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INFORMATION REDUCTION AND STUDIO PROJECT FRAMEWORKS

Richard FRY
Brigham Young University, USA

ABSTRACT
Studio projects increase from simple & straightforward to complex & indeterminate as undergraduate industrial design students' progress through their educational experiences. As project complexity increases, students are faced with information overload and can struggle to move forward in a meaningful way. Complex Problem Solving studies and Cognitive Load Theory suggest *information reduction* as a way to grasp the critical aspects of a problem and move beyond the impasse inherent with too much information. *Segmentation* and *chunking* are common strategies for information reduction but the abstraction inherent in the *chunking* process provides better conceptual understanding. The simplified but meaningful results from the chunking process can then be leveraged to create a model or framework that helps students organise and clarify what they have observed as well as point to new opportunities for design activity.
Despite the fear of oversimplification, significantly abstracted models have great "explanatory or predictive power" and can lead to rich results. Reviewing the concepts of complexity, cognitive load, and contrasting segmentation with data chunking, this paper will then highlight a portion of a student project where information reduction provided understanding beyond initial student impressions and encouraged them to move forward.

Keywords: Frameworks, Information Reduction, Segmentation, Chunking, Insight

1 INTRODUCTION

Studio problems start out clearly defined at the early stages of a designer's educational experience but rapidly escalate to a problem with many variables that have a "degree of interdependency" - one description of a complex problem [1]. Rather than solving clearly stated design problems such as "*design a stool using a 4x4 sheet of cardboard that supports 150 pounds"*, advanced studio projects deal with questions such as *"Why are we losing customers around age 10,"* and *"What type of products would help us retain more of them?"*
Kinni describes the difference between *complicated* and *complex*, stating "Complicated problems can be hard to solve, but they are addressable with rules and recipes…Complex problems involve too many unknowns and too many interrelated factors to reduce to rules and processes." [2]. Sargut and McGrath further explain that, "…the main difference between complicated and complex systems is that with the former, one can usually predict outcomes by knowing the starting conditions. In a complex system, the same starting conditions can produce different outcomes, depending on interactions of the elements in the system." [3]. Rather than being complicated, complexity better describes many studio projects.
Building a meaningful but *simplified* picture of the problem is an important step to finding solutions – or in other words, "a problem well stated is half solved." [4]. To help students more effectively navigate complex studio projects, this paper will review the roadblocks associated with too much information, discuss two strategies for information reduction (segmentation and chunking), and show how the interaction of meaningfully abstracted characteristics of a problem set can lead to insight.

2 COGNITIVE LOAD THEORY AND THE CREATIVE IMPASSE

Introduced by Robert Sweller, Cognitive Load Theory postulates that short-term, or "working memory", can only juggle/process two-to-four chunks of information simultaneously [5]. In contrast, "Long-term memory" has an unlimited capacity for retrieving chunks of knowledge. The knowledge acquisition phase of an advanced studio project almost always results in more than “two to four” chunks of information. When too much information is present, cognitive processing stops or significantly slows down. As Sull points out, “…when faced with a superabundance of alternatives, people are afraid of making the wrong choice. As a result, they delay decisions, default to the safest option, or avoid choosing altogether” [6]. McGrath cautions us, “…we are hampered by *cognitive limits* to our understanding… [We believe we] can take in and make sense of more information than [we] actually can. As a result, [we] act prematurely, making major decisions without fully comprehending the likely consequences…” [3].

This is not an ideal context for creative thought – especially in a product-development studio environment. Meaningful information reduction is required before students can insightfully understand the problem at hand and effectively move forward. The ability to simplify a complex problem or situation meaningfully down to a manageable size is critical for design success.

3 MANAGEABLE SEGMENTATION AND MEANINGFUL CHUNKING

The initial assumptions by a student about the structure and scope of a design studio problem may be “mostly false and often incomplete” [7]. A student needs the opportunity to engage in “knowledge acquisition” before they can more accurately define the problem space [8]. Gathering data and experience is not difficult for students. Strategies as simple as LOOK, DO, and ASK [9] quickly engage the students with the problem space and they gain more knowledge than they can realistically use. Students then struggle to effectively understand the problem in a holistic way, and often embrace outlying bits of data and try to move forward in the design process.

Two basic strategies for reducing the cognitive load around problems are *segmentation* and *chunking* [10]. These two simple strategies acknowledge the limitations of working (or short-term) memory, the paralysis associated with information overload, and attempt a reduction in cognitive load through different forms of simplification. Between the two strategies, *chunking* is more effective than *segmentation* in the complex studio project environment.

