

# **A4Q**

## **Design Thinking Foundation**

### **Syllabus**

1. Release version / Work in Progress

Version 0.6.5

## **Alliance for Qualification**



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# 0 Introduction

## 0.1 Purpose of this Syllabus

This syllabus presents the business outcomes, learning objectives, and concepts underlying the Design Thinking Foundation training and certification.

## 0.2 Examinable Learning Objectives and Cognitive Levels of Knowledge

Learning objectives support the business outcomes and are used to create the certified Design Thinking Foundation exams.

In general, all contents of this syllabus are examinable at a K1 level, except for the Introduction and Appendices. That is, the candidate may be asked to recognize, remember, or recall a keyword or concept mentioned in any of the three chapters. The knowledge levels of the specific learning objectives are shown at the beginning of each chapter, and classified as follows:

- K1: remember
- K2: understand
- K3: apply
- K4: analyze

Further details and examples of learning objectives are given in Appendix B.

The definitions of all terms listed as keywords just below chapter headings shall be remembered (K1), even if not explicitly mentioned in the learning objectives.

## 0.3 The Design Thinking Foundation Exam

The Design Thinking Foundation exam will be based on this syllabus and the accredited A4Q Design Thinking Foundation training course. Answers to exam questions may require the use of material based on more than one section of this syllabus and/or the Design Thinking Foundation training course. All sections of the syllabus and the Design Thinking Foundation training course are examinable, except for the Introduction and Appendices other than the Glossary.

Standards, books, and other literature may be included as references, but their content is not examinable, beyond what is summarized in this syllabus itself from such standards, books, and other literature.

The exam shall be comprised of 40 multiple-choice questions. Each correct answer has a value of one point. A score of at least 65% (that is, 26 or more questions answered correctly) is required to pass the exam. The time allowed to take the exam is 60 minutes. If the candidate's native language is not the examination language, the candidate may be allowed an extra 25% (15 minutes) time.

## 0.4 Accreditation

The A4Q training titled Design Thinking Foundation is the only accredited training course for the content presented in this syllabus.

## 0.5 Level of Detail

The level of detail in this syllabus allows internationally consistent exams. In order to achieve this goal, the syllabus consists of:

- General instructional objectives describing the intention of the Foundation Level
- A list of terms that students must be able to recall
- Learning objectives for each knowledge area, describing the cognitive learning outcome to be achieved
- A description of the key concepts, including references to sources such as accepted literature or standards

The syllabus content is not a description of the entire knowledge area of design thinking; it reflects the level of detail to be covered in Foundation Level training courses. It focuses on design-thinking processes in relation to product development. This syllabus highlights several design-thinking approaches with emphasis on Designing for Growth. Alternative design-thinking approaches and processes are available beyond those addressed in this syllabus. This Foundation Level course strives to provide a foundation of understanding that enables participation and adoption of alternative design-thinking approaches.



## 0.6 How this Syllabus is Organized

There are three chapters with examinable content. The top-level heading for each chapter specifies the time for the chapter; timing is not provided below chapter level. For the A4Q Design Thinking Foundation training course, the syllabus requires a minimum of 12 hours of instruction, distributed across the three chapters as follows:

Chapter 1: Design Thinking Background 55 minutes

Chapter 2: Design Thinking Approach 250 minutes

Chapter 3: Design Thinking in Practice 420 minutes

## 0.7 Business Outcomes

DTFL-BO-1 Explain the design thinking approach to solving problems

DTFL-BO-2 Apply design thinking approaches and tools to a variety of challenges and problems

DTFL-BO-3 Participate positively in collaborative ideation and evaluation.

## 0.8 Acronyms

A4Q	Alliance For Qualification
DTFL	Design Thinking Foundation Level
FMEA	Failure Modes and Effects Analysis
MMF	Minimal Marketable Feature
MVE	Minimal Viable Ecosystem
MVP	Minimal Viable Product

# Chapter 1 – Design Thinking Background

## Keywords

design thinking, design thinking mindset, Designing for Growth approach, disruptive solution, Double Diamond approach, human-centered design, Stanford d.School 5-Stage approach, user-centered design

## Learning Objectives for Design Thinking Background

- DTFL-1.1.0 (K1) Describe design thinking
- DTFL-1.2.0 (K2) Describe business uses of design thinking
- DTFL-1.3.0 (K2) Describe the variety of approaches within the design thinking discipline
- DTFL-1.4.0 (K2) Describe the design thinking mindset

## 1.1 Definition of Design Thinking

The term “design thinking” has been applied to two different but related areas of conceptual development. The first established body of knowledge, starting in the late 1960’s, investigates how designers (ex. architects, industrial designers, graphic artists) perform their craft and seeks to identify the skills, abilities and knowledge of expert designers. [A3] The second use of “design thinking” is related to business management. Since the mid-1980’s, interest within the business community grew in exploring how “designerly” thinking could be applied to business challenges, and be performed by employees and leaders not trained formally as designers. This course is dedicated to design thinking being a means to infuse business problem solving and spark innovation using a designer’s mindset.

