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Narrative drives design decision-making

Scott Ferguson [1,✉], Lisa Retzlaff [1], Kris Bryden [2] and Kenneth Mark Bryden [2]

[1] North Carolina State University, United States of America, [2] Iowa State University, United States of America

✉ scott_ferguson@ncsu.edu

Abstract

Scholars in economics, psychology, and business have recently defined narrative as the underlying mechanism by which humans internally process information and drive a decision forward. In this paper, we study narrative's use in design across Design Society publications. We discuss how narrative's role as the driver of design decision-making is an important, but missing, element of the design literature. We explain how engineers will be expected to move the design process forward despite facing decisions where the information is simultaneously too much to process, conflicting, and incomplete.

Keywords: decision making, narrative, design cognition, engineering design

1. Introduction

Narrative is a concept used by many disciplines. As a result, there has been a proliferation of definitions, perspectives, and uses of narrative in academic literature. Those scholars who explore narrative under traditional definitions examine how events are represented in the form of a story and how various mediums are used for that story's presentation. These stories then become the foundation of how we explain a situation to others or depict it for ourselves.

Recently—after being motivated by findings in behavioural economic studies—scholars in economics, psychology, and business have argued that narrative is the critical unexamined element in economic decision-making. They define narrative as the underlying mechanism by which humans internally process information so that they can make sense of a decision scenario and develop conviction for a course of action. For example, Tuckett and co-authors—after observing how investment decisions are made—propose a framework for how humans gather, assess, and combine qualitative and quantitative information (Johnson *et al.*, 2023). In their Conviction Narrative Theory this combination process is done so that a conviction narrative can be constructed that leads to action (that is, a decision is made). *Narrative, therefore, becomes the driver that moves a decision process forward.*

As scholars who study engineering and design, we find a (similar) limited understanding around the mechanisms by which engineers and designers process the information available to them and reach a state of action. We find this problem intriguing because decision-making is how engineers and designers commit resources and move the design process forward. We also find that traditional engineering design decision analysis and support tools are limited in how they represent design decisions because they are largely based on defining and optimizing a state space where the design decision can be reduced to a small world frame (Ferguson *et al.*, 2023). Yet, establishing a small world frame and optimizing the decision requires explicit goals, clear outcomes, and the mathematical representation of uncertainties. We find ourselves wondering how it is that design decisions come to be represented in this manner.

We raise this concern as today's engineers and designers are confronted by what has been called a triple crisis—of climate change, biodiversity loss, and pollution (UNEP, 2022). Dramatic and costly changes

in our built environment are required that will involve designing and implementing new power systems, developing and deploying carbon capture and sequestration systems, building carbon-free transportation systems, changing our agricultural practices, and developing new manufacturing processes. Rather than a decadal development cycle, managing these crises will require that such systems are designed, tested, and deployed in years. Design decisions for these systems will result in decision scenarios having

- non-deterministic partially observable events,
- dynamic and changing environments, and
- incomplete knowledge (Anderson, 2015).

Despite this, society will expect engineers to drive the design process forward despite facing decisions where the information is simultaneously too much to process, conflicting, and incomplete. That is, in many (perhaps most) cases, unresolvable uncertainty is a critical part of engineering design.
Researchers and observers of design have historically acknowledged that design is more than assembling numbers, creating a state space that summarizes the results, and identifying the option that optimizes the outcome. Hardy Cross, in describing the work of an engineer, writes

> *"The data must be put together, made into a new assembly that involves a large imaginative element, put together with due respect to the relative importance of the elements and to the probability of simultaneous occurrence; and all of this must be done with* ***some intuitive vision of what is wanted and what can be got*** *[emphasis ours]."* (*Cross, 1952*)

Similarly, Petroski describes the engineering design process "as a fundamental human process that has been practiced from the earliest days of civilization." He goes on to say,

> *"Mathematics and science help us to analyze existing ideas and their embodiment in 'things,' but these analytical tools do not in themselves give us ideas. We have to* ***think and scheme about nature and existing artifacts and figure out how they can be altered and improved*** *[emphasis ours] to better achieve objectives considered beneficial to humankind."* (*Petroski, 1996*)

This phenomenon of "intuitive vision" (Hardy's words) and "think and scheme … and figure out" (Petroski's words) is often called engineering judgement but is left undefined beyond acknowledging its existence. The question is, then, can scholars studying design develop a frame for studying the

- critical aspect of information processing that occurs in decision-making,
- reporting and sharing of decision-making by designers, and
- development and assessment of tools that implement the findings of our studies?