With *segmentation*, raw data is broken up into smaller, manageable bits that can be engaged individually and stored/recalled more effectively. For example, as a single element, the 10 digit string of raw numbers, 8605554589, is too much for the “two to four” element limit in short term/working memory. However, segmented into three or four small units, the string of digits can then be read and remembered in the format 860-555-4589.

For students, segmentation is the familiar “to do” list. Instructors help students with complicated tasks by segmenting them into smaller, more manageable groupings – i.e. “Phase 1, Phase 2, Phase 3, etc.” Segmentation is useful as a linear complicated-process *management* tool and not as an *interpretive* tool for a complex situation.

Rather than reducing the data set to smaller more *manageable* pieces, *chunking* reduces the data set to smaller, more *meaningful* pieces. In the example of a grocery list (Figure 1) we see the data represented in a Raw, Segmented, and Chunked state. In the chunked state, the raw list of 13 specific grocery items was reduced down to four categories that can now be used more effectively by working memory.

Problem simplification is critical to a successful outcome [7]. Therefore, to help students gain insight, chunking has more impact over segmentation and helps design students separate the vital from the irrelevant rather than requiring them to remember all of the data gathered and collected. Chunking results in a simplified set of characteristics that help students with an overall picture of the important elements *driving* a problem or situation.

Fundamental to chunking is grouping relevant/similar things, and simplifying or abstracting them in a way that summarises the meaningful similarities of objects or concepts in a group, but also defines the differences between groups. Finding the right level of abstraction can be difficult, as “*very abstract* cognitive categories have too few attributes to be informative…and *extremely specific* categories are often too overlapping.” [11]. Maeda describes this simplicity “sweet spot” as existing somewhere between “How simple can you make it?” and “How complex does it need to be?” [12]. The point at which this balance is achieved is often described as *“parsimonious yet viable”* – i.e. an extremely simplified model that provides an adequate interpretation of the current data/situation, while being open enough to provide new understanding.

RAW

Bread
Ice Cream
Milk
Tomatoes
Eggs
Butter
Apples
English Muffins
Frozen Vegetables
Bagels
Lettuce
Cream
Bananas

SEGMENTED

Bread
Ice Cream
Milk

Tomatoes
Eggs
Butter

Apples
English Muffins
Frozen Vegetables

Bagels
Lettuce
Cream
Bananas

CHUNKED

Frozen Foods
Ice Cream
Frozen Vegetables

Dairy
Milk
Eggs
Butter
Cream

Bakery
English Muffins
Bagels
Bread

Produce
Apples
Tomatoes
Lettuce
Bananas

Figure 1. Grocery List Raw, Segmented, and Chunked

4 INTERACTION OF ELEMENTS

Students are resistant to the idea that reducing a complex problem down to two to four pieces of relevant information will actually help them. They are worried that the limited result will provide an overly simplistic view and strangle creativity. Lowey warns of the danger of over reduction, and of "…simplifying complex realities in unhelpful ways" [13]. Sull however points out that "Simple rules *match* or *beat* more complicated analyses across a wide range of decisions [and]… can induce action without unnecessarily limiting options." [6].

The viability of a parsimonious description of a complex problem is revealed as those simplified and abstracted primary characteristics, those that are seen as fundamental *drivers* in a particular situation, interact in the form of a model. Anderson states, "To build a model is to encode a natural system into a formal system, compressing a longer description into a shorter one that is *easier to grasp*." And that rather than feel limited by a simplified description of a problem space, students should see that "…complex patterns can arise from the *interaction* of agents that follow relatively simple rules" [14].

To leverage the reduced data set, the designer builds a framework to provide "personally and culturally reinforcing nomenclature" [11] that will provide insight and direct their creative efforts. This type of framework is formed when the driving concepts abstracted out of the larger data set are put together in a way that they form and project new possibilities/relationships and help a designer "bridge the gap between strategy and execution – to [help them] make on-the-spot decisions and adapt to rapidly changing circumstances while keeping the big picture in mind." [6]

Familiar structures for creating an interactive model (Figure 2) abstracted from a larger data set include Venn diagrams, a 2x2 matrix. Even a simple list allows for students to creatively "*shift* the problem to a new place" [11]

