker Debra Schuckar said,

When I see a drawing, I can visualise it three dimensionally in my head ... it just comes to me ... I can see the finest detail, I can see the grain in the timber, I can see everything.⁶⁸

Here, Schuckar is describing how she spoke about drawing when she was interviewed for her patternmaking apprenticeship, as a fifteen-year-old. Speaking about drawing in this way got her the job.

It makes sense now to return to Cross’ ‘designerly ways of knowing’. Cross states that designers ‘use “codes” that translate abstract requirements into concrete objects’, and they ‘use these codes to both “read” and “write” in “object languages”’.⁶⁹ In this respect, patternmakers speak—and make—in that same language. Patternmakers



Fig 6. Patternmaking process for a brake strut, including layout, pattern, corebox and casting, 2009. Pattern and photographs by Tim Wighton, reproduced with permission.

understand form, geometry, light and visibility in a similar way to a designer. In my interview with Schuckar, she even used the same terminology, ‘language’, as Cross:

Patternmakers speak another language, and it’s very hard to describe. I don’t know if I described it well to you today, what a patternmaker does. It’s a language within itself.⁷⁰

To reiterate, patternmakers possess an understanding of the material world that is embodied, visual and object-oriented, enabling them to both ‘speak’ (draw) and ‘read’ the coded language of design form. As with designers, patternmakers ‘think’ through the process of drawing.

Patternmakers are solution focused

Returning to the ‘nutting out’ that Williams referred to, this is about how patternmakers had to plan for *how* the object was to be moulded and cast—in other words, the ‘methods’. While this planning process was partly undertaken by other specialists (e.g. engineer, toolmaker, moulder, industrial designer), patternmakers were traditionally very involved. Patternmaker Tim Wighton explained,

[My former employer] was very collaborative in [their] design processes. I was on equal footing with the product designers and methods engineers. They understood and took advantage of patternmaking being a multi-disciplinary trade, not just on the crafting side but on the intellectual side too. I can not only read drawings but understand and reinterpret them to make the object castable. Adding allowances for machining, contraction and taper. Designing cores, coreboxes, joint lines and loose pieces.

Then there [are] all the methoding considerations: How many castings can fit in a moulding box? Where/ how will we feed the casting? Ingates, runners, risers, chills, vents, tie-bars. All this before you even get to actually making the tooling ...

The methoder handed me a drawing, told me how many castings he wanted in a mould box, and suggested how the job was to be methoded. From that point the job was wholly mine; design, crafting, trialing and altering (it's a rare pattern that works first time without any modification)... the patternmaker still had control over the design and construction of the tooling.⁷¹

I have quoted Wighton at length here because of his intriguing use of the term *design*. It may be a subtly different understanding of design than we are used to at the *Journal of Design History*, but Wighton is quite clear: design, for him, is closely tied to the autonomy he was once afforded as a patternmaker at this particular foundry. It is about judgment, decisions, making and iterative testing. As Wighton explains, patternmakers do not merely make patterns, but must plan and design the pattern's cores, joint-lines, taper, runners and risers, vents and so forth. These elements may not be familiar terms outside of the foundry industry, but they are production considerations that are necessary for an effective mould and resultant casting to be created.

When understood in this way, we are not far from Cross' argument that designers' 'mode of problem-solving is "solution focused"',⁷² compared to scientists who focus on *understanding* the problem at hand. In this respect, patternmakers are more akin to designers, in the sense that their motivation is to produce the solution, rather than to articulate what the impeding issues are (unless this articulation is necessary in order to convince an engineer to make a change). For a patternmaker, the solution to the 'problem' is the realization of the design in a physical form that enables a mould to be successfully created. Patternmaker Murrells likewise reflected:

I guess, in a way, patternmakers solve problems. There's a design, that comes along, and it gets turned into a drawing, or a sketch, or whatever it is. And you solve that problem, you turn it into the three-dimensional object that they want.

Murrells added—discussing both patternmaking and clay modelling,

You're told what shape you have to do from a drawing and you're problem solving, and I think that at the end of the day you're probably 50 per cent a shape-maker,

and 50 per cent a problem-solver. That's how I saw myself ... So how do I make this? How do I do this?⁷³

Patternmaking, then, is cohesion of manual craft, tacit knowledge, intellectual understanding and aesthetic consideration. This process results in a myriad of decisions that the patternmaker must make, all of which can affect the ultimate form of the final product, although they are rarely recognized as possessing design expertise. Patternmaking may not constitute 'design' in the authorial sense of original creativity, but this type of process planning—enabled through experience, iteration and experimentation—embeds and actualizes design at every stage. We will return to Wighton's experience further on.

