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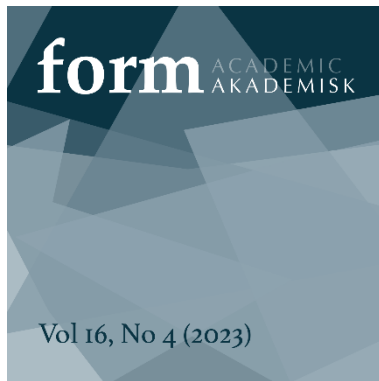
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Sensing the Rhythm

Analysing human and non-human movement in a glassblowing process

ABSTRACT

Glassblowing is a craft in which both human and material movement are essential. However, what kind of movement is required in glassblowing, and why does that movement happen? This article presents a practice-led case study conducted in a glassblowing studio. During a glassblowing session, clear drinking glass blanks are blown in a wooden turn mould. The process of glassblowing is documented on video and analysed using the visual data. Additionally, diary notes and participant observation are used to understand and contextualise video data more profoundly. The analysis focuses on the movement of the two main actants of the process: the human movement of the glassblower and the non-human movement of the hot glass. Altogether, six categories were identified to represent the human and material activity. This article concludes that the movement under investigation is relational between the glassblower and the hot glass, and it happens as a consequence of the glassblowers' situated embodied knowledge. Furthermore, we discovered that research in the processes of glassblowing offers a rich ground for practice-led research that adopts relational ontology and sociomateriality as its theoretical perspectives. The purpose of this study is to fortify the craft of glassblowing as a vital practice in the fields of art, design, and craft.

Keywords:

glassblowing, movement, human and non-human, practice-led research, video.

INTRODUCTION

As a handcraft, glassblowing was invented approximately 2000 years ago (Klein & Lloyd, 2000; Whitehouse, 2012). In our contemporary society, handcrafted glass is globally manufactured in glass factories and in smaller studio settings. Glassblowing expertise has been widely utilised in the field of Finnish design since the 1930s for both unique and serial production of glass (Koivisto, 2001; Koivisto & Lauren, 2013). While the objects and designer narratives have taken the spotlight in the common knowledge and appreciation of glass, the glassblower's work has remained in the shadows. As a skill, handcrafting glass is currently considered endangered (Finnish Heritage Agency, 2021).

The authors of this paper are practitioner-researchers. One is a master glassblower with over 20 years of practice in glassblowing (Author 1), another is a research assistant and current master's degree contemporary design student who has an artisan degree in glassblowing (Author 2), and the third is an artist-researcher with a background in ceramics (Author 3). Through a practice-led investigation in a university glassblowing studio, we aim to add knowledge of glassblowing as a practice in which movement is essential. In this paper, we ask a two-fold research question: what kind of movement happens in a glassblowing process and why? We conducted a case study in which we made clear drinking glass blanks in a turn mould and documented the glassblowing process using multiple video recorders to give us different perspectives of the movement. Additionally, we used diary notes and participant observation to enrich and triangulate the data.

In this article, glassblowing is understood and explored as a furnace-based handcraft in which both human and material movement are essential. The human movement refers to the glassblower's movement, and the non-human movement is that of the hot glass. Similarly, with tacit knowledge that takes years to evolve (Polanyi, 2006), the practitioner's sensitivity to the immaterial nuances of the practice, such as movement, develops within time. The glassblower's training guides her to work and think with glass in a proficient manner. The non-human movement is the movement of hot glass. Glass is defined as an amorphous solid. The randomly formed network structure allows glass to behave like both a fluid and a solid (Flygt & Falk, 2011, pp.14–15).

The glass used in this case study is soda-lime glass, which is the most common formula used in art and design glass-making. The three main ingredients in soda-lime glass are silica, (SiO_2) which forms the structure of glass, soda (Na_2CO_3) to reduce the viscosity and the melt temperature of the batch and lime (CaO) as a stabiliser (Flygt & Falk, 2011, pp.37–40). The working temperature of soda-lime glass is around 1000 to 1150 °Celsius, at which point the viscosity of glass resembles running honey, and the glass is malleable. To reach this temperature, the glass batch is melted in a glass furnace at approximately 1200° Celsius. In this study, we use the mould-blowing technique. It is a common glassblowing practice that was invented around the first century C.E. (e.g., Klein & Lloyd, 2000; Lightfoot, 2014). Compared to free-blowing, mould-blowing allows for a faster means of production of, e.g., drinking glasses, as the glass is directly blown in its shape. The glass must be worked on promptly while keeping it hot.

