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The Dual Drivers in Intuitive Design Thinking: Myself and Making

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Abstract

Background Design thinking is a problem-solving process, currently being used outside of the design domain in workshop format by companies around the world. Although both intuition and making are considered a crucial part in design thinking, little empirical research explores the possibility for making to enhance the application of intuition. In this study, we investigate the role and use of intuition and making in design thinking.

Methods In a controlled, comparative approach, teams participated in guided design thinking workshops. The teams explored a design problem, outlined pain points, and proposed a solution at the end of the workshop. Using independent measures, a control group in the non-making condition followed the traditional design thinking workshop approach, while in a making condition, a making activity was introduced at the start of the workshop using the Lego Serious Play © methodology replacing a graphing activity during the empathy stage, with the rest of the workshop following the traditional design thinking methodology. All workshops were video recorded. An analysis of the recordings was conducted, with time participants engaged making timestamped and compiled. The decisions of each participant were counted and sorted into three types: low, medium, and high-level decisions. High level decisions were used as evidence of the application of intuition.

Results The making activity at the start of the workshop increased the number of high-level decisions in comparison to the non-making condition. The use of Lego in the making condition not only increased the time the participants made but showed that both making and decisions were increasingly distributed across the design thinking workshop. Each participant had a predisposition for the use of their intuition, and by using the Myers Briggs type indicator, intuitive participants were found to have increased high-level decisions.

Conclusions The application of intuitive judgment during design thinking workshops depends upon the individual's predisposition to use their own intuitions. Opportunity to engage in the making activity also acts as a catalyst for enhancing the use of intuition. To encourage participants of the design thinking workshop to employ their expertise, we suggest making as a driver for experience-based intuitive judgment. For those less inclined to apply intuition, making acts as stimulation. For more intuitive participants, making can enhance their use of intuition.

Keywords Design Thinking, Intuition, Design Making

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1. Introduction

Design thinking (DT) is a problem-solving technique and idea generation process commonly used in industry and academia, often in workshop contexts. The process model of DT, popularized by IDEO (2014) (Sándorová et al., 2020, p. 2), emphasizes user-centered design to redefine a problem, generate creative solution opportunities, and prototype and test ideas. By following this process, DT is positioned as an approach to derive more creative solutions to complex problems. Using Rösch et al. (2023, p. 12) definition of DT as an iterative innovation and problem- solving process, which is based on specific principles and uses specific methods.

Since DT is used in a workshop setting time is restricted. This leads to decisions taking place when not all information is available due to the restricted timeframe. Decision making can be divided into two types: System 1 and System 2 decisions (Ghasemi et al., 2022, p. 1; Kahneman, 2003, p. 2; Stanovich & West, 2000, p. 14). System 2 decisions arise from a slow, analytical process in which all available information is carefully considered. It is slow, reflective, and conscious. In contrast, System 1 decisions are intuitive, unconscious, and made quickly, even when not all information is available. These decisions rely on intuitive heuristics, or "gut feelings" based on prior experience.

System 1 reasoning is closest to cognition engaged during DT. This is probably because of the nature of design problems, wherein little is known about the particulars or constraints of the problem prior to attempts made to solve them. The ability to engage in System 1 reasoning during DT is important, but the role of intuition in decision-making during DT workshops has received little attention from the design research community. In this study we explore the use of intuition in DT and test the assumption that embodied cognition techniques enacted through making, can enhance the use of intuitive judgment during design thinking activities.

In the current study we facilitate the use of intuition through making activities prior to design ideation. These activities primed participants to apply intuition when tackling design problems. Specifically, we introduced the Lego Serious Play (LSP) methodology at the empathy stage of DT workshops as experimental condition and compared the result against workshops that did not include this intervention. By comparing conditions, we found that participants interacting with LSP applied intuition to their decisions at an increased level compared to those that did not.

1. 1. Making

In our use of making as stimulation for intuitive decisions during Design Thinking (DT) workshops, we first defined an operational definition of the term. As Martin (2015, p. 2) suggests the semantics of making, used in a general sense, may encompass a variety of meanings, 'Building things, being creative, having fun, solving problems, doing social good, collaborating, and learning'.

To define making we need to understand both the variety of concepts that it groups, and the aspects of most interest to DT. In psychology literature, making has been linked to cognitive processes involved in learning and problem-solving. This approach to making references Piaglet's Constructivism (Piaget, 1971) and Papert's Constructionism (Kafai, 2005). The link between DT and Constructivism has been recently recognized by Pande and Bharathi (2020, p. 15) as critically important for the theoretical foundation of DT.

Constructivism suggests that 'all knowledge is tied to action and knowing an object, or an event is to use it by assimilating it to an action scheme' (Piaget, 1971, p. 6). Through the lens of Constructionism, a physical object is core to the construction of knowledge. According to Kafai (2005), a physical object becomes a learning bridge by building relationships between old and new knowledge through interactions with others while creating socially relevant artifacts.

Constructionism emphasizes the connection between making with our hands, learning, and going through problem-solving, with many studies in pedagogy and knowledge transfer investigating the relationship between thinking, hands, and making. For example, Pallasmaa (2017, p. 1) suggests that learning a skill is not primarily based on verbal teaching, but on the transfer of the skill from the teacher's muscles to the apprentice's muscles through sensory perception and bodily imitation. Of course, this depends upon the type of knowledge transfer. But for the purpose of DT as method to derive creative solutions, often using prototyping approaches to explore and communicate ideas, it is a useful definition for our purposes.

Making, thus described is also related to sensory perception, including embodied cognition (Shapiro, 2021, p. 1). By adopting an embodied approach, we also emphasize making as haptic experience that has at its core, 'a functionally discrete system involved in the seeking and extraction of information by the hand' (Peck, 2011, p. 18). In our definition of making we include the physical manipulation of materials in the world. The material quality of making. So, for example, making a webpage is beyond the scope of our definition. That is not to say such design work cannot be defined as making. Only that we focus open a definition of making involving the hands and material manipulation of objects and materials.