Patternmakers' mode of thinking is constructive

Cross claims that a designers' 'mode of thinking is "constructive"'.⁷⁴ In making this argument, he contrasts the 'analytic' mode of thought from the sciences, with the constructive nature of designing. Cross identifies what has now become a clichéd characteristic of design thinking: designers are well known for redefining the question, rather than simply analysing a given problem. Cross explains, 'design is a process of pattern synthesis, rather than pattern recognition ... it has to be actively constructed by the designer's own efforts'.⁷⁵ Curiously, were we to insert the term 'patternmaker' in place of the word 'designer' in the above quote, and it would still make sense, although a subtly different kind of sense.

In my discussions with patternmakers, many have noted that in the pattern planning process, the problems identified by engineers, moulders and managers were often quite different from the problems (and solutions) identified by patternmakers. One of most frequent ways that the problem was reframed had to do with the limitations of materials and their affordances. The most significant consideration for patternmakers was usually metal shrinkage: accounting for the amount that metal contracts as it cools. One of a patternmaker's most prized tools, therefore, was their set of contraction rules, known in different regions as a shrink rule, shrink gauge or a patternmakers' scale [7]. There were rules (gauges) for steel, copper, bronze, aluminium and so forth. Shrinkage meant, for example, that a pattern had a different form and dimensions to the desired end product, a factor that sometimes troubled their clients and designers, who did not always recognize their intended 'final product' in the pattern. Patternmaker Anthony Freemantle explained:

The other people from other trades and other skill areas ... didn't understand the concept of shrinkage, they didn't understand the concept of taper, they didn't understand the concepts of contraction and so forth, and they didn't understand the concept of actually how you could split your pattern up, and where you should place the joint line, which half is going in which half of the box, when are we going to add a third moulding box in the middle, and we found it was too hard to train these people.⁷⁶

Essentially, a patternmaker's understanding of material properties meant thinking about form in an entirely different way: a temporal, design-conscious and process-based understanding of object formation.

This brings us to the act of pattern construction itself. Having planned their pattern and methods, a patternmaker then used hand and machine tools to construct their pattern,



Fig 7. E. Preston & Sons, brass contraction rule. Photograph by Peter Williams, reproduced with permission.

alongside designing the core box, plate and cores.⁷⁷ Murrells described patternmaking prior to CNC:

There was no CNC machinery or anything high tech back in those days, it didn't exist. It was all just all hand and machinery, and all your work was done off a bandsaw, or a sander, and then chisels and planes and that sort of thing. All hand work, the majority of it.⁷⁸

Patternmakers tended to have larger tool collections than carpenters or cabinetmakers, often taking up several (handmade) toolboxes, and including tools they made themselves (because of the rarity and expense of their specialized kit).⁷⁹ This included chisels, paring gouges, swan neck gouges, spoon gouges, among many others. In a mid- to late twentieth-century patternshop, the machinery at hand often included a circular saw, band saw, buzzer, sanding machine, wood lathe, thicknesser and a router: all machinery that requires an active and careful handling by a trained user. The actual making of the pattern itself was an exercise in precision (or at least precision to the degree that timber will allow). When describing his colleague 'Colin', patternmaker Bryan Poynton observed:

There seem to be two types of patternmakers: one who likes to get a block of wood and start taking things out, like he might have a sculpture, pieces out to

find the model, ... then people like Colin, who had actually fabricate it out of small blocks ... So his patterns were very accurate but they were no visual works of art, you know they're sort of patchy looking but, you know, beautifully made. I sort of fitted somewhere in between those two methods of making. ... It's not sensible to make some things out of a solid block. It's much more accurate and quicker to build them up from pieces.⁸⁰

Here patternmaking is shown to be a constructive process requiring the individual judgement of the patternmaker as to how to proceed. There is usually more than one way to build up a pattern, although one way might be much more efficient or accurate than another.⁸¹

Tackling ill-defined problems?

