Chapter 1

The Prototype: Problem Work in the Relationship between Designer, Artist, and Gaffer in Glassblowing

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Introduction to the 'Hotshop'

Sarkis had been commissioned by Jasmine to produce glass prototypes of her designs for a home-accessory line. While Sarkis 'gaffed' (i.e. shaped the glass, while directing his assistant), Jasmine sat perched behind his workbench, watching and offering suggestions – but she was on his turf now. And, like most people who visit the 'hotshop' (i.e. glass-blowing studio) for their first time, Jasmine was captivated by the heat and luminosity of the furnace, the glory hole, and the undulating molten glass fires; by the intermingling scents of sweat and smoke, and by the rhythmic and skilful choreography of the craft. She observed intently as Sarkis moved back and forth between the glory hole to reheat the glass and his workbench to tool the 'Pit Bull piggy bank' – Jasmine's design interpretation of the classic coin bank.

Sarkis first blew a cylinder. His assistant then brought more hot glass from the furnace which Sarkis dolloped onto the vessel and began sculpting into the mouth, nostrils, eyes, and ears of a Pit Bull dog. Jasmine interjected that she wanted the dog's snout to be longer and its jaws opened as though it were barking. Sarkis said that he would need to try that the next time, since a longer snout would involve elongating the cylinder prior to sculpting. He finished up the spiked collar on the pit bull he was making. After several days of prototyping, neither Jasmine nor Sarkis was satisfied with the object. Sarkis was a highly proficient glassblower, but he admitted that evoking the Pit Bull's 'bark' was a challenge, and even the well-rendered features of the dog were difficult to discern in clear glass. The prototype failed and the design was dropped.

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1 Both authors were glassblowers at New York Glass in the mid-2000s. Erin O'Connor conducted fieldwork there over a four-year period in the capacity of student, teaching assistant, production assistant, and studio technician. The fieldwork formed the basis of her PhD dissertation, *Hotshop: An Ethnography of Embodied Knowledge in Glassblowing* (2009). Suzanne Peck enrolled in classes at New York Glass, where she also worked as a teaching assistant and production assistant. She is now a professional glassblower.

Sarkis belonged to a community of glassblowers who prototype in the so-called 'studio glass' tradition. Studio glass today tends to defy its original tenet of rejecting technique in favour of expression, and instead uses traditional technique and teamwork to explore the material and pursue expression.[2] The contemporary world of studio glass is populated by not only artists, but also production gaffers (i.e. glassblowers, who head the production team), designers, and hobbyists, and it is organised around academic and non-academic training, curricula, conferences, popular media, art and craft markets, galleries, and museums.

It is not unusual for studio glassblowers to take on multiple roles in order to earn a living. Thus, while many are artists and designers who prototype and produce their own work, they may also accept contracts as gaffers to do that work for others. In some cases, gaffing is carried out in a traditional factory setting in which a designer passes designs onto the gaffer for execution. In other cases, the entire process is a collaborative one between designer and gaffer, each who has varying degrees of input. There are also instances of contemporary fine artists contracting glassblowers to prototype their artwork, which is typically a 'one-off' object, rather than something to be reproduced in batch or mass production. Across these ways of working, glassblowers are presented with different kinds of problems that need solving through their craft knowledge and practice.

Drawing upon ethnographic research and interviews with studio glassblowers, this chapter explores the practice of prototyping across different contexts of production in order to better understand how tacit forms of knowledge are used to interpret, negotiate, and execute designs.[3] Prototypes are produced as a precursor for a production line or limited-run of goods, or sometimes for one-off objects. Prototyping is a complex process involving interaction between the maker's tacit knowledge, his imagination, and the material world. The objective is to resolve design problems through a practical, hands-on process of trial and error. While prototyping in glass, the gaffer's problem-solving activities involve both inductive and deductive methods. When presented with the opportunity to contribute input to a design, the gaffer draws inductively from her existing working knowledge of the material and her body-in-practice to shape the prototype. This is the 'bricolage work of improvisation'. When asked to execute rather than create (or co-create) a design, a gaffer may rely exclusively on measurements and drawings, and employ a deductive working style. Inductive and deductive methods are not necessarily mutually exclusive. Both approaches to problem solving employ 'embodied bricolage', but an inductive approach holds greater opportunity for discovering new problems.

2 See Oldknow (1996). The studio glass movement was originally informed by an interest in the materiality and process of glass rather than its practical applications.

3 Michael Polanyi defines 'tacit knowledge' as that for which we have a 'subsidiary awareness' (1962: 60). See also Polanyi 1966: 3–25.

Finn was a graphic design major in college in the mid-1990s. He took glassblowing as an elective, and got hooked. After finishing college, Finn worked on contract for professional studio-glass artists. Once he was married with children, however, he decided that he needed a more secure income, but was uncertain about how to earn a living in the art world. He therefore took a job at the Sedgewick glass factory in a New England town making traditional English-style stemware and other tableware designs.