Previous research in the practice of glassblowing is sporadic. In Finland, two studies in the field of ethnology investigated glassworkers and their work (Metsänkylä & Suutari, 1992; Nurmi, 1989). In the field of design, glassblowing is used as an example by craft researcher Camilla Groth in the context of embodied cognition (Groth, 2017). Additionally, Groth and ceramist Arild Berg used glassblowing when designing a research setting to better understand a co-creation situation between a designer and a glassblowing team (Groth & Berg, 2018). Internationally, the most acknowledged study in glassblowing is Erin O'Connor's ethnography on how she became a glassblower (O'Connor, 2009; see also Sennett, 2009, pp.173–176). Together with glass educator Suzanne Peck, O'Connor later explored the work relationship between artists, designers, and glassblowers (O'Connor & Peck, 2016). Recent studies in the field of design emphasise the embodied cognition of the craftsperson (Groth, 2017; Westerlund et al., 2022, pp.4, 52) and the human-material relationship (Aktas & Mäkelä, 2019). These perspectives of embodied cognition and material agency help us to understand both the human and non-human movement in our study. In the following sections, we present the methods we used to investigate the movement in a glassblowing process followed by an analysis of the investigation and the conclusions.

METHODS TO FIND HUMAN AND NON-HUMAN MOVEMENT IN A GLASSBLOWING PROCESS

In this chapter, we present our research methods for investigating the human and non-human movement in a glassblowing process. For the study presented in this paper, we conducted field work at the Aalto University's glass studio one day in late April 2023.

Author 1 and Author 2, who are a master glassblower and an artisan glassmaker, respectively, designed a mould-blowing session in which they made clear drinking glass blanks using a wooden turn mould. The mould-blowing was documented by audio and video equipment. In addition, the glassblower (Author 1) utilised morning and evening query questions for documenting her personal reflections on the study, and during the glassblowing session, the assistant (Author 2) observed the glassblowing process as a participant observer doing an ethnography.

In the field of design, practice-led research allows a practitioner-researcher to use their practice as a vehicle to investigate and communicate it in such a way that it contributes to already existing knowledge and understanding (Mäkelä & Routarinne, 2006, pp.12–13). In this study, practice-led research was used to explore the routines and movement while blowing glass. Groth notes that a practitioner, while practising their craft, needs full attention in the craft itself. Groth shows an example of using video recording as a tool in practice-led research, as it enables the practitioner-researchers to document their experiential knowledge in action and communicate it to their audience through a detailed written analysis (Groth, 2022, pp.48–50). In this study, we used multiple video recorders to document the glassblowing process from different angles.

As already described in the introduction, glassblowers' sensitivity to the rhythm and movement in glassblowing has been developed over years of practice. Autoethnography allows the practitioner-researcher to use her lived experiences as the foundation of this study. The personal, first-hand information of the glassblowing process "provides a perspective that others can use to make sense of similar experiences" (Adams et al, 2014, p.27). In the field of design, and in the context of practice-led research, diaries have become a beneficial method for the researcher to methodologically reflect her practice (Groth et al., 2015). Along with the lived experiences providing access to the practitioner-researcher's knowledge on glassblowing, Author 1 gathered written data on her thoughts and feelings through morning and evening diary notes made the glassblowing days. The questions are shown below in Table 1a.

TABLE 1a. Morning and evening diary questions.

Morning questions	Evening questions
What are you going to do and how?	Did you manage to do what was intended?
What are the challenges of the work?	Did the plans change? If so, why?
What possible challenges regarding movement can there be?	How did the change of plans affect your feeling of the movement?
What are your expectations for the day?	How did you react to the possible changes of rhythm or the work tempo?
How well are you prepared for the glassblowing session?	What were the critical points in the workflow?
How do you feel now?	How do you feel now?

We added participant observation (Spradley, 1980) as a method to further contextualise and triangulate the gathered data. In this study, the research assistant took the role of a participant observer to better understand the embodied knowledge causing the movement. This was conducted through taking notes on the action and checking the temperatures of the glass.