For design historians, it might be surprising to learn that patternmakers are not particularly interested in the final product—which of course designers and design historians *are*. In fact, often patternmakers never saw the final, mass-produced object that their pattern was used to produce. In a view that reflects what I heard from other patternmakers, Poynton said,

To be honest I was never all that interested in the final product. I was totally interested in the wooden aspect of it. If I was making component I didn't care what it was for basically ... of course, having a mind to the way it was successfully going to mould, and then my job was done.⁸²

Williams likewise reiterated that the actual function of the manufactured object—as it exists out in the world—was not a concern for him, unless it specifically affected the form of the pattern (e.g. if a surface needed to be machined):

Quite often you wouldn't even care what it was. You know, you'd be making a pattern for an object, and you'd look at the object and you might not even recognise it, not even know where it's going, what purpose it's serving in industry or manufacturing, you know, you really didn't think about it, you'd just make it.⁸³

Their focus was on achieving the best quality pattern and mould for the manufacturing process in use; in that respect, the *form* had to be just right, but the ongoing life of the thing was far less relevant (not part of their 'solution'). Other patternmakers had subtly different views about this. Patternmaker Paul Kay, for instance, said that he enjoyed it when he worked on patterns such as rail welding equipment, because it was not just more mass-produced junk: 'you could actually say, well this is something decent, it's required, it's useful. The general population, or industry, is getting something really worthwhile here'.⁸⁴ Exceptions aside, this still remains a rather different disposition to a designer: patternmakers *make forms*, not ideas.

This brings us to Cross' final category of 'designerly forms of knowing', where he states that designers 'tackle ill-defined problems'.⁸⁵ This point is a key divergence between the knowledge structures of designers and patternmakers, at least in terms of their paid labour. The required task of a patternmaker is highly specific and structured, rather than open-ended. Kay was quite clear about this:

We weren't designing the product. We were working from a drawing that was designed by someone else and it was using our knowledge of a product's mouldability. That was really the only part where we were being creative.⁸⁶

From here we can understand that patternmaking was not creative in a loose, free, ‘ill-defined’ sense. As I have noted earlier, a key distinction is the fact that patternmakers were not the ‘authors’ of the designed objects, but intermediaries who played an important role along the way. Accordingly, all of my statements about the ‘design knowledge’ of patternmakers must be understood not as a claim towards their creative, individual acts of designing new things, but their collaborative role in the actualization of design. This highlights my earlier clarification in the Introduction—I am not conflating the two professional categories, but rather, arguing that they have shared forms of design knowledge in many, but not all, respects. It was within the restrictions of their brief—to accurately produce a pattern, mould or tooling—that patternmakers exercised a considerable amount of decisional autonomy and judgment. There are moments, however, where patternmakers stepped beyond this, and where their expertise resulted in subtle but often important changes to the final product, as explained in the following section.

Making changes (and complaining about designers)

We have established that patternmakers did not mindlessly create mere copies of the ‘real thing’, but carefully planned and produced a pattern, which was a functional interpretation of a drawing in subtly different dimensions to the original. In this section, we explore how patternmakers’ expertise often resulted in modification to the form and moulding methods, in order to make production feasible and viable.⁸⁷ Such changes generally had to be negotiated with the engineer or designer, in a process of co-design (although it would almost never be called this). Wighton explained that at one of the foundries where he worked,

If through staring at the drawing longer than they [the engineers] did, you found something, it wasn’t a big issue to say, ‘Look, I reckon maybe you could squeeze an extra one in the [moulding] box if you did it this way’, or ‘maybe can we adjust that?’ ... So that was the planning stage, and then the actual pattern was made was more or less the patternmaker’s decision.⁸⁸

This collaborative communication between those involved in the pre-production and manufacturing stages is not just a contemporary phenomenon, and has also been noted by technology historian John K. Brown, in relation to the nineteenth-century drafting work of the engineer Robert Hawthorn. Brown stated, ‘when skilled patternmakers interpreted Robert Hawthorn’s sketches, they necessarily exerted a substantial influence over the full-sized design’.⁸⁹ Likewise, patternmaker John Looker described the close relationship between patternmakers and draughtsmen in 1950s Australia, ‘The daily visit between the drawing office staff was interesting to me. ... There was a mutual understanding between both groups’.⁹⁰ This close—daily!—connection between design and pre-production resulted in mutual understandings that have perhaps eroded in more recent times.