At Sedgewick, the division of labour for prototyping followed traditional factory conventions: designs were made 'upstairs' and then sent 'down' to the factory floor for production. On the floor, labour was organised into teams. Though smaller in scale, the organisational structure of the factory shared similarities with the division of labour in the early-American proto-industrial 'shop system' that served to increase specialisation and lay the groundwork for the automation of the American glass industry in the late nineteenth century (Scoville, 1948: 22; Labino, 1968: 117). Finn's job at Sedgewick was to assist in a team of two or three men that worked alongside ten other teams.

Finn told us that the first things he learned as a team member were 'taking measurements from drawings and [how to] use callipers'. Callipers function like a three-dimensional ruler – imagine hinged tweezers that open *around* an object – and they are one of the many tools used to achieve consistency in prototyping. The glassblower measures the drawn object by using different callipers. One calliper may be set to height, a second to the width of the vessel's 'mouth', and another to the width of the vessel's central body.

In glassblowing, vessels are 'blown out' using a hollow pipe onto which an orb of molten glass has been gathered from a furnace. As the orb is blown, it expands to create a vessel. By using breath, heat, and handtools, the vessel can be widened or constricted in a bilaterally symmetrical fashion along its central axis. Callipers guide the work of shaping and assist in achieving precision in reproduction. In the case of the Sedgewick glass factory, gaffers used callipers for matching the glass prototype to the exact specifications of the designer.

Although the stemware was simpler to make than the designs of the studio artists whom Finn assisted, he was nevertheless challenged by the precision demanded by the factory work: 'I realized that there was a discipline involved if you wanted to [master] a certain technique. The cups had to be a certain way. When you have to make something to specific parameters, you become skilled at it'. The challenge demanded that Finn make his skill technically precise and that he efficiently coordinate his movements with those of his team members. Finn's activities were structured by predetermined goals that were set prior to production. According to David Pye's classification, Finn's work could be categorised as a 'workmanship of certainty' (1968: 4). For Pye, certainty characterises workmanship when there is no element of risk; that is, when the outcome is certain.

Not all glassblowing factories produce prototypes in a top-down, hierarchical manner. According to glassblowing lore, Carlo Scarpa (1906–78), who was a designer at the esteemed Venini glass house on the island of Murano, 'descended' to the factory floor to watch, learn, and collaborate with the glass *maestros* in order to produce new designs.[4] In the case of Scarpa at Venini, the practices of both the designer and the makers were informed by their engagement with, and a deep understanding of, the material. By contrast, the stark division between designer and maker at Sedgewick precluded a design-making symbiosis. Finn's material knowledge therefore was not used to inform the design of the things he made. Instead, he directed it toward executing predetermined forms that were not necessarily attuned to the material from which they were made.

Learning to fulfil a pre-set goal improved Finn's technique. The kind of prototyping he was hired to do establishes distinct parameters for both physical action (namely, precise coordination with the team) and material translation (namely, an exact rendering of the proposed design) insofar as it calibrates bodily practice toward efficiency. But, he explained, it also made it more difficult to realize his own ideas when blowing glass: on the factory floor, 'You're solving a problem rather than creating your own'. According to Michael Polanyi's thinking, Finn's method of prototyping was tied to his difficulty in generating a problem. In prototyping by execution, Finn was required to work backwards from the design to the glass. Finn utilised a 'procedure' that is 'reversible in the sense that it could be traced back stepwise to its beginning and repeated at will any number of times' (Polanyi 1962: 123). For Polanyi, this method is not a 'means of achieving discovery'. Discoveries are made by overcoming a gap in logic – a leap that is necessarily 'irreversible' (Polanyi 1962: 123).

As a material, the ever-changing state of molten glass presents endless possibilities for 'discovery'. But at the Sedgewick factory, the method of prototyping from a pre-determined design supported not the discovery of new problems, but rather the instrumental division of labour in the shop system. If Finn would have intervened by proposing or exploring how the objects he was prototyping might be alternatively rendered, then the shop system would have broken down. In this context, the unexpected is not pursued as a potential discovery, but rather it is perceived as a mistake, and is corrected.

4 After working at the M.V.M. Cappellin glassworks on Murano from 1926 to 1932, Scarpa took a job at Venini, where he worked until 1947. Although Scarpa eventually left glass to practice architecture, his legacy in glass continues, as attested by the exhibition *Venini Glass by Carlo Scarpa: The Venini Company 1932–1947* that was hosted in 2013–14 at New York's Metropolitan Museum of Art.

Body and Imagination in Prototype Production

Allen was first drawn to the craft by a master glassblower who came to his college as a visiting artist more than a decade ago: 'That was the only time in my life I can say that I've been totally blown away. I'd never seen anything like that. I got so excited. I signed up for a class the following semester'. Allen was dedicated to mastering the craft skills, which included extensive training in traditional Venetian techniques. By the time he graduated from college, Allen was deemed by his seniors to be among the most technically promising of his generation.