Having clarified this possible source of confusion, for our purposes... What is design thinking? To paraphrase US Supreme Court Justice Potter Stewart’s famous 1964 threshold-test for obscenity “we will know it when we see it.” Scholars have written that design thinking lacks one unifying definition. [A2, A3] For our purposes, the following are critical aspects of design thinking. Design thinking is a solution seeking process that incorporates:

- User-centered or human-centered design that commonly refers to a design process that seeks to understand the user as a person as well as incorporate the user’s objectives, needs and pains in design efforts. The user is consulted throughout the design and implementation stages of a solution in order to seek their insights and feedback on how the solution can be made better for the user.
- Iteration that repeats cycles of activities that seek to identify and achieve a viable solution. [B3]
  - One cycle consists of three activities: learning, making, and evaluating
  - One cycle consists of two types of thinking: divergent and convergent thinking
- Multiple candidate solutions instead of initially committing to one “nearly correct” solution early in solution development.
- Commitment to learning about the problem space, constraints and users.
- Low cost and ideally quick mock ups or prototypes of solutions for evaluation within the design team and by users.
- Direct and collective participation, observation and evaluation by members of the design team.

These qualities of design thinking are the essence of professional design practice applied to business cases.

## 1.2 Business uses of Design Thinking

The value that design thinking has brought to organizations is innovation that has disrupted their markets, enhanced brands in terms of recognition, sales and performance, and business adaptation. This value has been achieved by innovating in the areas of product development (ex. Proctor & Gamble’s Swiffer), service development (ex. AARP’s LifeTuner.org), business models, and business

strategy. [B1] Design thinking can be applied to community settings (ex. economic revitalization, social services) and education (ex. student learning, learning experiences). In the business context, it is important to differentiate invention from innovation. Per Liedtka and Ogilvie, invention is developing something unique and interesting. Innovation relies on selecting invention that will yield net positive value to the business. [B1]

Innovation is inherently risky. Solving a problem for the first time means the answer is unknown, and grasp of the problem itself is often elusive. Businesses face indeterminate problems. According to Richard Buchanan, some qualities of these indeterminate problems are: they have more than one possible explanation, they may be symptoms of overarching problems, the opportunity to solve the problem comes by once, data about these problems are incomplete and uncertain, the problem is unique, and the decision maker is accountable for a bad solution. [A4]

Fear of spectacular failure plagues many business leaders and has a tendency to reduce risk tolerance sufficiently to stifle innovation. In part this risk aversion is based on the caretaker role business leaders have as stewards of investor capital, providing stable employment and proving to be a reliable business partner and supplier. According to Jamshid Gharajedaghi, a system's performance is essentially design-driven. To radically improve performance, such as, by an order of magnitude requires a redesign. [B4] Without potentially disruptive solutions, performance will cease to improve, as system attributes like cost efficiency reach their limit of effectiveness. For example, a gasoline engine requires gasoline, so the environmental, engineering, social, financial and business factors related to gasoline cannot be avoided without redesigning the engine to not depend upon gasoline.

Design thinking is a means to derisk innovation. Design thinking seeks to understand the problem from the stakeholders' point of view and thus improve the likelihood of a solution being relevant and accepted. Educated guesses are brought forward cheaply and quickly for evaluation. Stakeholders are able to inform design teams with actionable guidance by providing their perspective on tangible prototypes the team puts forward. The learning achieved is promptly infused into the next prototype iteration and once again subject to stakeholder critique. Design thinkers are committed to solving the problem not to a particular solution. This freedom liberates the team from emotional and actual sunk costs; thereby, avoiding time and capital-intensive investments that solve the wrong problem or suffer from fatal unverified assumptions. Design thinking does not guarantee success, but through faithful adoption even failure results in knowledge gained that yields insights that will benefit the business's next attempts.

### 1.3 Variety within the Design Thinking Discipline

Consistent with the spirit of design-thinking oriented problem solving, multiple systemized approaches to design thinking have been proposed to solve the problem of implementing design thinking in practice. This course explores the Design Council's Double Diamond approach [WR2], Stanford d.School 5-Stage approach [LA1] and the Designing for Growth approach by Liedtka and Ogilvie [B1]. The Hasso Plattner Institute uses six stages while there is a four-stage approach from

the Kanazawa Technical College in Japan. [B2] The design consulting company IDEO has yet a different approach. A collection of design-thinking approaches can be found at <https://designthinkingmethodology.weebly.com/methodologies.html> . Without a strict definition of what design thinking is, it can be challenging to determine how faithful a proposed method is to design thinking. Moreover, it can be difficult to determine which method is more likely to succeed or best aligns with one's business culture. At this time, there is no theoretical or evidence-based rationale for excluding any particular proposed approach so long as it holds to the attributes described in section 1.1.