Through the process of bringing a drawing to life, patternmakers were sometimes frustrated by the designers and engineers they worked with. Murrells explained how his tacit understanding of how light bounces off a curved surface was something that he learned over time, as a patternmaker and clay modeller for automotive design:

Designers are great at illustrating and ideas, but when it comes to three dimensions not all of them really have a clear understanding. But coming from a patternmaking background, having a good understanding of shape and form and

how to actually create that ... a lot of [designers] have an understanding of what they want it to look like, but not necessarily how to get to that finished product ... Working in three dimensions is different to working on a sketch or on a computer's instructions ... The designer may want a surface to do a certain thing and, I use the term, 'light up' in a certain way ... it creates a differentiation between surfaces hence gives you that proportional value. As a modeler [and patternmaker], you understand that sometimes it's not achievable. So you have to try and convince [the designers], and nine times out of ten you would put in what they want, and then you could explain to them in visual terms why it doesn't work, and then we attack that problem with a different solution.⁹¹

Not all designers, Murrells felt, possessed this form of three-dimensional comprehension.

Murrells is not alone in his gentle professional critique of designers. Other patternmakers I spoke with had similar views, variously describing designers as 'a bit precious',⁹² and sometimes even decrying their ineptitude.

Every day I'm asked to make or modify tooling in ways that I *know to be wrong*, that what I do today will come back some time in the future to be redone, either due to poor design or engineering.⁹³

The above quote, shared anonymously, reflects a frustration that patternmakers often express—where their technical and design knowledge surpasses that of the designers or engineers they are working with. Patternmaking business owner Deborah Tyrrell outlined similar processes of negotiation before a pattern was produced. Tyrrell observed that with the introduction of CADD, industrial designers have become less cognizant of the material and technological capacities of manufacturing processes:

This is where they [designers] don't understand ... One of our manufacturing companies has just employed a new industrial designer and it has taken him probably six to twelve months to get up to speed to understand the restrictions ... Some of the people coming out [of university], they think, 'we're industrial designers, we *know*.' And you think, 'No, you don't.'⁹⁴

As Tyrrell recounted to me, process knowledge meant that CADD files often included unworkable forms, which simply could not be produced, or did not have appropriate tolerances, curves or undercuts. The forms would then have to be reworked, through a collaborative process that was not always a positive experience, hampered by economic stresses, power relations and time constraints.

I return now to Wighton's experience, as it offers a striking example of how, more recently, some of the decisional autonomy afforded to patternmakers has been shifted out of their hands. When Wighton moved foundries, he found that the agency given to him also changed:

[This foundry] just presents me with the finished pattern and accompanying methods ... All I have to do is post-process it (sanding, painting, branding) and stick it in a moulding box. No designing, no methoding consultation...⁹⁵

This dynamic is tied in with the increasing use of CNC machines, 3D printing and CADD in the patternmaking process. With the introduction of these technologies, one result is that more decisional autonomy tends to be afforded to engineers and managers, with less tacit decision-making afforded to tradespeople on the shopfloor.⁹⁶ Like Tyrrell, Wighton felt that his shopfloor experience meant that he understood far more about

how to plan a pattern's methods, than, for example, a recently graduated engineer who sat in front of a computer all day, and rarely visited the shopfloor.

These tensions are underwritten by social class: engineering patternmakers are qualified tradespeople with apprenticeship backgrounds. Industrial designers and engineers are, at least in the past four decades in Australia,⁹⁷ tertiary educated, white-collar professionals. It is not unheard of for designers, engineers and managers to ignore the advice of skilled tradespeople on this basis. Of course, tensions between occupational groups are not unusual in workplaces,⁹⁸ but the relationship between designers and tradespeople is yet to be thoroughly explored in design history.⁹⁹ This dynamic is complex enough to warrant an article on its own, and I cannot do justice to it comprehensively in the space remaining. But let this be said: the patternmakers' critique of designers (and engineers) is a crucial relation for design historians and designers to acknowledge. The twenty-first century enthusiasm for 'design thinking' has placed designers' knowledge and skills on a pedestal, with the inferred meaning that other professional groups are perhaps not as capable, creative or clever. More often than not, manufacturing tradespeople, when they are considered at all, are thought to be process workers, inflexible traditional thinkers, not in keeping with the 'innovative' times ahead. As this article has shown, the reality of object production (past and present) is far more collaborative, integrated and entangled, where a variety of specialized groups work together to bring an object into being.¹⁰⁰ It is important to be reminded of the complexities of authorship and production in industrial manufacture—intricacies that are easily glossed-over when we name an industrial designer as *the* creator of a design.