Making is also considered an important activity in design process. For example, Wang (2013) suggests that making is core to the very nature of design activity. For the purposes of our current study to look at the role and use of making in DT, we adopt the following definition: Making is an embodied process that involves a haptic experience with materials in the world. The act of making creates opportunities for the application and development of knowledge through material manipulation. An operational understanding of making is essential for our research, as it allows us to objectively identify and measure the amount of making engaged by participants in DT contexts. This is important to investigate our assumption that making influences the use of intuitive judgment during DT workshops.

1. 2. Intuition & decision making

Intuition has long been recognized as an abrupt and subconscious process that leads to sudden insights, as noted by Koestler (1964), 'the moment of truth, the sudden emergence of a new insight, is an act of intuition'. Epstein (1994) characterizes intuition as an experimental information-processing method that requires little effort and conscious awareness. Likewise, Hogarth (2001) describes intuitive decisions as requiring no conscious deliberation. This definition of intuition clearly leans into the idea that intuitive judgement is heuristic, at least in the moment of application. In our study, we adopt the notion that intuitive judgments are reflexive and unconscious. However, it is important to note that intuition is also informed by past experiences, and it is this wealth of knowledge that enables instantaneous decision-making. For example, Taura and Nagai (2017) suggest, 'that which enables instantaneous decision-making following patterns recognized based on one's experience' (p.6). Therefore, although intuitive judgments may appear sudden and reflective, they are in fact grounded in prior expertise and experience.

Intuition is a difficult concept to measure in the context of Design Thinking (DT) because there are currently no tools or approaches available to identify its use. However, a well-known self-report intuition test is the Myers-Briggs Type Indicator, or MBTI test (Myers, 1962). The MBTI is based on Jungian Theory which measures human personality through an exclusive, dualistic approach. The MBTI assesses personality along four dimensions: Extraversion/Introversion, Intuitive/Sensate, Thinking/Feeling, and Judgement/Perception. In the application of the MBTI test, the test subject chooses an option in each pair to create a result that indicates personal preference. For example, the test defines an ISTJ individual as: Introvert, Sensate, Thinking, Judger. While an ENFP individual indicates: Extrovert, Intuitive, Feeling & Perceptive. As the current study explored the use of intuition, we applied the Intuitive/Sensate dimension of the MBTI as means to classify our participants as more or less intuitive by nature. It is also important to note that the MBTI test requires subjects to self-report and has seen widest use in psychology. Paulhus and Vazire (2007) explain that self-tests are advantageous since they directly tap into the responder's self-perceived personality. While there may be a gap between a subject's self-reported response and the truth, risk can be reduced through careful administration of the test.

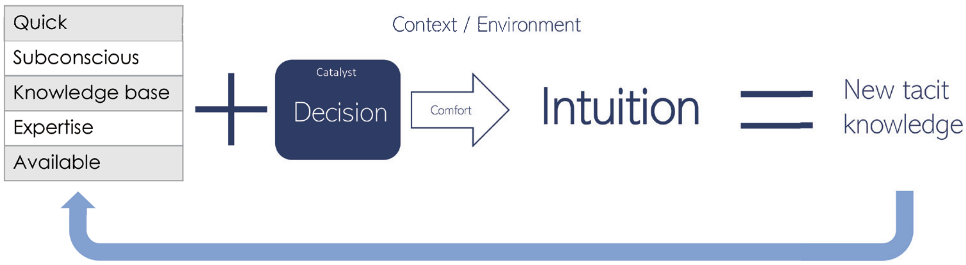

Figure 1 Model of intuitive decision making.

Figure 1 describes intuition as quick and subconscious, previous knowledge and expertise based, as well as always available to the individual. However, for intuition to become active it needs a catalyst in the form of a decision. The individual must also be comfortable in applying their intuition when making a decision. Once used it can create new tacit knowledge for the participant. This tacit knowledge then becomes part of the participant's experience. As a result, it can be used again in the future. To identify the presence of intuitive judgement, we focus on an analysis of decisions, indicated in Figure 1 by the dark blue box. We investigate the type of decision taken, including the likelihood that intuition was used.

There are various types of human decisions, from mundane choices like taking the bus or getting a taxi to far-reaching decisions like pursuing a demanding career. Steele (2020) indicates the importance of decision theory, describing the variety of decisions we take in our daily lives, 'Decision theory is concerned with the reasoning underlying an [individuals'] choices, whether this is a mundane choice between taking the bus or getting a taxi or a more far-reaching choice about whether to pursue a demanding political career.'

According to Buchana and O'connell (2006, p. 1), a decision marks the end of deliberation and the beginning of action, the bridging point between thought and action. In other words, it is the point at which thought transitions into activity, making it a crucial aspect of the decision-making process. In this study, we also examine the consequences of decisions to help determine the role of intuitive judgment in arriving at them.

Decision-making has been studied by disciplines such as psychology, politics, and business. (Sloman, 1996, p. 3). One influential ontology of decisions distinguishes between analytic deliberation and intuitive references (Thoma et al., 2015, p. 2), a duality that can be traced back to Aristotle (Sloman, 1996, p. 3).

Furthermore, this duality can be categorized as System 1 and System 2 decisions (Stanovich & West, 2000). System 1 decisions are fast, automatic, and often emotionally charged, while System 2 decisions are slower, more reflective, and associated with language and higher-order control. (Evans, 2008, p. 5) Evans identifies and categorized some attributes to each system to better understand their differences.

The literature discusses the difference in using Type 1 and Type 2 reasoning. In summary, the type of decision used depends upon how much information the individual has at the time of the decision. Westcott (1961) studied the gap between available information and making a decision, referring to the use of Type 1 decisions as 'Intuitive Leaps' when information is scarce. Conversely, where there is an abundance of information available, Type 2 reasoning is more likely to be employed.

During the DT process many decisions must be made, In fact, often under time pressure and with limited information. In the literature on reasoning and decision-making, Type 1 decisions are particularly relevant to our study of DT. This is because DT workshops are constrained by time, which means that the decisions made often require quick, intuitive judgment. These judgments, as is often the case in design, are made where information availability is lacking.