The 1 min 22 sec-long video clip linked to this section of the article communicates, on a general level, what kind of movement we talk about in our study. The video shows how the glassblower moves in the studio set up between the glass furnace, the glassblowers' bench, and the mould-blowing station. In addition, it shows the movement of the hot glass (Video 1).



VIDEO 1. This video communicates what kind of movement happens in a glassblowing process.

ANALYSING THE HUMAN AND NON-HUMAN MOVEMENT IN A GLASSBLOWING PROCESS

The analysis phase of this study included three main methods: the autoethnographic diary notes, the video recordings and participant observation. As evidenced in earlier studies, “knowing is situated in action and in relation to previous experiences and material skills [...]” (Groth, 2017, p.vii). The diary notes taken in this study confirm the glassblower’s excitement to blow glass. This is evidenced by the fact that she has a relational understanding of what she is about to embark on. As shown in Table 1b, the glassblower had concerns regarding the glass, as it was her first time for using that specific soda-lime batch melted in the university glass furnace. Furthermore, she revealed her personal concern about having dry hands that could affect the tempo of the rotating blow pipe. We believe that this understanding is fundamental in acknowledging the importance of proper movement and how to achieve that in a glassblowing process. Additionally, the glassblower’s willingness to keep on going despite the changes in the work tempo displayed a positive attitude and showed that she was in work rhythm. The research situation itself caused an additional worry for us because the video recording equipment did not always function as intended—especially in the hot studio setting.

When analysing the videos, we first created multiple screen video files using Adobe Premiere to synchronise the video material we had recorded from different angles. Using multiple angles allowed us to view and analyse the process in more detail. In total, we gathered 2 hours and 28 minutes of synchronised video for this study. In the analysis process, we noticed that a nearly 4-minute-long video on mould-blowing is rich enough to answer our two-fold research question on what kind of movement happens in a glassblowing process and why. Although audio was recorded, we did not utilise it due to the notion that the communication was mainly embodied in the process.

TABLE 1b. Morning and evening diary questions and the answers. The answers are slightly modified grammatically.

Morning questions, 8.30 am.	Evening questions, 21.47 pm
What are you going to do and how? Today, I am going to blow drinking glass blanks in a mould. The glass I use is (melted from) clear Kügler cullet. It will be the first time I use this glass for mould blowing.	Did you manage to do what was intended? I managed to blow glass, as I intended to do.
What are the challenges of the work? The first challenge of the work will probably be getting familiar with working in this studio and with this glass. As a quite experienced glassblower with some knowledge about this studio, I believe I will quickly figure out how to work in this environment. Other challenges are research related. Will the video recording work as I have planned? Will I get enough data to be analysed in the next phase of this project?	Did the plans change? If so, why? The plans changed regarding the documentation. The GoPro didn't work as I thought, and the documentation of the audio/video took time away from the actual work of blowing glass.
What possible challenges regarding movement there can be? Regarding movement the possible challenges are the embodied, personal aches and for example the dryness of my hands. Am I able to turn the blowpipe in a tempo that is required? Also, the new glass can have a different feel to it so- (regarding movement) the temperature of the glass can be too low, for example.	How did the change of plans affect your feeling of the movement? I felt that the movement was interrupted too many times, it was hard to get the flow in the movement. I managed to have the flow but then it was interrupted by some of the video failures.
What are your expectations of the day? I expect that today will go well. I am expecting to make at least twenty mould-blown cup blanks into annealer.	How did you react to the possible changes of rhythm or the work tempo? I kept going as much as I could despite the changes.
How are you prepared for the glassblowing session? I am prepared with an excited attitude, and I am ready to go! This morning I had a long walk with my dog, and during the walk, I stretched. I am prepared with my tools. The wooden mould is ready to be blown into. I have an assistant who helps me with the research.	What were the critical points in the workflow? Critical points in the workflow were having the blowpipes not ready and trying to document with the GoPro attached to the blowpipe, which felt awkward. The weight of the camera displaced the balance. Balance is important for the movement.
How do you feel now? I feel energetic!	How do you feel now? I feel tired. All in all, the workday was long. It started at 8.30 and my assistant and I left from the studio at approx. 17.30. After that, I went to pick up sketches for tomorrow (from my office space on the campus). I was at home at 18.15.