Conclusion

Returning to Scarlett's account of late nineteenth-century patternmaking, she notes that patternmaking was 'a greatly respected skill that required a significant degree of individual creativity, precision, and intimacy with materials'.¹⁰¹ In spite of this, Scarlett notes that designers such as Rohlf's were driven to conceal their trade 'roots', so as not to tarnish his identity as a furniture designer. While the denigration of factory production may have had its roots in the industrial revolution, it reverberated throughout the twentieth century and still lingers today, within and beyond the world of design. The generalized lack of appreciation of the skills, knowledge and capacities of industrial craft practitioners is also part of what has led to a largely uncritical embrace of technologies such as CNC machines and 3D printing.¹⁰²

While robotics and additive manufacturing technologies have been much celebrated in the first decades of the twenty-first century, far more could be said of how these emerging technologies augment the labour of highly skilled tradespeople—often reducing their roles to mundane hand-finishing tasks. Sanding and painting, sanding and painting: for a highly skilled patternmaker accustomed to planning and building an entire pattern, this was often too much to bear. This deskilling of specialist trades is usually seen as an inevitable consequence of technological change. Yet if we amassed a deeper understanding of industrial craftworkers' skill, knowledge and capacities—including their understanding of design—then we may not be so swift to undermine them. This is why I have chosen to draw attention to invisible actors in production processes—those who are key players in making objects materialize, but who are rarely acknowledged, let alone highly valued, within and beyond design history. In the race to embrace digital fabrication technologies and robotic production, I urge us to pause and

look back to the recent past, asking not only what we have lost, but also what might be revalued and reimagined in the present context.

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Notes

- 1 P. Williams, interview with author, 26 November 2017, *Reshaping Australian Manufacturing Oral History Project*, National Library of Australia (NLA), Canberra, Bib ID: 7540153, <https://nla.gov.au/nla.obj-584861891>. Italics indicate speaker's emphasis.
- 2 Fieldwork conducted in July 2015 with A. V. Simpson, M. Berti and A. Hermens, UTS Business School, UTS Human Ethics Approval #ETH16-1004.
- 3 Interview participants' identities withheld, as per ethics approval; *ibid*.
- 4 Frank, interview with author and A. V. Simpson, full details withheld, July 2015.
- 5 Joseph Horner, *Patternmaking: A Practical Treatise*, 3rd edn (London: Crosby Lockwood & Son, 1902), 1. See also J. H. Zeitlin, *Craft Regulation and the Division of Labour: Engineers and Compositors in Britain 1890–1914*, PhD thesis, University of Warwick, 1981.
- 6 One clarification on tenses is necessary. I have been faced with a tricky decision about whether to use past or present tense, as, technically speaking, patternmaking remains a currently practiced trade, albeit on the fringe. On the other hand, the most in-depth engagement with patternmaking craft is indeed a thing of the past, and deserved of, I argue, a place in design history. For this reason, in this article I will generally use past tense to describe patternmakers' processes. But I do so with the acknowledgment that a small number of patternshops are operating, albeit on the margins.