We have previously posited that "narrative" is a critical element of the design process and provides the frame for answering these questions (Bryden and Ferguson, 2021). Toward finding evidence that supports this argument, we review and characterize how the word *narrative* has been used in Design Society publications. Our objective is to construct a definition of narrative that fits design. From our review, we identify and describe five themes around narrative and discuss how narrative's role as the driver of design decision-making is an important, but missing, element of the reviewed literature. We used this finding to describe why new strategies are needed for observing, characterizing, and documenting the dynamics of information processing associated with the narrative process.

2. A review of narrative in Design Society literature

Scholars in other disciplines are interested in narrative through the lens of explaining how humans frame the decision problem, process information, and develop enough conviction so that they can reach a state of action. Toward understanding the decisions made during the design process, we are particularly interested in the dynamics of information processing. Yet, it is not clear how well design papers describe narrative's role in this process. Toward this end, a literature review and thematic analysis were conducted of papers published by the Design Society where the term *'narrative'* is used.

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2.1. Summary of review process and theme identification

We used the following process in conducting our review:

- Using a keyword search of the term 'narrative,' we searched the publication repository on the Design Society website. This search returned 39 papers.
- As a first pass, we reviewed the 39 papers by searching for the keyword 'narrative' within each document. Eight papers were removed from consideration, with some removed because they did not contain the word 'narrative' in the text. Others were removed because the focus of the paper was not design-oriented even if they had the word narrative somewhere in the manuscript.
- The remaining papers were then read and reviewed by the authors. Of the remaining 31 papers, two were removed because they 1) introduced the term meta-narrative, but no definition for this term was provided, or 2) used narrative once, in a list where the author referred to how a model can exist in various forms such as sketching, physical prototypes, frameworks, photographs, CAD drawings, equations, or narratives.
- Thematic analysis was used to identify inductively generated themes after reading the remaining 29 papers to explain the ways that narrative is used in Design Society literature.

The 29 papers we reviewed spanned six conferences with publication dates ranging a seventeen-year span from 2006 and 2023. The number of papers associated with each conference is listed in Table 1. A third of the papers were published within the last five years (2019-2023).

Table 1. The 29 reviewed papers have been presented at six Design Society conferences

Conference	Number of papers
International Conference on Engineering and Product Design Education	13
International Conference on Engineering Design (ICED)	5
International Design Conference (Design)	4
NordDesign	3
International Conference on Design Creativity (ICDC)	2
International Conference on Research into Design Engineering	2

Five themes were inductively identified from our literature review: customer need identification, storyboarding, product design, sequencing, and future forecasting. In the following sub-sections we discuss each theme in the context of the literature we reviewed.

2.1.1. Customer needs identification: Narratives as the customer's voice

The identity of an individual and how they internalize the world around them becomes a key component in both narrative inquiry and narrative theory. *Narrative inquiry is defined as a method used to examine the experience of an individual* (Brewis, 2015; Clandinin and Huber, 2010). *Narrative theory is used to describe how people "make sense of the world" via the use of stories* (Project Narrative, 2023). Liquete et al. (2021) use narrative inquiry to investigate how many engineering graduates in the UK chose not to become practicing engineers after graduating because they had not yet developed their professional engineering identity. Pucillo et al. (2014) extract customer motives from online reviews (stories) about running shoes to gain insight into customer feelings and inform designers about the user experience.

Narrative from potential consumers, presumably as a dialogue, is explored by Brace and Thramboulidis (2010) to formalize design requirements. Yet, this dialogue may not contain all information needed for the design process to begin. In such situations, the designer must internalize customer requirements based on the provided narrative (dialogue). Designers must also establish their own voice. A study conducted in a fashion and textile design course explored whether students were able to more freely experiment if they had constructed a more positive and affirming perception of themselves (Høgh-Mikkelsen, 2022). This establishment of a growth mindset, or internal voice, reduced their fear of making mistakes. Additional studies found that some students felt more comfortable with the unknown, and with possible failure, when they could let situations guide their thinking (Hall et al., 2016).