Allen gaffed for Clayton, co-owner and head designer of Alcove, one of New York's leading boutique-design houses. Starting as an assistant, he rose through the hierarchy of the hotshop team. After more than a decade of blowing glass, he became the head of product development, which, he explained, 'is really the head of prototyping'. In contrast to Finn's experience at Sedgewick where design decisions were made separately from production, at Alcove, Allen would meet with Clayton before physically prototyping in the hotshop in order to discuss the feasibility, scale, colour, and thickness of a design, as well as the overall idea that the object was meant to convey, and how glass might best work as a conduit for that idea. The design idea was thus collaboratively achieved. On the day of prototyping a new design, Allen would ask Clayton to be present in the hotshop:

> I request that. I will not make prototypes without the designer there. I just won't do it. It's a prerequisite if somebody hires me. It's nearly impossible for the first time to take somebody's drawing and get what they want without them being there. [The hotshop is] not dangerous … I want you right here; you're not going to get burnt; nothing is going to happen to you. But you need to be comfortable with me and I need to be comfortable with you, so you can open up and give me what's in your head, so I can best translate that in this material. I want an open dialogue.

A designer may be able to imagine a glass object with computer software, or while at their drafting table, but imagining the process 'hot' – in other words, in terms of the formative properties of the molten material – is an entirely different matter. In the context of the hotshop, Allen could familiarise the designer with the craft, his skill set, and the formative properties of glass: 'What we do is extremely difficult. It's time sensitive. It takes a lot of physical strength and effort to do'.

A former task that Allen found especially stimulating was the re-purposing of a design for the production of hurricane lamps. Clayton believed that prototyping the new iteration would simply involve inverting the design. Allen described the new concept as contemporary, modern and angular. Nevertheless, he began prototyping the piece in a way that felt comfortable to him:

> So, I completely went 180 degrees opposite of [Clayton's aesthetic] and made something that I thought would look good and that I was comfortable making …

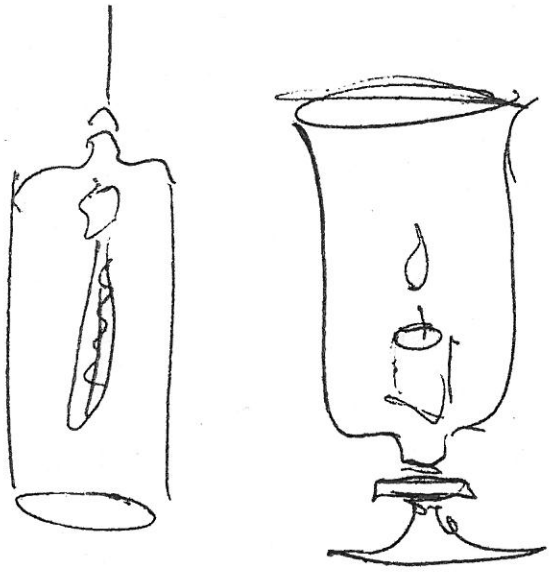

Figure 1.1 Allen's sketch of the original design (left) and of the object re-purposed as a hurricane lamp (right).

> I made it pretty sensual. Instead of a square, really hard-angled stem, I made a ball, a nice sphere and a really delicate connection between the foot and the stem ... I think it had to do a lot with my comfort level. For my first time making this, I just needed to be in my zone. It's like shaping something out of a lump of clay: you have to whittle it away and get the details.

Allen's first iteration might have seemed wrong. He knowingly veered '180 degrees in the opposite direction' from what he and Clayton had discussed. The resulting hurricane lamp was informed by his training in the Venetian tradition, which Allen, like John Ruskin more than a century earlier, favoured for its rounded profile (2009: 168, 395). But by first prototyping a rounded Venetian hurricane lamp, Allen initiated a search for the modern, angular hurricane lamp that was grounded in his existing practical knowledge.

As Allen worked on the first prototype, Clayton confirmed that its scale and size were fine, but he noted that its overall shape was not right. He pushed Allen to achieve the angular form, but he did so with knowledge about the limitations and possibilities of both the medium and Allen's capabilities. Allen had anticipated this rejection, but he knew that Clayton would be able to read his Venetian iteration as a step toward the modern hurricane lamp. This dynamic, in which designer and gaffer engage the formative rather than the formal properties of glass, approaches an inductive way of prototyping, as described earlier. A drawing may catalyse the prototyping project, but the actual work of prototyping begins with the

gaffer's body – from his or her disposition toward the drawing, rather than from the drawing itself.

While Allen articulated the central problem of prototyping as 'going from paper to 3-D object in glass, from start to finish', in practice, part of the problem lies in the interpretation of body to object. With an awareness of this, Allen specified that technique alone cannot 'get the idea out of the head of the designer'. Unlike a machine, or routinised handwork, a gaffer who is collaborating with a designer must amalgamate disparate components of his working knowledge of the medium while prototyping. At the level of the body, solving the problems thrown up by the prototype is not a straightforward process of deduction. Allen commented:

> I've made hundreds-of-thousands of shapes in my career – just shapes. There isn't much that I haven't seen or tried to make. So [when] a person says, "I need this", I've got to go through my back catalogue of things that I've made in the past and relate it. I go through my file cabinet and say, "Ok, this part of this object is like this; this part of this object is like that;" and then take those two parts, put them together, and remember how to make that object. Once I remember how to make that object, I then refine it down further and further to be more efficient, or to make the object look better while being more efficient. So when that happens, then I'm happy.