- 7 Patterns are also known as ‘masters’ or ‘bucks’.
- 8 S. Winchester, *Exactly: How Precision Engineers Created the Modern World* (London: William Collins, 2018), 17. Winchester might argue that the term ‘precision woodworker’ is oxymoronic, but it describes the precision that patternmakers strove for.
- 9 Anonymous, ‘Patternmaking and Capitalism’, *The Socialist*, November 1904, 7, as cited in R. Samuel, ‘Workshop of the World: Steam Power and Hand Technology in mid-Victorian Britain’, *History Workshop* 3 (Spring 1977): 67. As Samuel notes, this is an extraordinary historical piece that outlines industrial relations challenges for British patternmakers from the 1860s onwards.
- 10 Anonymous, ‘Patternmaking and Capitalism’, 7.
- 11 S. Murrells, interview with author, 25 November 2017, *Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7540149, <https://nla.gov.au/nla.cat-vn7540149>.
- 12 P. Hazell and K. Fallan, ‘The Enthusiast’s Eye: The Value of Unsanctioned Knowledge in Design Historical Scholarship’, *Design and Culture* 7, no. 1 (2015): 107–123.
- 13 N. Cross, *Designerly Ways of Knowing* (London: Springer, 2006). See also B. Lawson and K. Dorst, *Design Expertise* (Oxford: Architectural Press, 2009); B. Lawson, *How Designers Think: The Process Demystified* (Boston: Elsevier/Architectural Press, 2005).
- 14 Cross, op. cit., 10.
- 15 L. Kimbell, ‘Rethinking Design Thinking: Part II’, *Design and Culture* 4, no. 2 (2012): 129.
- 16 I have conducted observational fieldwork in industrial design offices, foundries and patternshops (2015–2018), see footnote 2.
- 17 T. Fry, ‘Whither Design/Whether History’, in *Design and the Question of History*, eds T. Fry, C. Dilnot and S. Stewart (London and New York: Bloomsbury), 1–97.
- 18 *Ibid.*, 4.
- 19 E. Shales, ‘A “Little Journey” to Empathize with (and Complicate) the Factory’, *Design and Culture* 4, no. 2 (2012): 218.
- 20 This collaborative fieldwork involved five days’ observation of a foundry, patternshop and 3D printing lab, see footnote 2.
- 21 The *Reshaping Australian Manufacturing Oral History Project* (2017–ongoing) is held in the Oral History & Folklore Collection at the NLA, <https://nla.gov.au/nla.cat-vn7540760>. At the time of writing I had interviewed eleven patternmakers, and one patternmaking business owner (not originally in the trade)—nine men and two women. The interviews are lengthy—two to five hours each—and take a ‘whole of life’ approach. The project also involves unrecorded conversations with other engineering patternmakers. UTS Human Research Ethics approval no. ETH17-1385.
- 22 See, for example, J. Shields (ed.), *All Our Labours: Oral Histories of Working Life in Twentieth Century Sydney* (Sydney: New South Wales University Press, 1992); S. Turkel, *Working* (New York: Avon, 1972).
- 23 Perhaps of most relevance to readers of this journal: L. Sandino, ‘Oral Histories and Design: Objects and Subjects’, *Journal of Design History* 19, no. 4 (2006): 275–282; A. Oak, ‘Particularising the Past: Persuasion and Value in Oral History Interviews and Design Critiques’, *Journal of Design History* 19, no. 4 (2006): 345–356. See also: K. Bradley and A. Puri, ‘Creating an Oral History Archive: Digital Opportunities and Ethical Issues’, *Australian Historical Studies* 47, no. 1 (2016): 75–91.
- 24 In previous work I have analysed the use of oral history to tap into sensory, embodied and affective accounts of working life, see: J. A. Stein, ‘The Co-construction of Spatial Memory: Enriching Architectural Histories of “Ordinary” Buildings’, *Fabrications* 24, no. 2 (2014): 178–197.
- 25 G. Contini, ‘Creativity at work: Miners and Quarrymen in Tuscany’, *Oral History* 37, no. 2 (2009): 64–70.
- 26 My interviews also indicate that most patternmakers are also creative makers—artists, designers, poets, furniture makers—in their spare time. While this aspect of their activities falls beyond the scope of this particular article, I do not plan to leave that aspect untouched in future analysis.
- 27 It is here I must acknowledge that my focus on Australian patternmakers is limited to specific aspects: design knowledge and patternmaking practice. I have set aside complex industrial relations discussions for reasons of brevity, and also because Australian patternmakers tend to be fairly low in union membership, owing to the small size of many patternshops (which made collective organising difficult). For deeper discussions of the workplace politics of industrial craft, I suggest: W. Mosses, *A History of the United Pattern Makers’ Association 1872–1922* (London: United Pattern Makers’ Association, 1922); M. Cooley, *Architect or Bee? The Human Price of Technology*, Revised ed. (London: The Hogarth Press, 1987); P. Cook, *The Industrial Craftsworker: Skill, Managerial Strategies and Workplace Relationships* (London and New York: Mansell, 1996); Anonymous, ‘Patternmaking and Capitalism’, op. cit.; Zeitlin, op. cit.
- 28 Reyner Banham did not make the connection between plastics production and precision woodworking when he stated, ‘While many craftsmen do work in plastics and enjoy it, the feeling is that plastics are yielding, forgiving, boring, senseless materials with no nature, materials with no structure, and in fact the death of craftsmanship. You