2. Research Aims

Through the author's own industry experience of running DT (Design Thinking) events, it was noted that participants had difficulty applying their own intuition though out the workshops. That is why our study explores the role of making as catalyst for decision-making in the context of Design Thinking (DT) workshops. In particular, we are interested in testing an assumption that making enhances the use of intuition when deciding a course of action in relation to a design problem. As such our study addresses the following research question:

Can making act as a stimulus for the application of intuition in a design thinking workshops?

To answer this question, we adopted a definition of making as embodied interaction with material in the hand. We focus on the decisions made by participants in DT workshops, examining the types of decisions made and the influence of making on the type and frequency of these decisions. Our objective is to empirically assess the relationship between making and the application of intuition.

This study's aim is an initial exploration of the assumption that making would influence the use of intuition in design thinking workshop setting. The goal and expected contribution of this study to start to begin to understand the relationship between making and intuition. By testing that if providing participants, the opportunity to make, it would enhance the use of their intuition. With hopes of driving more interesting or more appropriate design outcomes from these DT activities.

3. Methods

Two types of workshops were conducted as independent measures and randomly assigned to a control group, referred to as Non-making, and an experimental group, referred to as Making. Workshop teams were presented the same workshop topic "A Day as a UNIST student", and were designed to help participants empathize with students, identify pain points, and develop solutions. And, finally, explore solutions to address identified student needs. The workshops lasted 3 hours and were held on separate days.

3. 1. Participants

The participants were graduate students enrolled in the Master and Ph.D. of Design program at UNIST, with a mean age of 24 years. Of the participants, 64% were male and 36% were female. In this study N=10 of the participants is of Korean nationality while N=6 were international students. N=11 of participants has an undergraduate degree in design the other N=5 have an engineering field undergraduate degree. The Non-making condition consisted of two teams of three participants each, for a total of six participants. The Making condition consisted of four teams, with two teams consisting of two participants and two teams consisting of three participants, for a total of ten participants. The teams were randomly assigned to the control and experimental groups.

3. 2. Workshop process

The classic design thinking (DT) approach, as popularized by Stanford's D. School (IDEO, 2014), was chosen as the basis for the workshops. The approach involved providing teams with a key question to work with and proceeding through a series of discrete stages. These stages included empathizing with the user, defining the problem, ideating potential solutions, prototyping, and testing.

For the Experimental group, the Lego Serious Play (LSP) system was introduced at the start of the workshop. The LSP system, developed by Lego (LEGO, 2010, p. 2), is based on the making of Lego models and the use of metaphors to deepen the reflection process and support effective dialogue. In the workshop, the LSP system was integrated into the classic DT approach. Participants were asked to create Lego models that represented specific aspects of the problem and to use metaphors to provide a better understanding of the problem. The models were then shared to stimulate further discussion and idea generation.
The workshops were designed to last 3 hours, proceeding through the stages of the design thinking process (Table 1).

Table 1 Time allocation for each workshop segment

DT workshop segments	Allotted time
Intuition test	10 minutes
Introduction	5 minutes
Day as a UNIST student (representation)	15 minutes
Pain-point selection	6 minutes
Redefine the problem	6 minutes
Ideation	20 minutes
Break	20 minutes
Idea selection	18 minutes
Prototype	30 minutes
PPT creation	15 minutes
Final idea presentation	20 minutes (5 minutes per team)
Exit Survey	5 minutes

At the beginning of the workshop, participants were assigned to their teams and asked to sit at their designated tables. Once the workshop began, participants were given 10 minutes to complete an intuition test. Following this, a brief introduction was given to explain the use of the DT methodology and the structure of the workshop. Participants were informed that each team would be required to present their work at the end of the workshop.
The first segment, “Day as a UNIST student,” required each team to create a representation of a typical day for a student. The Non-making group used paper and pencil to create a graph as seen on the left of Figure 2, while the making group used sets of Lego Serious Play to create their representation as shown in the right of Figure 2.

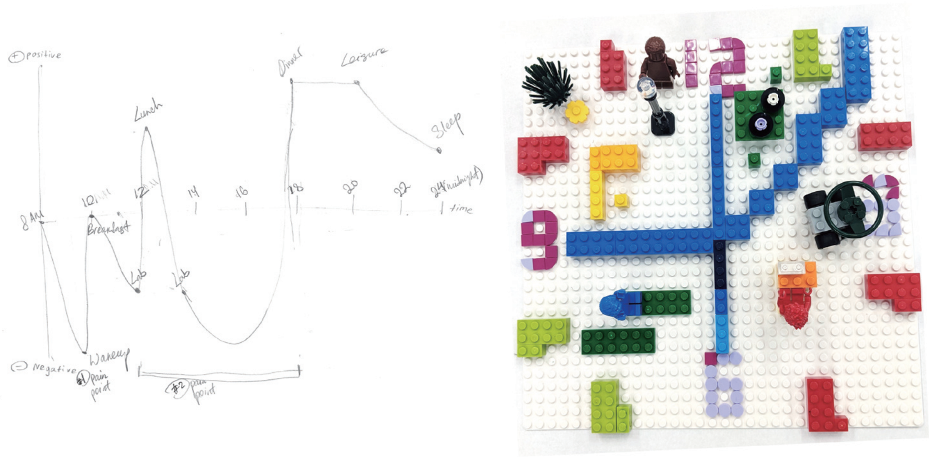

Figure 2 Representations of Day as a UNIST Student.

The next segment involved a 6-minute team discussion to select a pain point derived from their representation. The following 6-minute segment was spent on redefining the problem by creating a problem statement based on the pain point.

The ideation segment followed for 20 minutes in which the teams individually created as many ideas as possible. And the idea selection segment was introduced afterward. During this segment, teams discussed the ideas that were individually created during ideation and selected one or a combination of several ideas to serve as the solution for the identified pain point. The Prototyping stage followed, with an allotted time of 30 minutes for teams to create a presentation. Once all teams had finished, they were given 5 minutes each to present their pain point and proposed solution. The workshop concluded with an exit survey, and participants were free to leave.