Allen's 'file cabinet' was a conceptual resource, less so of static images than of practical relations and actions to objects. As he went through it, he abstracted from 'this and that' in order to forge a new disposition. This method exemplified inductive as opposed to deductive problem solving; an interpretation, since Allen was constructing a memory from prior experience in light of a new demand. Though the new hurricane lamp was meant to be contemporary with angular and clean lines, Allen, by drawing on his embodied knowledge and 'hot' imagination, iterated it as an assemblage of Venetian components. Subsequently, this assemblage could be 'whittled away' in order to arrive at the desired object. While prototyping aims to create new objects, it only does so via the past.

In bricolage fashion, the maker adopts and adapts various dispositions for production – bodily ways of comprehending the world – in order to approximate the proposed design (Bourdieu 1990: 54). That is, he makes the object by 'trying out' elements of past projects to achieve the new goal. In his ethnography of a Saab auto mechanic named Willy, Douglas Harper notes that Willy's ingenuity and creativity are expressed through 'bricolage work', in which the tinkerer draws from odds and ends to develop a solution to a problem (1987: 74). Similarly, political philosopher Matthew Crawford attributes the piecemeal approach to problem solving in motorcycle repair to the deep satisfaction of mechanical work. He contrasts this with repair work that requires the worker to carry out procedures issued by a diagnostic machine (Crawford, 2009: 171–5). Like Crawford's problem-solving motorcycle mechanic, Allen, too, depended on his intuitive

working knowledge as a gaffer. His practice was that of 'approximation' (Pye 1968: 13–14), thereby putting the intended glass vessel at risk.

In the studio glass context, the 'workmanship of risk' is not carried out by an individual maverick, but rather it is orchestrated and regulated by tight teamwork. The team typically consists of the gaffer and his/her assistants. A commonplace understanding of 'assistant' is a person who executes directives. Glassblowing, however, demands collaboration. In Allen's case, his assistants share his dispositions and he expects them to recall what may be useful, such as hand techniques, styles of heating, or how the labour was divided across team members, by using similar bricolage fashion. Allen told us:

> I'm in constant communication with my assistants, as far as technical. I need to get whatever is in the designer's brain out into the physical, so I need [the assistant's] help to get the physical out of me. They remind me, "Hey, remember how you made that … whatever … avolio. Maybe that'll work?" And I'll be like, "Yeah, right, let's try that". They help me translate what I can do for that person.

As Allen and his assistants worked toward approximating an object that was imagined by the designer, the assistants evaluated their own embodied memory against Allen's practice. In this sense, the assistants simultaneously stood apart from, and were part of, the making body.

Some of the success achieved by Allen, Clayton, and the team in problem solving while prototyping might be attributed to their shared ability to think 'hot' and to practically engage in the work in an inductive manner despite having started with a drawing. While Allen's body was the fulcrum on which the material approximation of the design balanced, the interpretation from design to material was negotiated from multiple imagined and embodied dispositions. If one member of the team was not attuned to corporeal and material properties, the prototyping process would break down. This was the case in one of Allen's earliest collaborations with a foreign designer named Milan.

> I didn't really understand what he wanted. I thought it was because of the language barrier. [Milan] was talking about a table. And I was like, "Ok, a table … like a table top?" And he said "No". "Okay, table legs?" And he said, "Yeah, kinda!" So, I was thinking, "Okay, table legs". So I was like, "Here", (Allen gestures a pushing motion) and gave him some paper and a pen. "Draw what you want". So he literally said, "You [pause] Blow [pause] Table". And [he] draws the blowpipe and literally, a fucking table coming out of the [pipe]. He was like "Yeah, you blow the table!" I was like, "That's not possible, that's not really … (laughing)". So he went onto other things. "You blow a bicycle?" …

Allen realised that the designer lacked any understanding of what the material could do, or what the process entailed, so he invited Milan into the hotshop. That was where Milan finally 'got it'. The ability of the gaffer's body to approximate the imagined object is dependent upon not only his or her embodied knowledge, but also that of the designer and the extent to which they can imagine 'hot'. Allen had learned from such early experiences to seek out and cultivate hot collaborations, such as the one he enjoyed with Clayton at Alcove.

Experience and Material in Prototyping

Diana, a glassblower and artist, was first introduced to 'cuppings' when Evelyn (Diana's partner and also a glassblower) took a job bagging coffee beans at True Source coffee roasters. Evelyn took the job to help pay their household bills. She speculated that she had been hired, in part, because of her 'glassiness': the True Source owners enjoyed employing an 'in-house glassblower'. Although the vast majority of Evelyn's time was spent on the factory floor, the owners hoped they might commission a glass project from her. The company regularly invited employees to 'coffee cuppings' in which a number of different roasts were brewed using a variety of methods, and these were sampled in two-tiered ceramic cupping cups. As the drinker sipped, a ridge inside the cup separated the liquid from the dregs that were left behind in the smaller, bottom tier that was the size of a silver dollar. As the coffee was filtered into the wider upper tier of the cup, its aroma swirled and could be savoured. Diana often accompanied Evelyn to the 'cupping' events, and, together with the other guests, they unpacked the 'notes' in the coffee aromas.