- do not have to develop a deep sensibility to the grain of wood, if you can get along quite nicely without wood'. Banham, op. cit., 42.
- 29 B. Poynton, interview with the author, 22 February 2018, *Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7580610, <https://nla.gov.au/nla.cat-vn7580610>.
- 30 This is partly due to the pleasure and ease of working with Huon Pine. Also, Huon Pine (*Lagorobostrobos franklinii*) is a rare Tasmanian tree species—which can live for up to 2,000 years—and is now subject to strict conservation control.
- 31 With thanks to Berto Pandolfo for his advice.
- 32 E. Humphrys, 'Simultaneously Deepening Corporatism and Advancing Neoliberalism: Australia under the Accord', *Journal of Sociology* 54, no. 1 (2018): 49–63.
- 33 J. Stanford, *Manufacturing (Still) Matters: Why the Decline of Australian Manufacturing is NOT Inevitable, and What Government Can Do About it* (Canberra: Centre for Future Work, The Australia Institute, 2016).
- 34 T. Barnes, J. M. Roose, L. Heap and B. S. Turner, 'Employment, Spillovers and "Decent Work": Challenging the Productivity Commission's Auto Industry Narrative', *The Economic and Labour Relations Review* 27, no. 2 (2016): 215–230.
- 35 In the USA, there were 3,200 patternmakers recorded as working in 2017. 'Occupational Employment and Wages, Patternmakers, Metal and Plastic', US Bureau of Labor Statistics, www.bls.gov/oes/current/oes514062.htm, accessed 13 March 2019.
- 36 The amount of CADD work given to patternmakers in a post-CNC era varies from patternshop to patternshop.
- 37 While Australian manufacturing has experienced a recent recovery (2016–2018), it has broadly been in decline since the mid-1970s. J. Stanford and T. Swann, *Manufacturing: A Moment of Opportunity* (Canberra: Centre for Future Work, The Australia Institute, 2017).
- 38 'Sam', interview with author and A. V. Simpson, full details withheld for confidentiality, July 2015. 'Stuart' is also a pseudonym.
- 39 A. Freemantle, Queensland TAFE, interview with author, 4 September 2018, telephone interview.
- 40 Note this statistic actually refers to toolmakers and patternmakers. It remains indicative of a general trend. See 'Toolmakers and Engineering Patternmakers', *JobOutlook*, <https://joboutlook.gov.au/Occupation.aspx?search=&code=3234>, accessed 13 March 2019.
- 41 L. Romensky, 'Hard, Dirty Foundry Work Copes with Digital Disruption and Lack of Apprenticeship Courses', *ABC News—Central Victoria*, 30 September 2018, www.abc.net.au/news/2018-09-30/hard-dirty-foundry-work-coping-with-digital-disruption/10303254, accessed 19 October 2018. J. A. Stein, 'Don't Be too Quick to Dismiss "Dying Trades", Those Skills Are Still in Demand', *The Conversation* (6 December 2018), <https://theconversation.com/dont-be-too-quick-to-dismiss-dying-trades-those-skills-are-still-in-demand-107894>, accessed 13 March 2019.
- 42 R. Holt and A. Popp, 'Josiah Wedgwood, Manufacturing and Craft', *Journal of Design History* 29, no. 2 (2016): 99–119; S. F. Scarlett, 'The Craft of Industrial Patternmaking', *Journal of Modern Craft* 4, no. 1 (2011): 27–48; Shales, 'A "Little Journey"', 215–220.
- 43 G. Adamson, *The Invention of Craft* (London and New York: Bloomsbury, 2013), xv.
- 44 *Ibid.*, xiii.
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- 57 Ibid. See also: M. Zapf, *The Making of Industrial Artisans: Training Engineers in Britain, 1964–1979*, MA Dissertation, V&A History of Design, RCA, London, 2012, 10. Tony Fry is one early exception: T. Fry, *Design History Australia: A Source Text in Methods and Resources* (Sydney: Hale & Iremonger, Power Institute of Fine Arts, 1988), 70.
- 58 Zapf, op. cit., 11.
- 59 Scarlett, op. cit., 30; Adamson, *The Invention of Craft*, 145–146.
- 60 Scarlett, op. cit.
- 61 Adamson, *The Invention of Craft*, 145.
- 62 Ibid., 146.
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- 65 Holt and Popp, op. cit.
- 66 P. Pacey, "'Anyone Designing Anything?": Non-professional Designers and the History of Design', *Journal of Design History* 5, no. 3 (1992): 217–225.
- 67 Williams, op. cit.
- 68 D. Schuckar, interview with the author, 23 February 2018, *Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7580622, <https://nla.gov.au/nla.cat-vn7580622>, accessed 23 July 2018.
- 69 Cross, op. cit., 12.
- 70 Schuckar, op. cit.
- 71 T. Wighton, pers. comm. with author, 19 May 2017.
- 72 Cross, op. cit., 12.
- 73 Murrells, op. cit.
- 74 Cross, op. cit., 12.
- 75 Ibid., 8.
- 76 Freemantle, op. cit.
- 77 Cores are the parts of a pattern and mould that allow a hollow to be produced, e.g., the inside of a pipe.
- 78 Murrells, op. cit. Minor note: CNC machinery of various kinds has existed since the late 1940s but in terms of its uptake in Australian patternmaking, the shift did not occur until the 1990s and early 2000s.
- 79 See Samuel, op. cit., 38–39, for a discussion of whether or not a patternmaker's much prized (and almost always privately owned) toolkit meant that patternmakers owned their own means of production. I tend to think it did not, as patternmakers were always reliant upon other industries (e.g. foundries) in order to effectively sell their labour.
- 80 Poynton, op. cit.
- 81 Throughout the twentieth century, patternmakers have adapted to use more timber repair fillers—"bog filler"—making the process less about carving, and more about building-up a form gradually.
- 82 Poynton, op. cit.
- 83 Williams, op. cit.
- 84 P. Kay, interview with author, 30 April 2018, *The Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7765725. <https://nla.gov.au/nla.cat-vn7765725>, accessed 23 October 2018.
- 85 Cross, op. cit., 12.
- 86 Kay, op. cit.
- 87 J. K. Brown, 'Design Plans, Working Drawings, National Styles: Engineering Practice in Great Britain and the United States, 1775–1945', *Technology and Culture* 41, no. 2 (2000): 202.
- 88 T. Wighton, interview with author, 27 November 2017, *The Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7540155, <https://nla.gov.au/nla.cat-vn7540155>.