3. 3. Materials

The workshop took place in the Trans-disciplinary room in the Design department at the authors' home institution. Each team was assigned one of the working spaces available. (Figure 3)

Figure 3 Picture of the Trans- Disciplinary room with each team in their assigned workspace

A PowerPoint deck was created to explain each stage of the workshop in detail. The participants were provided with various materials, including the intuition test, exit survey form, white paper, pens, and pencils. For the prototyping stage, a table was set up with a range of art and crafting supplies such as craft paper, clay, scissors, tape, and four boxes of Lego parts. The Making condition teams were given an additional box of Lego Serious Play kits at their desk from the beginning of the workshop.

3. 4. Data analysis

To analyze the data, we utilized the recordings and videos captured during the workshop, which served as the raw information for our analysis. The video recordings were then transcribed by the online Word transcription tool and afterwards a manual review by the author took place. Firstly, we conducted a time analysis to determine the amount of time spent by each participant on prototyping. We accomplished this by time-stamping the videos from the moment a participant picked up a prototyping material until they put it down. Then, in a second round of analysis, we focused on identifying instances of decision-making during the workshop. We time-stamped and categorized these decisions as low, mid, or high-level, depending on their complexity and significance in guiding the direction of the task following the Decision encoding frame shown on Table 2.

Table 2 Decision encoding frame

(D) Decision = A decision is always a statement. To count as a decision the statement MUST include A, K, and/or E (can include more than one).		
Decision MUST be a statement, AND include A, K and/or E.		
(A) Agreement: agreement statement from another directly (0–10sec) following a statement (i.e., I agree, okay then).	(K) Knowledge: evidence of prior knowledge within statement (i.e., let's think about user needs).	(E) Experience*: Reference to personal, prior experience within a statement, Any small evidence of past experience (i.e., it never works like that, after you go back to work).
Decision Type: weaker (LD) to stronger (HD) relation to an intuitive decision.		
(LD) Low Decision = The agreement statement A (see A above).		
(MD) Mid Decision = A decision described by D + A (above).		
(HD) High Decision = A Decision including K and/or E (above). + Impact in the forward process (max. 2 minutes) + Mentioned for the first time in the workshop		

The reason for our focus on decisions is because of our theoretical definition of intuition, in which decisions are used as evidence of the emergence and the application of intuition, particularly focusing on high level decisions. Because of this we tried to objectively identify instances of decisions in the video recordings and transcripts of the workshops. We counted the absolute frequencies of the 3 levels of decisions to derive the application of intuition during the workshop. An intercoder reliability check took place in terms of the frequency, timestamp location of the decisions and level of decision (Low, Medium or High), any discrepancies were discussed and the encoding frame was slightly revised.

Lastly, we administered the intuition test based on the Myers-Briggs Type Indicator (MBTI) to classify participants as either Intuitive (N) or Sensitive (S). We used the test results to further categorize and analyze the data on the participants on an individual level.

4. Results

4. 1. Increased frequency of high-level decisions in making condition

Figure 4 illustrates the location and frequencies of all decisions across the Making and Non-making workshop conditions. The black spots around the circle represent the time and decision type. The inner circle represents Low decision, the middle circle represents Medium decision, and the outer circle represents High decisions. Session start is at 12 o'clock. Session activities across the workshops are shown within the center of each info-graphic (i.e. Intuition Test, Instructions etc.). Making and Non-Making conditions are color-coded blue and red, respectively.

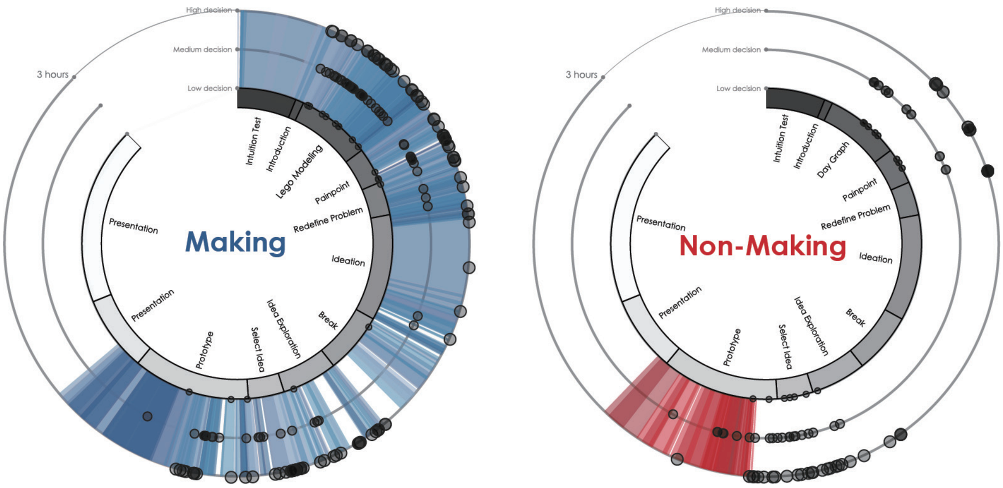

Figure 4 Making VS Non-Making decisions and time making

The center of each graph illustrates the 12 sections of the workshop in time-order, and the respective timeslots across the 3-hour workshop session are also indicated in Figure 4. The three categories of decisions grow radially from the center of the graph, with the size of the circle used to mark the decision in the workshop increasing from small (Low-level decision) to larger (High-level decision). As indicated in Figure 4, the total frequency of decision in the Making condition was higher (f=184), compared to the Non-making control (f=99). This is unsurprising as the Making condition consisted of four teams, with the Non-making control group consisting of only two teams. Likewise, in terms of High-level decisions, as indication of intuitive decisions, a total of 96 (f=96) were identified in the Making condition, compared to 42 (f =42) in the Non-making condition. These results are further illustrated in Table 3 below.

Table 3 Absolute frequency of decisions across the 3 decision types and between the two conditions.