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2.1.2. Storyboarding: A design tool for communicating a narrative

Narrative appears frequently with storyboarding and is found to be interrelated with the idea of the *storyteller*. The idea that the storyteller is responsible for establishing a connection between the scenes taking place via the medium and the audience is essential; otherwise, the message cannot be internalized by the audience (Hoftijzer et al., 2020; Lewis and Coles-Kemp, 2014). Howell et al. (2023), for example, assert that audience receptivity is altered by the presentation flow and the medium used.

Storyboarding also has applications in a product design context, especially when there are multiple individuals working on the same product. The creation of a product story helps avoid confusion and miscommunication. That is, it helps build consensus (Cobreros et al., 2023; Innella and Gatto, 2022; Tully, 2023). This is particularly important for a team with multi-disciplinary personnel (Smith et al., 2010). Storyboarding helps explain what a product will be and who will be working on it, and establishes a common frame of understanding amongst all team members (Stompff et al., 2011). Further, storyboarding allows individuals to focus on one element of the problem at a time so that they do not become distracted by the end result (Andersson et al., 2011; Wikstrom and Verganti, 2013).

2.1.3. Product design: Communicating a narrative through products and artifacts

Our designs tell a story. If the customer base does not resonate with this story in the intended way, the value of the product decreases (Howell, 2010; Howell and Christensen, 2011). An example of an abstract, SLS-printed chair design is described as a vessel for highlighting how typical manufacturing methods may become less relevant because of additive manufacturing. The designer's intent was to convey messages about the design possibilities offered by new manufacturing technologies, and how such technologies could reduce material use and waste. Yet, if a customer is not concerned about sustainability, material use, or interested in abstract design, the product loses value in their eyes. The notion that products contain a narrative is critical to consider during design, especially when designing products that are intended to emotionally appeal to customers (Maclachlan et al., 2010).

We also found instances of narrative assisting visualization and ideation efforts. Students were instructed to select a meaningful (to them) object and combine it with a contemporary design trend (Howell and Christensen, 2011). Students re-visualized the narrative of their selected product and developed a new, innovative design. Simpson and Macaulay (2006) gave their students a project where narrative had to be used with visualization and the act of making to "create a method that would provoke a spoken dialogue between the three activities." Students were asked to create a stop-frame animation creature. The scenarios in their stories were inspired by famous creature stories and their animations drew inspiration from famous stop-motion animators. That is, they were guided by past experiences.

The term *narrative jewellery* is introduced by Pereira and Tschimmel (2012) to reflect the intended message that may be communicated to the viewer by the wearer.

2.1.4. Sequencing: Using narrative to establish a timeline of events

Unlike other design tools, narrative is temporal. Childs et al. (2013) define narrative as a sequence of events that occur over time. They note that narrative is used to communicate not only the story of certain characters but also the "setting of a proposed or designed object." Eng et al. (2008) assert that "narratives are a structure that enables the presence of a story" and that the story has an experiential component." Pimenta and Poovaiah (2009, 2011) explore static visual narratives, a story consisting of a sequence of events and the form in which that story is presented. Time becomes a trajectory within the space. Attenburrow (2012) uses sequencing to develop a design decision trail intended to document the timing of critical design decisions in a student's project. A visual narrative captures the student's thinking and methodology in the form of a sketchbook, which is analogous to a diary of the process.