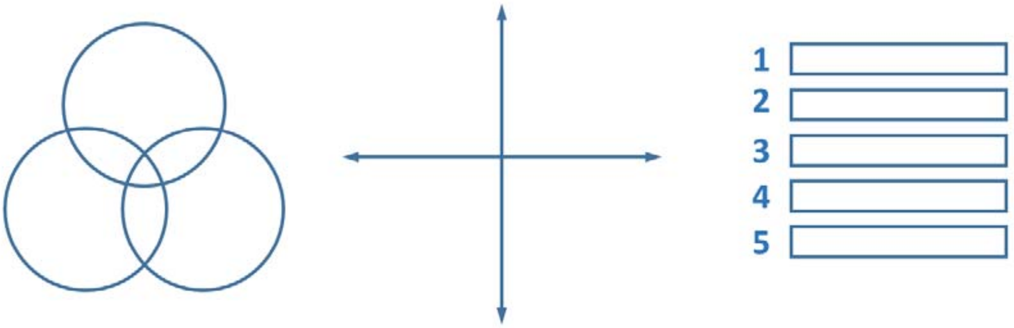

Figure 2. Example Formats for Chunked Data Interaction

5 PROJECT APPLICATION:

On a recent third-year studio project, there were several opportunities to use *chunking* (or information reduction through meaningful abstraction), to simplify *observations* into *insights*, and insights into *drivers*. In one specific instance, the sponsor of the project had an obvious "family" component to their brand values and messaging. During the data gathering/understanding phase of the project, one group of students was tasked with working to understand this element of "families", and to help their peers understand the complexities of the topic beyond the view that was held by the sponsor.

Their presentation on the topic was full of interesting insights based on observations and experiences about groups that could be considered small "communities" rather than just "families". Their presentation elicited lot of student discussion, with each student trying to input their own biases and suggestions about what constituted a "family". It was obvious that the student group did NOT have a framework that helped to anchor their final conclusions, and the other students working on the project projected frustration at not really understanding the concept of either "families" or "communities" in a way that could help them move forward.

The instructor observed that many of the immediate conversations revolved around the concepts of: RELATEDNESS, RESPONSIBILITY, and RESOURCES. These abstracted concepts (i.e. - the *driving* aspects of the students' discussion of "families"), could intersect as shown in Figure 3. Not meant to be a definitive framework for the concept of "families", it adequately described the group's observations and provided an additional area that they had not considered, but that emerged through the intersection of the three driving concepts.

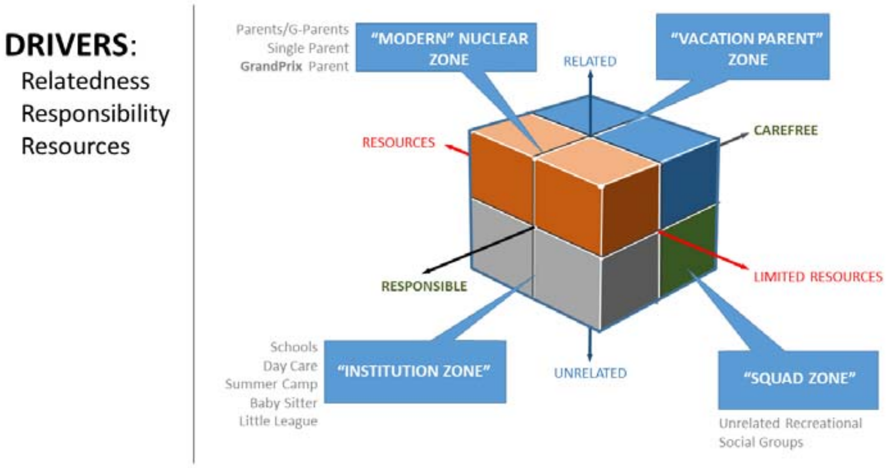

Figure 3. Interaction of Three Abstracted Drivers Describing User Groups

Later, on the same project, there was a need to define the concept of "sport", with reference to the gear that is used/needed for the activity. Class discussion revealed a significant difference of opinions among the students. Gathering personal experiences, and systematically *chunking* these from observations to insights and from insights to *drivers*, ranking the drivers in order of impact, and eliminating all but the top three, the following model was generated that adequately described their current thoughts about "sports", and revealed four new areas for their creative effort (Figure 4).

Figure 4. Interaction of Three Abstracted Drivers – Simple Taxonomy of Sport

6 CONCLUSION

Representations, models, or frameworks of complex problems situations are foundational to solving them [15]. As students begin working on a complex studio project, they automatically create an internal model that drives their decisions as they work to solve complex problem spaces. This model may or may not be accurate or effective. If there is no effort to construct visible or external models of a studio problem, students have limited resources for identifying, evaluating, or critiquing their own internal assumptions. This can make progress on a complex studio problem frustrating, and stifle enthusiasm and forward moving progress.

In addition to being a method for *checking* a student's internal assumptions, an external model can give them access to knowledge and skills that are "unavailable from internal representations" only [16]. But because they are new to complex problem solving, the cognitive load can be high. There is a need to simplify the problem to a series of abstracted principles that allow them to gain insight, confidently make decisions, and move towards solutions in a meaningful way.

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