To get a more precise understanding of the video recorded data, we used ELAN software to create sequences of the critical action in the mould-blowing process and watch the sequences frame-by-frame. We discovered that the making of one mould-blown drinking glass blank consists of 13 critical sequences regarding movement. We base this decision on our expertise and previous knowledge of glassblowing. The lower part of Figure 1 shows the 13 sequences which we numbered, named, and analysed. We added the time at which the movement started to this categorisation, shown in Figure 1. The sequences are named as follows: First Gather (1), Marvering (2), Blowing the starter bubble (3), Stretch and blow (4), Making the neckline (5), Letting the bubble cool (6), Post gather (7), Swing (8), Blocking (9), Blowing and stretching (10), Blowing, centring, lifting the blowpipe, stretching the glass, blowing (11), Securing

the flatness of the bottom (12), and Knocking off the blank into annealer (13). All this happens in 3 minutes and 55 seconds. The upper part of Figure 1 is a visualisation of the heat curve, showing that most action and movement happens when the glass is around 1000 °Celsius.

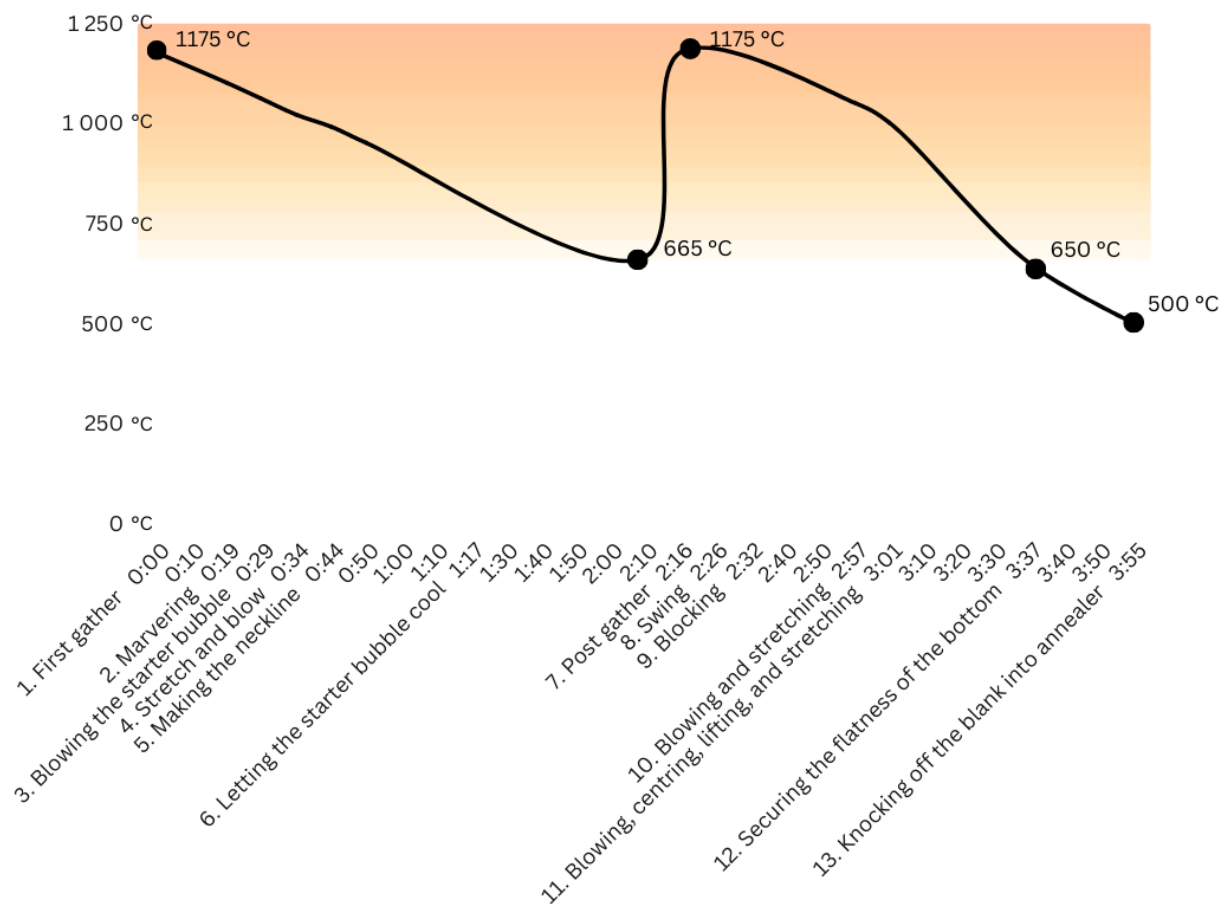


FIGURE 1. Temperature range and the sequences analysed.