Selecting an approach is a choice based on a team or business leader's level of comfort with the documentation, objectives, principles, tools and processes developed for a particular approach. Adopting design thinking conceptually and a particular style of it via a selected approach will require experimentation and reflection. A challenge will be to differentiate sources of issues that arise, because they may stem from the approach, the practitioners or the test case. The test case is inherently a source of risks. The practitioners may be inadequately trained or the team's composition may be ill suited for the experiment. These risk sources can make it challenging to determine whether a particular approach is adequate. In the early stages of design thinking maturity, It is recommended to choose projects with limited visibility that will provide an opportunity to learn how design-thinking methods work within one's particular business setting. It may be helpful to introduce design-thinking methods without making a full-fledged commitment to an entire approach. Early integration of the user's perspective and determining the problem actually being solved prior to committing to a solution approach is a good way to get started.

Former NASA flight director Gene Krantz is famous for saying, "Failure is not an option" during the Apollo 13 mission<sup>1</sup>. The design-thinking philosophy is oriented to embracing failure in the sense that getting innovation wrong initially is likely and learning by making an attempt is necessary to learn what is wrong with a solution approach before too much time and money is invested in an inadequate solution. This willingness to err for the sake of learning is necessary to mature in design-thinking practice. Getting it wrong has real costs so when mastering design thinking it is prudent to pick projects with lower costs upon failure.

While on the topic of variety, it is important to note that although an approach is presented with an overall flow from beginning to the end, the actual flow through an approach may not be linear or take a consistent path through the stages. This may be observed within a single project or between projects. For many approaches this is an acceptable dynamic. Events (ex. news, discovery, conversations, interactions) and opportunities (ex. new team member, user interaction) may arise that cause the team to shift to a stage previously performed or cause the process to skip ahead. Project managers need to weigh the value various stage transitions contribute to the innovation process against the time planned.

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<sup>1</sup> "Failure is not an option", by Gene Krantz, 2000, ISBN 978-1-4391-4881-5

## 1.4 Design Thinking Mindset

Members of a design-thinking team need to adopt a “design thinking mindset” when they are participating on design-thinking projects. The attitudes and expectations of each member have a direct effect on the design-thinking effort. This section explores the qualities that comprise the design-thinking mindset.

Design thinking is an interdisciplinary team effort. The team consists of colleagues from across the business and levels of authority. Considering the stakeholder as a live or virtual member of the team reinforces the user centric nature of design thinking. The team, not an individual, is going to yield an effective solution through design thinking. This requires a willingness to listen, cooperate and collaborate with each member no matter what business role and discipline they perform outside of the team.

Innovation inherently means the answer is unknown until innovation is successful. To get from unknown to known requires each member and the team collectively to seek learning and be mindful throughout the design-thinking process. Mindfulness is being present in the moment and being aware of the “now” and “here.” This requires team members to focus all their senses to capture what is occurring within and around them. Verbal communication is fundamentally limited by vocabulary, culture and the ideas previously expressed linguistically. Beyond being at a loss for words, team members and stakeholders will struggle making their meaning understood by others when limited by verbal expression. Making is an essential part of design thinking. By making, meaning is conveyed visually, tactilely and experientially. Often within the process the thing made is intended to be temporary and transitional, but the meaning it conveys is closest to being universal and stable.

Designing is an emotional process. Design thinkers are aware that stakeholders are emotional beings. The problems being solved elicit emotion as well as solutions produced by designers evoke emotion.

Design thinkers need to be explorers looking for and describing the problem being solved. In order to unfold the problem and pursue potential solutions, design thinkers are brave, inquisitive, playful, imaginative, expansive in thinking, versatile, flexible and ultimately practical when it is necessary within the process. Design thinking works best when each team member is committed and contributes with enthusiasm.

Humility may not be a frequently considered professional trait, but it is the foundational trait that enables each team member and the team to succeed. Design thinking involves solving problems with no known answers. Each team member and the team collectively are limited by unknown unknowns in terms of what they know and can do. Humility is necessary to be aware that assumptions are being made about the problem and the candidate solutions. These assumptions may be flawed and what is considered “known” may actually be an assumption that has yet to be verified. Humility is required to allow oneself to be corrected. Being wrong is a natural consequence

of exploration and probing for answers. The sooner a credible understanding or fact is discovered and embraced the sooner a solution is achieved.