	Frequency Decisions		high	medium	low
Non Making	Team A–nm	53	20	22	11
	Team B–nm	46	22	14	10
	total	*99*	*42*	*36*	*21*
Making	Team A–m	49	26	14	9
	Team B–m	60	31	25	4
	Team C–m	36	18	16	2
	Team D–m	39	21	13	5
	total	*184*	*96*	*68*	*20*

In terms of the absolute frequency of High-level decisions, Team B-m (Making) achieved the highest frequency (f=31), while Team C-m (also Making) had the lowest frequency (f=18). In fact, across High-level decisions, as indication of the application of intuition, the analysis of decisions per team indicated limited difference between Making and the Non-making control. The two Non-making control teams both achieved frequencies of f=20 and f=22 High-level decisions. In rank order of frequency of High-level decisions per team, the two Non-making controls placed 3rd and 5th. This result suggested the Making condition had a limited impact upon the frequency of High-level decisions per team, with the Non-making control (x=21, SD=1.41) and Making (x =24, SD=5.7) conditions being comparatively similar.

Contrary to our assumption, the Making condition did not lead to a significant increase in High-level decisions per team compared to the Non-making control condition. When measured as frequencies of decisions per team, the Making condition did not result in significantly (qualitatively speaking) increased frequency of High-level decisions. Ergo, the Making condition had a limited effect in enhancing the application of intuition. Similarly, when considering the total decisions made in the workshops, Team A-nm and Team B-nm in the Non-making control condition achieved frequencies of f=53 and f=46, respectively. In contrast, in the Making condition, Team A-m recorded f=49, Team B-m f=60, Team C-m f=36, and Team D-m f=39.

To further explore the application of intuitive decision making, we analyzed the frequencies of decisions per individual participant across the six teams in both Making and Non-making conditions due to the uneven distribution of participants within the teams, we calculated the mean value (x) of decisions per participant (Table 4). The purpose of this analysis was to investigate whether the Making condition led to increased frequencies of High-level decisions per individual participant, indicative of the application of intuition.

Table 4 Mean and Standard Deviation of decisions across the 3 decision types and between the two conditions

	Mean Decisions per Participant		high	medium	low
Non Making	Team A–nm	18.5	6.0	9.0	3.5
	Team B–nm	16.0	7.5	5	3.5
	Mean		*6.7*		
	Standard Deviation		*.75*		
Making	Team A–m	16.3	8.6	4.6	3
	Team B–m	20	10.3	8.3	1.3
	Team C–m	18.0	9.0	8.0	1.0
	Team D–m	19.5	10.5	6.5	2.5
	Mean		*9.6*		
	Standard Deviation		*.81*		

In the Non-making condition, the mean value for total decisions per individual was x=18.5 for Team A-nm and x=16 for Team B-nm, with mean values of High-level decisions of x=6 and x=7.5, respectively. In the Making condition, when calculating the mean value of High-level decisions per participant per team, we found all mean values to be higher in the Making condition compared to the two Non-making controls (Table 4). Specifically, participants in the Making condition tended to make more High-level decisions than those in the Non-making condition. The mean value of High-level decisions for all participants in the Non-making condition was x=6.7 (SD=0.75), while in the Making condition it was x=9.6 (SD=0.81) (Table 3).

This result extended findings from an analysis of High-level decisions per team (Table 4). While the frequency analysis of decision per team suggested the more modest impact of the Making condition on High-level decisions, our analysis of High-level decisions per participant provided more compelling evidence of the Making condition's influence on the application of intuition. Specifically, the mean values of High-level decisions per participant were higher in the Making condition compared to the two Non-making control teams (Table 4), indicating that individuals in the Making condition tended to make more High-level decisions. Moreover, the mean value of High-level decisions across all participants in the Making condition was significantly higher than in the Non-making condition (Table 4), demonstrating the substantive impact of the Making condition on the use of intuition in the design thinking workshop.

However, our analysis also revealed that the application of intuition varied among individual participants within the Making condition's four teams, as indicated by the standard deviations from the mean.

4. 2. Distribution of decisions between making and non-making conditions

Because of the nature of the workshops and the variation in activities between Making and Non-making conditions, it was anticipated that there would be more making in the Making condition. Figure 5 shows where making was expected to take place, highlighted with grey shade.

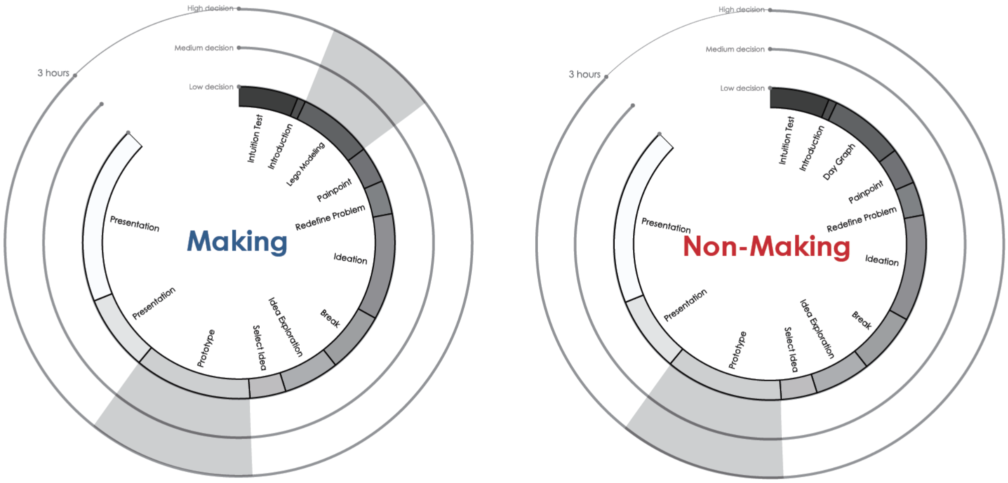

Figure 5 Expected segments of making during the workshops.

As indicated in Figure 5, making activity was anticipated in the Non-making condition during the prototyping stage and in the Making condition, at the Lego Modeling stage as well as in the Prototyping stage.