In the final video analysing process, we created three categories to specify the human movement and similar categories to specify the non-human movement that we identified in our data. This categorisation allowed us to better-understand the different levels of action in a glassblowing process. In the human context, we named these levels *Meta level activity* to describe the movement on caption level, *Meso level activity* to describe the same activity in detail, and *Micro level activity* to describe the embodied, sensing level of the movement. In the non-human context, we named the levels *Heat activity* to explain what happens with the glass in relation to human action, *Movement activity* to explain what happens with the movement of the glass, and *Colour of the glass* to inform readers that the glassblower assesses the movement and the workability of the glass by its colour. In summary, we identified six categories that we used for further analysis on the movement and its reasons in all the thirteen sequences that we show in Figure 1. Due the limited space in this paper, we elaborate on only one of the thirteen sequences as an example of the analysis. In Table 2 below, we show the findings of Sequence 11. In the Figure 2 below Table 2, we show a screenshot of Sequence 11. Using the link to Video 1, the sequence can be seen as it was recorded.

TABLE 2. We identified six categories to define the human movement and the non-human movement. This table shows the categories and the findings.

SEQUENCE 11 / BLOWING, CENTRING, LIFTING THE BLOWPIPE, STRETCHING THE GLASS, BLOWING					
HUMAN MOVEMENT			NON-HUMAN MOVEMENT		
<i>Meta level activity</i>	<i>Meso level activity</i>	<i>Micro level activity</i>	<i>Heat activity</i>	<i>Movement activity</i>	<i>Colour of the glass</i>
Blowing, centring, lifting the blowpipe, stretching the glass, blowing.	The right-hand thumb upwards along the blowpipe, close to the glassblower's mouth. The left-hand thumb downwards along the blowpipe supporting, balancing the upright position of the blowpipe. Actively rotating the blowpipe counterclockwise and blowing into it.	Sensitive blowing in relation to sensory perception of how the glass feels and moves. The sensing is partly in the airways of the glassblower. She senses resistance when the glass is fully blown into its form and assesses the next movements to come according to the feedback and feeling gotten from the glass	From malleable hot in 1000°C to approximately 700 °C, except the bottom part where the material thickness is larger.	The glass stretches as it rotates. Atoms continue to move rapidly until the glass is blown into its shape. The bottom part stays malleable enough for the next work phase.	From orange to clear.

To further triangulate the collected data, we used the participant observation notes. The notes confirmed to us that the rhythm and movement of the glassblower and glass guided the event. The workflow mentioned in the autoethnographic diary notes consists of the rhythm and the tempo of the human-material collaboration. The participant observation notes that the rhythm of glassblowing is very lively, communicating the nature of the process itself. This rhythm resembles improvisational jazz: it has no choruses. Instead, there is a layered interaction that appears as comments between the actants. The dynamics and rhythm between the human and non-human movement were noticeable throughout the entire process as a continuous movement of the glassblower and the glass. Based on that movement and the changing colour of the glass, it is possible to estimate the temperature, weight and malleability of the glass. The initiator or catalyst of the movement remains uncertain, but its maintenance was undoubtedly dependent on the interaction between two entities. In addition to rhythm, the non-verbal multi-level cognitive process shared by the participants was guided by embodied knowledge. As a result of this embodied knowledge, verbal communication was hardly needed.