Nondi, a True Source owner and former gymnast with an entrepreneurial spirit, wanted to market the coffee cupping experience. He therefore decided to open an Italian-style coffee bar next door to his existing full-service café, where customers could either 'shoot coffee on the go' in true Roman style, or linger at the bar and 'cup' their beverage. The opportunity to commission a project from Evelyn – teamed with Diana – had arrived. Nondi wanted the two women to create unique handmade cups that would distinguish the coffee cupping experience at True Source from other cafés. He invited them to the café to discuss the possibility of making two-tiered glass cups, as opposed to the more conventional ceramic type.

The start of their meeting began with the three handling the existing ceramic cups. Nondi explained that, while the ceramic cup was functional, he 'wanted an equal amount of craft [to go into both] the vessel and the liquid – into the container and in the contained'. He envisioned a 'bespoke glass "cupping" cup'. Unlike the relatively seamless research-and-design meetings between Allen and Clayton, the question of feasibility was an immediate concern for Diana, specifically regarding the stability of the material. 'I pictured bleeding, burnt yuppies at 8 a.m. and dishwashers full of broken glass', she recounted to us. 'We wondered whether we could make it thicker? Could we make it taller? Or of a different shape? There was drawing on the back of menus. I even remember trying to dissuade Nondi, and offering to make carafes or candlesticks instead'. Regarding the form of the cups, Diana explained, 'there was pretty much no swaying him away from that original

shape'. Nondi was tenacious of his idea. Having never seen anyone blow glass, he was characteristically over-enthusiastic. 'He wanted one hundred cups by the end of the week!' Diana exclaimed, laughing.

The first step for Evelyn and Diana was to explain to Nondi the process of prototyping. He needed to understand that it would take time to create a first iteration of the cup, then to tweak the form, and, finally, when a form had been agreed, for Evelyn and Diana to hone the choreography of their activities for an efficient batch production. With these factors in mind, they agreed a quantity and price. 'We settled on forty cups at twenty dollars per [cup]', Diana told us. 'Nondi was footing the bill for the studio rental time too. And Evelyn was still getting her hourly while we were blowing. It was really a fantastic deal for us'. This commission was unusual in the sense that a design is typically determined in relation to pricing, but Nondi had enough capital to fund his vision and so the question of pricing was secondary to achieving the right aesthetic for the 'cupping' experience. With the order and pricing agreed, and a model two-tiered ceramic cup in hand, Diana and Evelyn booked hotshop time at a local public access facility.

Working from an existing ceramic object meant that Diana and Evelyn's charge was a material-to-material translation, from 3-D to 3-D. Moreover, they had been 'trained' in the 'cupping' experience, so they knew the function that their prototype had to satisfy. The first step was to take measurements from the ceramic cup with callipers, as Finn had done at Sedgewick. In the beginning, Diana and Evelyn tried to replicate the ceramic cup exactly. They found that the glass blew out rounder than needed and that glass blown to the thickness of the ceramic model looked chunky and clumsy. In short, the conventional design was better suited to ceramic than to glass. The ceramic cup had two subtle curving tiers, like an hourglass with a larger top than bottom. Though the constriction that separated the two tiers from each other (what would be the 'waist' of an hourglass) appeared sharply cut and narrow when viewed from the exterior of the vessel, when viewed from the cup's interior it appeared more rounded. The thickness of the ceramic walls allowed for exterior and interior execution of the constriction to differ. There was also the problem of translucence and luminosity. Whereas the thickness of the ceramic cup was concealed by the opacity of the material, it was plainly visible in glass and even produced a magnifying effect.

Evelyn and Diana's initial glass iterations looked either clumsy or cartoonish. Nondi had envisaged the machined exactitude of the ceramic cups, but perfectly translated into glass. The problem, Diana explained, was one of translation: '[The] translation from material to material wasn't one to one. These ceramic cups were machined ... The glass itself has desires and limitations in regard to form. The maker has desires and limitations in regards to capability. The fact that it is the hand making it and not the machine requires a bit of elasticity in how it is to be done'. In order to honour what they perceived to be 'aesthetic dignity' and to complete the order, Diana and Evelyn realised that the glass iteration would need to diverge from the ceramic cup.

Enhancing the cup from a clumsy to an elegant form would require thinning its walls. But, thinning the walls meant that their technique would need to become more precise. It also posed a challenge to achieving a rounded upper tier. To overcome the challenges posed by the need to thin the object, they used a sophietta. A sophietta is a funnel-like puffing tool that fits into small openings that glassblowers use to 'puff out', and thereby round the walls of the cup's upper tier before 'opening up' the mouth of the cup. This technical adaptation ensured that the top tier could be both thin and round. Additionally, they tightened the 'waist' of the cup, which allowed for less tooling and created a 'cleaner' clear vessel.