2.1.5. Future forecasting: Narratives about the impact of possible futures

Three papers discuss how narrative plays an important role in imagining and forecasting possible futures. Alvarado (2022) describes how expectations in narratives play an important role as they "legitimize, inform, and coordinate efforts" and help "people anticipate and act regarding what they think could happen." The alignment between narrative and worldbuilding is also discussed, in that

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narratives become the stories we tell ourselves to attain coherence about "probable, possible, desired, and undesired futures." Hansen et al. (2011) integrate narrative simulations and numerical simulations to address the overly simplified assumptions and outcomes associated with agent-based models. Narrative simulation—or Interactive Scenario Analysis—focuses on scenario development between decision-makers, planners, and stakeholders so that all involved can have a picture of "what might be" and "how to get there". We (in Ferguson et al., 2023), explored how uncertainty impacts our ability to envision futures and questions when it is appropriate to convert a messy decision scenario (a large world frame) into a decision scenario where the state space can be fully defined, and probabilities assessed (a small world frame). These papers align with the concept of decision-making described in Section 1.

2.2. Summary of literature review findings

Five distinct themes characterize how the 29 papers use the word narrative in design contexts. In *customer need identification*, narrative reflects the customer's voice expressed as a dialogue or written story. The six papers placed in this category describe how designers can glean insights from dialogues and stories because they reflect the customer's experience and their act of sense-making. Ten papers conveyed the theme of *storyboarding*. In this category, narrative conveys how designers describe information to others or create consensus amongst members of the design team. Focus in placed on how the message is externalized to an audience and the medium by which the message is conveyed. In total, 16 of the 29 papers describe narrative in design as a formalized story or account of perspective, or a means of presenting a situation or series of events to reflect a particular point of view.

Five papers discussed how our *product design* efforts tell a story and reflect a set of values. Researchers acknowledge the interplay between the intended message of the designer and the message perceived by the consumer/audience. Five papers also discuss the importance of *sequencing* events. This use of narrative aligns with the traditional definitions of storytelling. In a story, the sequencing of events helps convey a message and provides a particular perspective.

The theme of *future forecasting* describes an internal narrative process of envisioning what is possible, and probable, given the information that the decision-maker has internalized. The three papers in this theme acknowledge the dynamic process by which information is processed, possible outcomes are envisioned, and decision frames are constructed. Rather than making sense of external information (*customer need identification*), *future forecasting* makes sense of the designer's internal information.

In the next section, we align the reviewed design literature with the historical framing provided by narratology research. We use this to motivate why the focus on internal information processing, future envisioning, and committing to a course of action represents the future of narrative research in design.

3. Alignment of Design Society literature with narratology research

A traditional definition of narrative that captures its essential elements is given by Peter Abbott from the field of narratology: "Narrative is the representation of events, consisting of story and narrative discourse" (Abbott, 2008). He states that story consists of "the events and the entities" (both animate and inanimate). Narrative discourse is then about how the story is constructed and the medium used for its presentation. We see these uses of narrative and narrative discourse reflected in the Design Society papers we reviewed with the themes of *storyboarding* and *customer need identification*.

For a narrative to be interesting and fulfilling, it should establish causality and provide a sense of normalization and closure. This aligns with the concepts we identified in the Design Society papers focused on *sequencing*. Many of the early studies by narratologists focused on the structure of narratives (how narrative elements are organized and ordered) and on finding universal attributes for all narratives. Vladimir Propp (1928), who is credited by many with laying the foundations of the field of narratology, analysed plot components of Russian folktales and their underlying narrative functions; that is, possible actions that are commonly used in all narratives regardless of historical or social contexts. Later, Roland Barthes (1975), drawing on linguistics and other narratologists, developed themes to classify the various units within narrative and a grammar to explore how these units are linked together.

This focus on, and interest in, developing a universal theme for how narratives are constructed resulted in a shift toward exploring the meaning of the narrative itself and the role of various narrative elements. Ruth Ronen characterizes the shift to meaning as “a more dynamic and eclectic view of narrative

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organization" (1990, pp. 840). Going to a more broad view of finding the meaning in a narrative as a whole, Toolan's discussion of *coherence in narrative* points out that several recent works (e.g., Gerrig, 1993; Herman, 2009; Ryan, 1991) put forth the idea that "for a full understanding and experiencing of a narrative, the interpreter must reconstruct a story world . . . or mental model, a rich projection of the entire, developing situation in which events, characters and their variously motivated actions are embedded" (Toolan, 2013). Addressing the use of narrative for constructing meaning, Tsoukas (2005) explains that narratives present meaning as something that emerges rather than something that already exists. According to Bruner, this emergent meaning occurs in three ways: (1) it triggers presuppositions, which create implicit rather than explicit meaning. (2) It subjectifies by providing stories from the perspective of the protagonist, and (3) it provides multiple perspectives (Bruner, 1986, pp. 25-26).
It is this shift toward, and identification of, narrative as a means for constructing meaning and establishing coherence that we find particularly intriguing for design research. The view that narrative is the elusive process by which we navigate decision-making for entangled, complex, and ill-defined systems and situations is consistent with recent discussions by scholars in economics, psychology, and business. Arguing that people do not think probabilistically, but rather approach murky, uncertain decisions from the perspective of sense-making, Kay and King write