Figure 3 provides an analysis of the time spent making throughout the workshop sessions and across the 6 teams, with color coding indicating the engagement of participants in making activity. Red color indicates Non-making condition, while blue represents the Making condition, with darker hues indicating more members' engagement in making activity. By comparison to Figure 4, we can see how making activity took place outside of the expected times and stages of the workshop in the Making condition. For example, across the 4 teams in the Making condition (Teams A-m, B-m, C-m, D-m), making extended beyond the Lego making activity stage to the Pain point activity, Problem Redefinition, Ideation, and Idea Exploration.

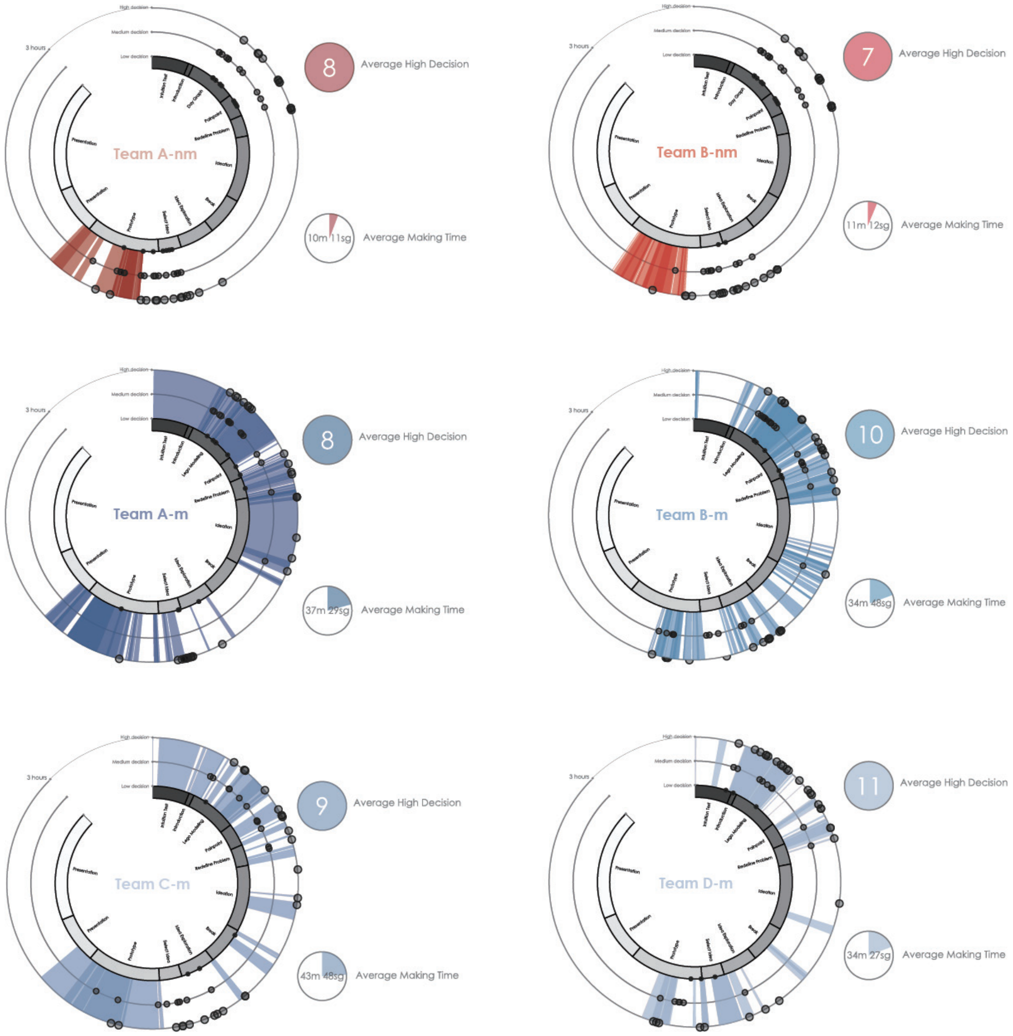

Figure 6 Making teams are in blue, while non–making teams are shown in red.

For Team A-m, making activity (Figure 6, left) began from the start of the workshop and continued until the Ideation phase, with a break during the Participation section. Some fragmented making activity was also seen in the Idea Exploration section and Select Idea phase. Making intensified during the Prototyping stage of the workshop, as expected. For Team A-m, making was most intense (as indicated by darker blue) during Lego Making and Prototyping phases. Fragmented intensity also appeared during Redefine Problem and Ideation phases.

Team B-m (Figure 6, right) exhibited a more widespread distribution of making throughout the workshop sections compared to the two control teams in the Non-Making condition (Figure 6, top). However, in contrast to Team A-m, Team B-m showed fragmented making activity from the beginning of the workshop to the Lego Modeling section. Making activity then continued through to Ideation, where it again tailed-off, to re-emerge later in the Ideation section. This contrasted with Team A-m, who's making activity continued throughout the Ideation section. The team continued to sporadically engage making activity across Break, and Idea Exploration phases, before increasing in intensity during Prototyping. Additionally, the absolute time spent making for Team B-m was reduced (∑t = 34m 48s), compared to Team A-m (∑t = 37m 29s).

For Team C-m, (Figure 6, left-bottom), like Team A-m, making activity commenced from near the start of the workshop. It then continued across Introduction, Lego Modeling, Pain point, and Redefine Problem, but with increased fragmentation across the two later phases. Team C-m engaged some limited and sporadic making activity during Break, the start of Idea Exploration, before increasing in intensity during Prototyping and into the Presentation phase.

Interestingly, for both Team A-m and Team C-m making activity commenced from near the start of the session, and extended beyond the Prototyping phase, and into the Presentation section. In contrast, for Teams B-m, and D-m limited making was engaged in Intuition Test, with no making undertaken beyond the first half of the Prototyping section.
For Team D-m, making only extended as far as half-way through the Lego Modeling section, with two very limited making episodes in the section's second half. Making was re-engaged near the start and end of Paint Point and bled into the beginning of the Redefine Problem section. Limited making briefly reemerged during Ideation and Break. Sporadic and fragmented making was also undertaken during Idea Explanation, Idea Selection, and Prototyping itself. Team D-m engaged the least making activity compared to the other three teams in the Making condition (∑t =34m 27s).