- 89 Brown, op. cit., 202.
- 90 J. Looker, *I Want to be a Patternmaker: A Memoir* (Melbourne: Memoirs Foundation Inc., 2011), 51.
- 91 Murrells, op. cit.
- 92 Poynton, op. cit.
- 93 Anon, pers. comm. with author, 2016.
- 94 Deborah Tyrrell, interview with author, 19 October 2018, the *Reshaping Australian Manufacturing Oral History Project*, NLA, Canberra, Bib ID: 7861536, <https://nla.gov.au/nla.cat-vn7861536>.
- 95 Wighton, pers. comm., op. cit.
- 96 This process was famously documented by D. F. Noble. His works refer to CNC machines in the context of 1970s American metalwork more generally. See: D. F. Noble, 'Social Choice in Machine Design: The Case of Automatically Controlled Machine Tools, and a Challenge for Labor', *Politics & Society* 8, no. 3–4 (1978): 313–347. The dynamic between technology and management decisions is a highly contingent and political issue and does not always unfold in exactly the same way.
- 97 S. Jackson, 'Institutionalising Design Education and Design Promotion in Australia: From early British influences to wider international engagement', *Design & Technology Education* 21, no. 3 (2016): 8–14.
- 98 Cook, op. cit.
- 99 There is a relevant parallel in architecture, see: C. Wall, *An Architecture of Parts: Architects, Building Workers, and Industrialisation in Britain 1940–1970* (London and New York: Routledge, 2013).
- 100 Kimbell, op. cit.
- 101 Scarlett, op. cit., 30.
- 102 J. A. Stein, 'Political Imaginaries of 3D Printing: Prompting Mainstream Awareness of Design and Making', *Design and Culture* 9, no. 1 (2017): 1–26; P. Atkinson, 'Boundaries? What Boundaries? The Crisis of Design in a Post-Professional Era', *The Design Journal* 13, no. 2 (2010): 137–155.