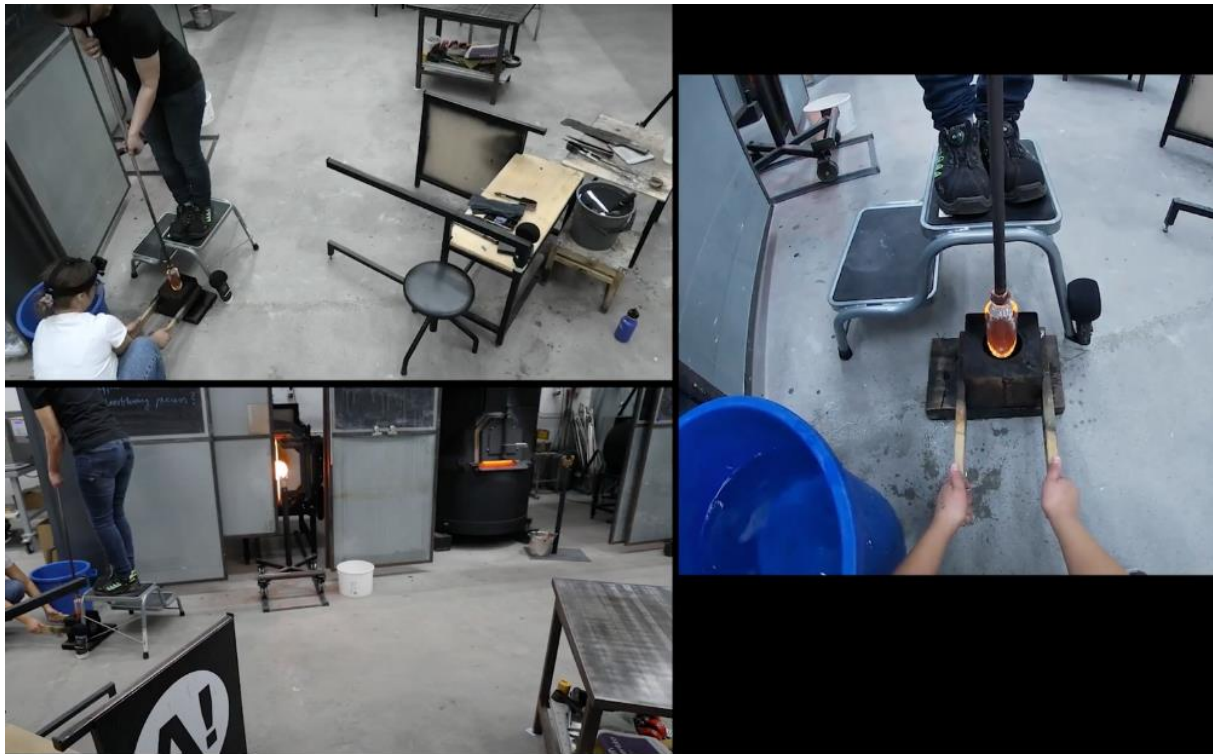


FIGURE 2. The screen shot of the Sequence 11 *Blowing, centring, lifting the blowpipe, and stretching, blowing* as shown on a multiple video screen. The sequence is analysed in Table 2 above this figure.

We discovered that social scientist Donald Schön's notion of reflection-on-action became an important method because it allowed us to reflect our thinking as well as the actions and feelings we had experienced during the practice (Schön, 1983, p.278; Mäkelä & Nimkulrat, 2011). Due to the prompt manner of working with glass, there is no time for deep reflection-in-action during the work. Hence, when watching the working process on video, we were enthusiastic about the possibility to slow the action to a frame-by-frame movement. Only this method gave us the access to see the movement, how it starts and where it goes to. Despite the technical struggles we experienced in the glass studio when video recording our working process, the outcome of the recordings was rich research data.

CONCLUSION

The case study was conducted using practice-led research as its overarching research method. Through contextualising and triangulating the data gathered through video recordings, diary notes and participant observation, we have described what kind of movement happens in a glassblowing process. However, we have only partially answered the second part of our two-fold research question: why the movement happens. We discovered that glassblowers' proficiency is embedded in sensing the rhythm of the workflow, constantly balancing the movement of themselves and the material, and importantly, a capability to assess problematic situations and act accordingly. Whereas this study strongly demonstrates embodied cognition and material agency, we did not utilise any specific theory in the analysis as it seemed conclusive at this point of the study. We realised that, to further explain the reasons for the movement, we need a deeper reflective analysis.

However, we discovered that, when exploring the practice of glassblowing, distributed thinking occurs naturally since the glassblower's work is always in relation to the actively moving material as well as to the teamwork. Although we identified the relational movement of the glassblower and the hot glass, we did not go into the depth of that track. Designer-researcher Luis Vega discusses sociomateriality and distributed thinking through the term "distributed thinking through making" to expand the practice-led research method towards collaborative sense-making in practice (Vega, 2021). Based on this notion, we

suggest that research in glassblowing processes can benefit from adapting relational ontology as its theoretical approach.

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