In our analysis of making activity across the sections of the workshop, we also looked at any relationship between making activity and the location of high-level decisions.

The results showed that, across the four teams in the Making condition, there were more High-level decisions during making activity. Team A-m had a total of 26 High-level decisions, with 22 during making activity. Team B-m had a total of 31 High-level decisions, with 26 during making activity. Team C-m had a total of 18 high-level decisions, with 7 during making. Finally, for the making condition, Team D-m had a total of 21 High-level decisions, with 12 made during making activity. However, it is not clear whether making activity led to an increase in the propensity to take High-level decisions or whether an increase in High-level decisions led to more making activity.

In contrast to the four teams in the Making condition, the two teams in the Non-making control showed significant differences in the distribution of making and location of High-level decisions.

Team A-nm and Team B-nm did not engage in any making activities until the Prototyping phase of the workshop. For Team B-nm, making activities were limited to the Prototyping section only. In contrast, Team A-nm extended their making activities into the Presentation stage. Only one High-level decision was made during making activities for Team B-nm, while Team A-nm had two during making. The limited location of making activities in the two control teams was expected, as the Non-Making condition provided fewer opportunities for making. This limited opportunity to make may have contributed to the reduced number of High-level decisions made during making activities in the control teams.

However, there may be more to this than simply the result of less making in the Non-making condition. When we examined the distribution of making and High-level decisions between teams in the Making and Non-making conditions, for the teams in the Making condition, making emerged at various phases of the workshop, extending beyond the initial making activity and between the making activity and prototyping (less so for Team D-m, but still present). It was interesting to us that the initial making activity appeared to stimulate increased making during subsequent sections of the workshop. This suggested that the Lego making primer activity, did work as catalyst for increased making throughout the workshop. But with the caveat that the degree of increase depended upon the different teams. For example, the effect appeared least impactful for Team D-m's subsequent making activity during the session, although still having some impact. We are able to make this claim by comparison with the two teams in the Non-making control. While Teams A-nm and B-nm had access to making materials throughout the workshop, their making was largely confined to the Prototyping phase.

Comparing the distribution of High-level decisions and making activity between teams in the Making and Non-making conditions, we observed an increased distribution of High-level decisions in the Making condition compared to the Non-making control. In the Non-making condition, no High-level decisions were made during the Ideation or Break phases of the workshop. In contrast, during the Ideation section, Team A-m engaged in making activity throughout the section and recorded four High-level decisions. Teams B-m, C-m, and D-m recorded two, three, and one High-level decision, respectively, during their Ideation sections. However, the two teams in the Non-making control did not make any decisions during the Ideation phase. The analysis of the distribution of decisions and High-level decisions across the Making and Non-making conditions (see Figure 6 above) shows that the distribution of decisions is more dispersed across the entire workshop in the Making condition, while decisions in the Non-making condition are confined to the first and final thirds of the workshop.

In Table 5 below we provide objective statistics to show total time engaged in Making and Non-making conditions across the 6 teams.

Table 5 Total Time during the workshops

	Total time	
Non Making	Team A–nm	30m 42 s
	Team B–nm	33m 41 s
	total	*1h 04 m 23 s*
Making	Team A–m	1h 52m 27 s
	Team B–m	1h 44m 24 s
	Team C–m	1h 26m 16 s
	Team D–m	1h 8m 27 s
	total	*6h 12m 00 s*

The total time making in the Non-making condition for Team A-nm was of 30 minutes and 42 seconds. While Team B-nm made for 33 minutes and 41 seconds. This brings the total making time in the Non-making condition to 1 hour 4 minutes and 23 seconds. For the Making condition, Team A-m had a total of 1 hour 52 minutes, and 27 seconds. Team B-m made for 1 hour 44 minutes and 24 seconds; Team C-m for 1-hour 26minutes and 16 seconds. And Team D-m for 1 hour 8 minutes and 27 seconds. This brings a total time making to 6 hours and 12 minutes in the Making condition. In terms of time spent making, Team A-m spent the most time (∑t=1h 52 m 27 s) and Team A-nm spent the least amount of time Making (∑t = 30 m 42 s).

To obtain a comparable distribution per participant, since not all teams had the same number of participants, we also calculated the mean making time per participant (Table 6).

Table 6 Mean time spent making per participant.

		Mean time per Participant
Non Making	Team A–nm	10m 14 s
	Team B–nm	11m 14 s
	Mean	***10 m 29 s***
	Standard Deviation	***30 s***
Making	Team A–m	37m 29s
	Team B–m	34m 48s
	Team C–m	43m 8s
	Team D–m	34m 27s
	Mean	***37 m 12 s***
	Standard Deviation	***3 m 28 s***

In the Non-making condition Team A-nm's Mean making time was 10 minutes and 14 seconds per participant, Team B-nm's was 11 minutes 14 seconds. The Non-making condition mean time per participant was (x=10m 29s, SD=30 s). For the Making condition, Team A-m's mean was 37 minutes and 29 seconds, Team B-m's 34 minutes 48 seconds, Team C-m's 43 minutes and 8 seconds, and Team D-m's 34 minutes and 27 seconds. This resulted in a mean value for the Making condition (x=37 m 12s, SD=3m 28 s).

The analysis of mean time spent making per participant per team showed that there was less variation between teams in each condition, highlighting the impact of workshop format on making activity. The results further demonstrated that the Making condition facilitated a greater distribution of decisions throughout the workshop and increased making activity across different workshop sections. This finding was unexpected and intriguing, as it suggests that making not only leads to more making but also prompts more frequent and High-level decisions. This supports our assumption that making promotes intuitive decisions, as evidenced by the increase in both making activity and high-level decisions in the Making condition.

4. 3. "N" participants tend to make more high-level decisions.