These 'tweaks' to the design and making happened over numerous successive iterations of the cup. Evelyn would gaff a cup in its entirety and then tap the pipe to release the cup onto a wooden service (to avoid immediate thermal shock), so that she and Diana could inspect it and discuss what did and did not work. Diana would then take over gaffing, changing a few of the steps in the process. They did this 'maybe three or four times', they told us, until achieving an agreed form and choreography of skilled actions. Richard Sennett characterises this process as the 'experimental rhythm of problem solving and finding' (2008: 26). Though Diana and Evelyn took the measurements directly off the ceramic cup, they had to 'dial it into something that the glass wanted to do'. Arriving at the glass iteration involved using both their working knowledge of the material and their coffee cupping experiences. Instead of 'working off' the ceramic cup in a deductive manner, the two women – in the spirit of the workmanship of risk – moved between material and object, and they used their imagination to 'conceptualize the object *during* the process of making' (Risatti, 2007: 172). With their tacit knowledge, they 'intimated' (in Polanyi's sense) the two-tiered glass cup.

Because this prototyping project was not a 'one-to-one' translation between materials, Diana and Evelyn had to search for both the form in the material and the material in the form. Although they lacked steady production experience, their years of blowing glass generated a storehouse of material and working knowledge that prepared them to both see and pursue the problem of material-to-material translation – a moment that Polanyi argues is marked by a 'heuristic tension' in which interpretation becomes a possibility (1966: 89). Whereas Finn had worked backwards from the calliper measurements to produce an object that was identical to a pre-determined design, Diana and Evelyn 'measured' the material in relation to the form and to the experience intended for the coffee sipper, and thereby adjusted the formal measurements.

By making a material-to-material interpretation of the ceramic cup with glass, and by being attentive to the experience that the cup would supply to café patrons, Evelyn and Diana gave form to Nondi's vision. In terms of 'cupping' experience, 'You would put your face over the cup and you would get this hit of whatever that bean was supposed to be doing. So whether it was smoky and almost acidic, or whether it had those rounder, sweet chocolate notes – it happened!' they exclaimed triumphantly. The object also clearly signalled the qualities of 'handmade' and 'bespoke'. Diana recounted, 'Evelyn and I would sort of snobbily joke that these

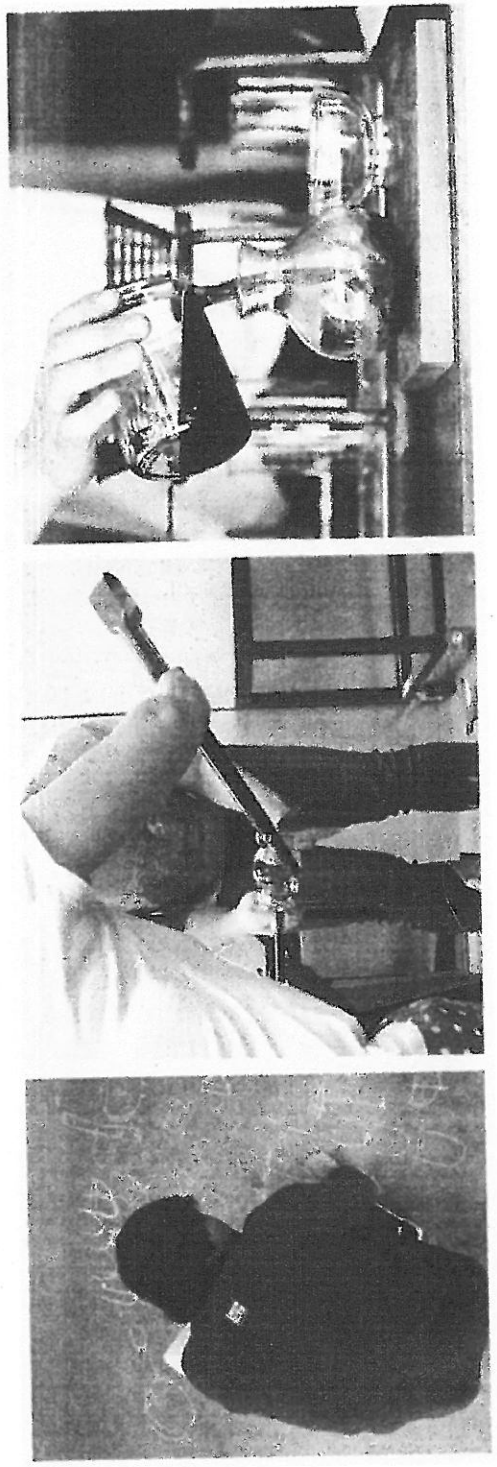

Figure 1.2 Two-tiered glass 'cupping' cup: drawing, making, and in use.

aren't great forms for glass. There's a lot of tooling that has to go onto such a small object. You can see all the jack-lines and parchoffi (i.e. a large wooden chopstick-like tool used for shaping) marks'.

The end result was not an exact replica of the original ceramic cup, as Finn's translation of the model would have been, but instead an interpretation in glass that was deemed appropriate to the makers' sense of the formal and technical possibilities, as well as to the client's intended use. The selection of the prototype that was put into production was due to its form, but also to the success of that form in satisfying the client's need. When commissioning a gaffer, a client depends on that gaffer's working knowledge of the material to interpret not only the proposed object, but also the intended experience in looking at, handling, or using it.