> *Narrative reasoning is the most powerful mechanism available for organizing our imperfect knowledge. Understanding the complex world is a matter of constructing the best explanation - a narrative account - from a myriad of little details and the knowledge of context derived from personal experience and … others." (Kay and King, 2020)*

It is this aspect of narrative—narrative reasoning—that we see only marginally represented, or studied, in the reviewed Design Society literature or in design discussions elsewhere. However, the papers from our review offer a pathway toward this goal. We explore this claim in the next section.

4. Narrative as a driver of design decision-making

Designers make decisions throughout the entirety of the design process. Complicating matters is that design decisions are often messy. Schön has described how engineers look for "a coherence that guides subsequent moves" (Schön, 1988) while Cross claims that engineers know that the information available to them (analysis, experiments, and experience) are "merely evidence bearing upon their problem, to be judiciously weighed in drawing conclusions" (Cross, 1952). The challenge that designers face is that they often have too much information, the information may be incomplete and conflicting, and that time and resource constraints limit how this information can be processed.
Narrative has a presence in both internalization (understanding) and externalization (storytelling). It becomes the mechanism by which we make sense of events and the world, how we connect our goals and plans, and how we share our ideas and products. Based on our review of Design Society literature, our exploration of narratology research, and the recent work of scholars in economics, psychology, and business, we posit that narrative plays four major roles in engineering design. These four roles are similar to the three ways (analysis, simulation, consensus) in which MacKenzie et al. (2020) propose narrative can be used in engineering design decision-making. Narrative is the way that we:

1. *Understand a situation* (the past and present) by processing and linking information.
2. *Imagine and forecast* possible futures to understand the outcome of our design process.
3. *Communicate* our beliefs, values, perspectives, and solutions to others.
4. *Manage our commitment* to a course of action over time.

Given these four roles of narrative, we revisit the extent to which each role is represented by the Design Society publications that we reviewed. We also identify where there are opportunities in each role for additional research, and why this research is important for design.

4.1. Understand a situation

The themes of *need identification* and *sequencing* address how we process and link information to understand a situation. Sixteen of the 29 papers were classified in these themes. *Need identification* is an internalization of others' narratives (an external source) through processing and sense-making.

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Sequencing describes the order in which decisions are addressed, in that it frames the problem and introduces an aspect of prioritization. Framing and prioritization are components of sense-making that connects how our understanding of the past and present influence our current actions.

Engineering judgement is also an important part of sense-making, and an important part of narrative. We find limited discussion in our review about how designers bring together and understand pieces of information. This internalization process is complicated by the fact that designers will often begin with too much information, must evaluate each piece of information (requiring assessment on the content, the presentation, and the trustworthiness of the information), and then decide which pieces of information to keep and how much to weigh them. As designers tackle societal-level challenges and vast sources of information become available with the increased use of machine learning tools, this internalization process requires more attention. Design tools are needed that 1) support designers in evaluating and linking information during this internalization process, and 2) communicate to others how designers navigated this process, providing transparency into how the design process unfolded.

4.2. Imagine and forecast

The act of imagining and *forecasting* possible futures in an internal process is unique to each decision-maker. This envisioning process is based on analysing information about agents and events, prior experience, and creativity. Only three of the 29 papers focused on the role of narrative in this step. However, each paper—directly or indirectly—acknowledges that designers will face decision scenarios where uncertainties cannot be fully resolved. In Ferguson et al. (2023), this discussion focused on the distinction between small and large world frames. In Alvarado (2022), 'open futures' describe the important role that narrative (and expectations around narratives) play in this envisioning process.