We identified variation in the number of High-level decisions made on an individual level which we attributed to the participants' involvement in the Making or Non-making condition, with Making participants shown to have more decisions and High-level decisions. However, we also found variation in the number of decisions per participant within condition, and across teams. Of course the individual participants brought to the workshop their own intuition and various propensity to use it during the workshop. To understand the potential influence of the individual on the emergence and application of intuition we administered the MBTI (S-N) segments of the Myers-Briggs Type Indicator (MBTI) test at the beginning of the workshop. We then reviewed each participants' MBTI (S-N) test result.

In Table 7 we show the participant's MBTI(S-N) result, their team, the condition they participated in and the total frequency (f) of their individual High-level decisions during workshop.

Table 7 Participants MBTI and Decisions during workshop

	Team	Participant	MBTI	High decisions
Making	Team A–nm	A	N	16
		B	S	6
		C	S	4
	Team B–nm	D	S	8
		E	N	10
		F	S	13
	Team C–nm	G	N	13
		H	N	5
	Team D–nm	I	N	11
		J	N	10
Non–Making	Team A–nm	K	S	12
		L	S	4
		M	S	4
	Team B–nm	N	S	7
		O	S	6
		P	N	9
		Mean of High Decision		8.9
		Standard deviation		3.7
Total Participants	N	7	S	9
Frequency High Decisions		74		64
Mean of High Decision		10.57		7.11
Standard deviation		3.13		3.17

For all 16 participants (N=16), we calculated the mean value of High-level decisions (x= 8.9, SD=3.7). Of the 9 S-sensitive participants, 7 had an absolute frequency of high-decisions lower than the sample mean. Of the 7 N-intuitive subjects, all bar one (Participant H, f=5) had a frequency of High-level decisions greater than the sample mean. This result indicated a tendency for N-intuitive participants to achieve a frequency of High-level decisions above the sample mean. In contrast, S-sensitive subjects tended to achieve a frequency below sample mean. These findings suggest a potential relationship between intuition and decision-making, as measured by the MBTI (S-N) segments. Participants who scored higher on the N-intuitive scale tended to make more High-level decisions compared to those who scored higher on the S-sensitive scale.

We also calculated the Mean value of High-level decisions for N-intuitive subjects (x=10.57, SD=3.4, f=74). This contrasted with the S-sensitive participants' mean (x=7.11, SD=3.37, f=64). This result again showed participants self-reporting as N-intuitive achieved a greater frequency of High-level decisions compared to S-sensitive subjects.

While our previous result (see section above) indicated the Making condition as influence upon High-level decisions, our analysis of the pre-workshop intuition text results shows how the participant's existing propensity toward the use of their own intuition also influenced their use of intuition in decision making during the DT workshops.

We assumed that the individual's existing intuitiveness would influence their use of intuition during the workshop. This result supports our assumption and is less surprising to us. However, taken together with our presentation of results in the previous sections, findings indicate a mix of making and a prior intuitiveness as dual drivers for the application of intuition. The result also suggests that even for participants with reduced inclination to apply intuition (i.e. S-sensitive), the Making condition acted to stimulate the application of intuition during the DT workshop. We can see further evidence of this claim if we look at the mean value of High-level decisions by S-sensitive subjects in the Making condition (x=7.75, SD=3.86), compared to the Non-making condition (x=6.6, SD=3.29). Although we also confess the limited number of data-points (and resulting high deviation from the mean) make this insight tentative.

4. Discussion

In this study, we aimed to explore the role of intuition in Design Thinking (DT) workshops and test if introducing a making activity at the start of the workshop could encourage participants to engage their intuition. Peck (2011) in his work on haptic study in marketing describes that information can be extracted by the use of hands, this study agrees with this since the addition of the making activity at the beginning of the workshop appears to have helped the participants bring their expertise and knowledge to the empathy stage of the workshop.

Firstly, the Making condition led to more High-level decisions than the Non-making condition, indicating that making acts as a stimulus for the application of intuition in a DT workshop context. We suggest that if the use of intuition is to be encouraged during a DT workshop, a making activity can be introduced at the beginning stages of the workshop. Taura and Nagai (2017) in their creativity in innovation study suggest that intuition and decision are closely linked, this study supports this position. When participant's intuition is stimulated it correlates with the number of High-level decision taking place. Our findings also indicate that a making activity as primer at the start of a workshop can enhance the distribution and frequency of making and the application intuitive judgment.

Second, participants who self-reported as more intuitive tended to have more High-level decisions than those who self-reported as sensitive according to the MBTI test. This finding suggests that participant characteristics are important to consider in DT workshops, as intuitive participants tend to make more use of their intuition regardless of the workshop condition.

5. Conclusions

Our assumption was based upon the first author's extensive experience coordinating DT workshops in industry settings. The results of our study provide several insights that answer the research question: Can making act as a stimulus for the application of intuition in design thinking workshops? Based upon the insights gained from this initial study, we propose a dual drivers approach for the stimulation of intuition. On one hand, stimulation of intuition through making and the use of embodied cognition. And on the other, the participant's predisposition to use their intuition. For example, in the results we found participants that both self-reported as more intuitive and participated in the Making condition, were more inclined to apply their intuition, as indicated by the quantity and distribution of high decisions individually taken.

The study's limitations include the use of a specific DT methodology (IDEO) and the use of a specific material (LEGO). Additionally, all participants were (UNIST), design graduate students. Because designers are comfortable with the DT process, it would be of interest to run a similar study on non-design participants. Due to the limited scale of this initial study, further investigation of the validity of our proposed dual drives for intuition are also now required.

In conclusion, the study's results support the use of a making activity to stimulate the application of intuition in DT workshops. This finding supports the initial assumption that if the participants intuitions want to be engaged in DT workshops making activity provide enhanced opportunity for intuitive decisions The proposed dual drivers approach of making and the participants intuitiveness provides a framework for understanding the role of intuition in DT, with future research exploring the approach's effectiveness with non-design and design participants, in various industry and academic contexts. Future studies to further develop this framework could include replicating the workshops with non-designers, and then comparing results with the current study. Future works could also include investigation of how personality, background, or specific professionalism influence our dual driver approach to intuitive decisions in DT. Varying the making materials, time, and making activity as primer could also provide further insights.

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