Concept in Prototyping

The practice of interpretation is made even more apparent in the case of Allen prototyping for Isabel, a successful contemporary artist with no prior experience of working with glass. Their collaboration took place at a glass school on America's West Coast that supports two artists in residence for two-week periods during the summer term. Two gaffers are hired each session, and it is their exclusive charge to help and collaborate with the invited artist. Allen was one of the contracted gaffers. When he met Isabel, she explained that she wanted him to make 'soap suds'. Allen recounted, 'She had reference material and had an idea in her head of an art piece that she wanted to make. She wanted to replicate … when multiple bubbles are kind-of sudded together – soap suds. Big soap suds'.

When charged with making 'suds', Allen's tacit knowledge equipped him to infer 'bubbles' since their shapes are analogous. Initially, Allen thought that the project would be easy because a bubble is the most 'natural' shape to blow in glass. So, quite simply, he and the second gaffer on staff each blew out a bubble and then mashed them together: 'So we were, like, "Great!" And she was, like, "Awesome! Now we need six more on it". We were, like, "Oh fuck". So that means that we would have to put six bubbles together simultaneously and have six different air pressures coming together – which really wasn't an option'. In order for molten glass bubbles to touch one another and create one membrane, they need to come into contact at exactly the same temperature. This allows each gaffer to blow into the pipe to centre and keep the membrane 'from wandering' without 'blowing out' either side of the membrane. Allen explained, 'Because when you push the two of them together and you blow from one side, the membrane is going to blow in. So, we needed to sculpt it through pressure to make that membrane just one, centred'. There were not enough gaffers or glory holes in the studio to coordinate the 'sudsing'. What at first seemed a simple form, and one natural to the material, proved to be untenable in practice.

To realise the conglomeration of suds, Allen and the second gaffer had to 'fake it' in the end; or, in other words, improvise. Allen told us, 'So, we started with the

two. That would be the main body. And then we would add a third in a specific area … try to blow that up to sort of fake where that was. And then add a couple more in a couple of other spots, and just try to heat those in a way to try to meld everything together in the right way'. In face of the unknown, but equipped with

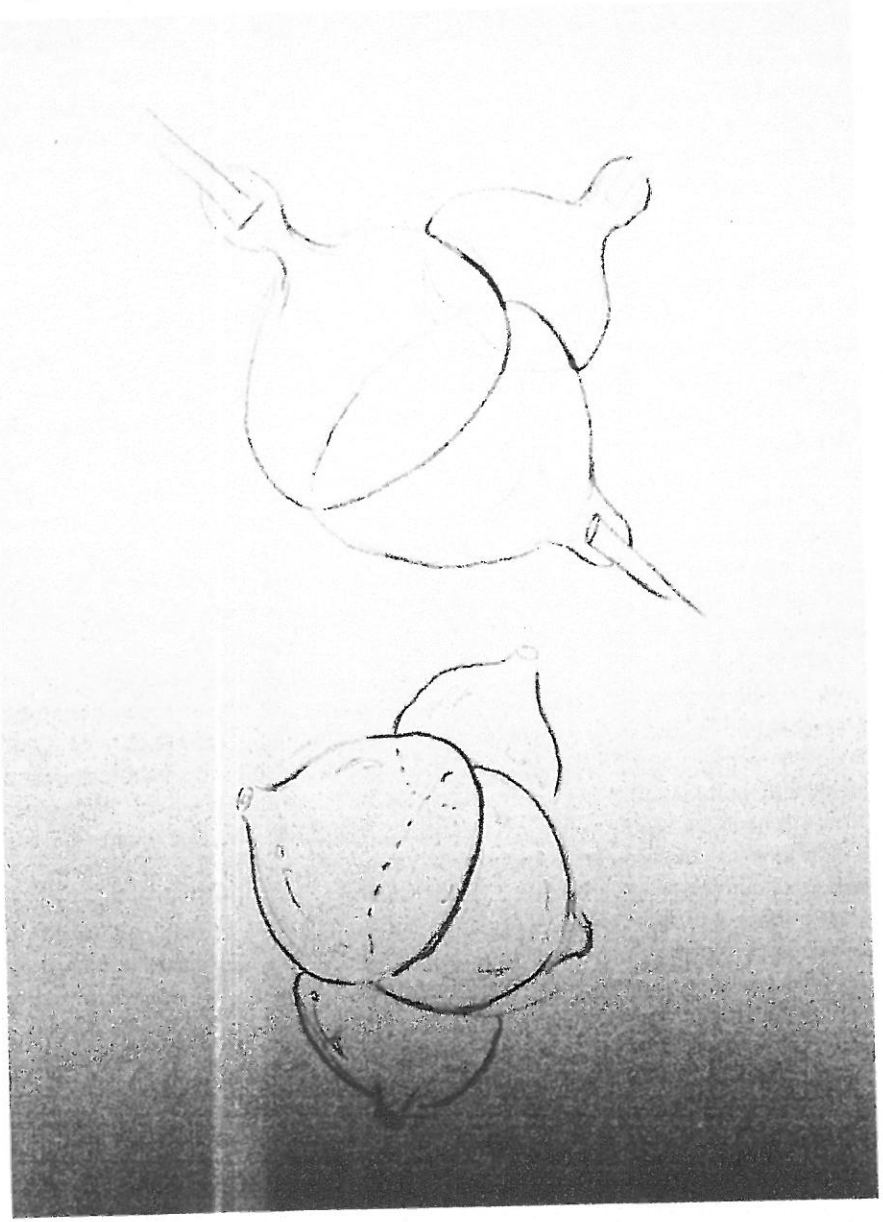

Figure 1.3 Allen's sketch of 'sudsing'.