With the emergence of engineered systems in society, designers must consider how such systems will evolve and adapt given unknown futures. This calls into question how designers optimize their decisions, if they can, and how design tools can assist in the modelling of options and likelihoods when probabilities are no longer available. Gaining insight into how designers imagine and forecast futures in these scenarios is necessary to understand how system architectures are defined and evolved over time.

4.3. Communicate

Once a decision is made, designers must then communicate their beliefs, values, perspectives, and solutions to others. Ten of the papers reviewed address some form of how we communicate our narratives through various media. When communicating, the medium plays a significant role in how others make sense of the information being conveyed. *Storyboards* are one way that designers can communicate their personal (internal) understanding of the situation to other designers and stakeholders. The products that are embodied from our design process are also a form of communication and an expression of our beliefs and values. While we may try to convey a message with a particular product, each individual perceives the product differently based on their past experiences and judgement.

While designers communicate to others through the product, they also communicate through presentations, reports, and documentation. In all cases, a designer internalizes information and expresses a narrative through some form of externalization. This narrative is then internalized by the recipient. We find limited discussion of how to best communicate our beliefs. Research is needed into how narratives help us build common understanding and consensus, even when individual narratives conflict.

4.4. Manage our commitment

Finally, narrative is also how we manage our commitment to a course of action over time. If we realize our current course will not lead to a desired outcome, we explore what options are available and make changes. None of the papers reviewed, however, address this aspect of narrative. As we design evolvable, adaptable, just, and sustainable systems, the design problem harder to evaluate and systems will require alteration over time. Our objectives for, and our understanding of the system, will be continuously changing. Initial commitments to action may be challenged. We must understand how designers maintain conviction in the face of uncertainty, and what causes them to choose a new course of action. Scholarship in economics, psychology, and business provide research that can be leveraged.

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Together, these four components of narrative drive the decision-making process. Narrative, therefore, is responsible for the path that a design takes and how the outcome of that process is received by others. Yet, there are many aspects of narrative that require additional investigation.

5. Conclusions and future work

Narrative is a complicated term. In a review of Design Society publications, we identified five themes around narrative—customer need identification, storyboarding, product design, sequencing, and future forecasting. However, these themes do not fully reflect how narrative is used in design decision-making and the use of narrative in engineering design decision-making is an area that requires further research and exploration. Specifically, narrative has not been clearly identified as an element of engineering decision-making, however, it is clear that narrative plays a critical role.

While we find evidence of research into how engineers begin to make sense of a situation, and how they communicate their beliefs and solutions across various media, we find little evidence describing how engineering designers imagine and forecast possible futures (that is, what worlds they are creating) and how they manage their commitment to a course of action over time. We believe that a more complete study of narrative in engineering decision-making requires additional considerations of what we record and capture during the decision-making process, how the dynamics of information processing during future forecasting should be modelled, and how computational methods will allow for the representation of narrative and enable further research.

For example, in considering what we record and capture, Eng et al. (2008) describes how the narrative contained within old engineering design documentation may not be transferred to new design documents. This failure of information transfer results in a loss of valuable knowledge. As our understanding of narrative becomes richer, Bucciarelli warns of a similar loss if we only observe the results of a decision analysis and its accompanying documentation:

> *"…. But the story he constructed is gone. His assumptions, presumptions, tacit feelings, hard-nosed calculations, and confident voice are gone." (Bucciarelli, 1996)*

In the same way, Wikstrom and Verganti (2013) in their research on storyboarding note that closure is inevitably desired after a narrative is presented. Opportunities exist to explore the relationship between closure and managing a commitment to action over time. That is, does the act of choosing an option, and sticking with it, represent a form of closure for the designer as decision-maker? And, if a designer feels the need to "re-open" the decision, how did their understanding of the design situation change?

We posit that narrative fulfils four critical roles in engineering design decision-making—understand a situation, imagine and forecast, communicate, and manage our commitment. Yet, there is little scholarly literature addressing these topics. Further research is needed to understand their role and enable design to more effectively confront the triple crisis of climate change, biodiversity loss, and pollution.

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