the experience to deal with the challenge, Allen made 'proleptic adjustments to the demands of the field' and offered a solution to the problem posed by the suds through practice-based improvisation (Bourdieu, 1990: 66).

Isabel, however, was not satisfied with the improvised result. She expressed the problem in formal terms: she wanted the suds to be complete like bubbles, meaning that the suds should have no holes. In response, Allen provided a material explanation: a hot glass bubble needs an opening in order to avoid creating a vacuum. At this juncture, their collaborative efforts were stumped. To Allen's surprise, Isabel took the cooled suds and enlarged the holes by using a saw to cut off the aperture made by Allen (i.e. imagine cutting off the neck of a glass bottle so that the wider glass bottom is exposed). It was this action that gave rise to Allen's epiphany.

He became aware that the stalemate was caused not by an inadequate solution, but rather by an inadequate problem: 'What this did was expose the inner membrane that had been created through attaching the bubbles. We were able to say "Okay, it's not really about the shape of the bubbles themselves. It's really about what's happening on the inside – the connectivity of everything". She was, like, "Yeah". Once we got that out of her, we could really concentrate on doing that. It took us six days of working with her to discern that [i.e. the points of contact between the bubbles]'. In Crawford's words, Allen was 'attentive in the way of conversation, rather than assertive in the way of a demonstration' (2009: 82). He was able to step back from his formal and structural preoccupations, and, through attentiveness to Isabel's practical communication, discern 'connectivity'.

In his discussion with us about prototyping for Clayton, Allen suggested that technique is secondary to the sleuth work of 'whittling away'. In the context of prototyping for Isabel, the work of whittling away took on new meaning. By attending to the dynamic of the form (i.e. to what was actually happening, instead of the idea of suds and bubbles from previous experience), Allen discovered the new problem of 'connectivity'. As in the case of the hurricane lamp, whittling away at the form led to new iterations of the form. But, unlike the hurricane lamp, it also led to the appearance of a new non-formal focus: namely, the idea of connectivity.

Creating something new demands that the maker not only amalgamates various kinds of knowledge from their skill set (exemplified by Allen's bricolage work in making the hurricane lamp), but that they also work from attention. The latter involves a 'tending towards' through which the maker is drawn out of him or herself and toward what is happening, including the experiences and intentions of others, and changes in the surrounding material world. This active search for a problem which, as Sennett argues, calls on the maker to make an intuitive leap between unlike domains, differs from perceiving a problem by way of 'inference', meaning that one responds to a problem without seeing the problem anew.[5] For

5 Sennett wrote, 'The capacity to open up a problem draws on intuitive leaps, specifically on its powers to draw unlike domains close to one another and to preserve tacit knowledge in the leap between them' (2008: 279).

scientist David Bohm and philosopher Simone Weil, attention is the vehicle of discovery (Bohm, 1996: 5; Weil, 1999: 116). Allen attended to Isabel's focus on the inner membranes, while whittling away at the form, thereby making possible his leap to the concept of 'connectivity'. Through the activity of prototyping, objects become manifest; but so, too, do concepts.

Conclusion: Prototyping as a Way of Thinking

While prototyping is commonly understood to be about objects, the analysis in this chapter has shifted the focus away from the physical prototype to the prototyping process. Anchored in the gaffer's tacit knowledge of the craft, the organisation of labour, and the product end-goal (whether a one-off prototype like Allen and Isabel's suds, a limited production like Evelyn and Diana's 'cupping' cups, or a full-fledged product line like Finn's stemware for Sedgewick), prototyping is equally about the creation and deployment of dispositions and relations (i.e. embodied bricolage) as it is about producing an object. As we have shown, the designer–gaffer relationship may calibrate these dispositions and relations in order to achieve exact specifications. In this case, the glassblower must take a deductive approach to problem solving: that is, she must work from the design backwards to her body. In other kinds of working relationships, the gaffer is asked to think outward from her body and her existing working knowledge toward (and about) a design. In this scenario, the glassblower is able to work inductively and thereby integrate material and experiential sensibilities into the design process. As such, discovery and the generation of new problems can be part of the problem solving processes in prototyping. This may result not only in the achievement of a prototype object, but also in a new concept or way of thinking. The body generates schema of perception; and when the prototype is the outcome of an inductive process of making and solving problems, it has the potential to generate new ways of doing, as well as thinking (Sheets-Johnstone, 2011: 114–52).

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