## Chapter 2 – Design Thinking Approach

### Keywords

assumption, assumption testing, concept development, convergent thinking, curator, design brief, design criteria, Designing for Growth approach, divergent thinking, Double Diamond approach, empathy, ethnography, facilitator, hypothesis, learning guide, napkin pitch, progressive elaboration, project, project management aid, prototyping, social norm, sprint, Stanford d.School 5-Stage approach, vision prototype, visual thinking

## Learning Objectives for Design Thinking Approach

### 2.1 Fundamental Concepts

- DTFL-2.1.1 (K2) Explain the concept of empathy in the context of design thinking
- DTFL-2.1.2 (K2) Explain the concept of ethnography in the context of design thinking
- DTFL-2.1.3 (K2) Explain the concept of divergent thinking within the context of design thinking
- DTFL-2.1.4 (K2) Explain the concept of convergent thinking within the context of design thinking
- DTFL-2.1.5 (K2) Explain the concept of visual thinking within the context of design thinking
- DTFL-2.1.6 (K2) Explain the concept of assumption testing within the context of design thinking
- DTFL-2.1.7 (K2) Explain the concept of prototyping within the context of design thinking
- DTFL-2.1.8 (K2) Explain when the objective is to learn and when it is to validate within design thinking

### 2.2 Design Thinking Resources

- DTFL-2.2.1 (K2) Describe the human resources needed for design thinking projects
- DTFL-2.2.2 (K2) Describe the preferred space prepared for design thinking projects
- DTFL-2.2.3 (K2) Describe the materials commonly used in design thinking projects
- DTFL-2.2.4 (K2) Describe the dynamic between design thinking teams and the organization

### 2.3 Design Thinking Processes

- DTFL-2.3.1 (K1) Recognize there is a variety of design thinking approaches
- DTFL-2.3.2 (K2) Describe the Double Diamond approach
- DTFL-2.3.3 (K2) Describe the d.School 5-Stage approach
- DTFL-2.3.4 (K2) Describe the Designing for Growth approach
- DTFL-2.3.5 (K2) Explain the role of project management within design thinking



## 2.1 Fundamental Concepts

This section will explore concepts essential to the practice of design thinking. These notions are integral to the approaches discussed in section 2.3.

### 2.1.1 Empathy

The New Oxford American Dictionary defines empathy as “the ability to understand and share the feelings of another.” Television, cinema and other arts have explored insensitive characters (ex. doctor, captain, android, artificial intelligence) and the impact the lack of concern or understanding of others’ feelings has had on communications, understanding and the objectives of the insensitive character. Often this insensitivity is portrayed as an obstacle or a hazard or even as a threat. Can a character that does not empathize with those their decisions effect be trusted?

Trust is an integral part of the design-thinking process. A collection of individuals will not form into a team if the teammates mistrust each other. Design-thinking collaboration requires trust at a personal level within the team and between the team and stakeholders. Team members will hesitate to share their ideas, feelings, concerns, biases, weaknesses and strengths if they do not trust they will be respected or appreciated or think they may be in professional jeopardy. Stakeholders sensing insincerity are less likely to be forthcoming or cooperative. A team that distrusts project sponsors’ potential responses to failure resulting from diligent work may seek “safer” solution candidates, which may possibly hinder or fail to achieve a viable solution. Many of these issues of trust are not simply a matter of trustworthiness but of others being sensitive, polite, honorable and discreet with what and how ideas and thoughts are shared. All of these qualities require a measure of empathy.

Empathy is necessary to understand the problem being solved more completely. A design thinkers’ ability to share the feelings of the stakeholder helps the designer to recognize meaningful effects and affects the problem has on the person. Empathy allows the design team to anticipate or recognize why a solution may fail to be accepted. Stakeholder culture and physical limitations influence the problem as well as the solution. For example, an elderly person may find smartphones difficult to use because of necessary visual acuity and fine motor skills they no longer possess or have begun to lose. Smartphone speaker location and technology may interfere or misalign with their hearing aids. A design-thinking team may find these factors critical to their design of a senior friendly smartphone or seniors apps developed for mobile-health monitoring and management. Design thinkers may wear glasses or earpieces that mimic senior health conditions as they propose and evaluate solution candidates.

Cross-cultural design is complex. [A1] Culture influences values, interpretation, motivation and tolerance. People across different cultures do not have a universal response to color, shapes and symbols. Why do bustling marketplaces in Lucknow, Shanghai, New York City, Paris, Mexico City, Sao Paulo, and Alice Springs look, feel, smell and sound so different? Are those differences result of random design and people? If the team lacks members of the targeted culture, empathy will be essential to bridge the cultural distance. People in culture X may not mind daily hygiene habits

unacceptable to culture Y. Individual agency of a person in culture A may be prized over social harmony as it is in culture B. Cultural attributes like these influence what problems are and what solutions should be.

Keep in mind, the solution is in the eye of the stakeholder - to borrow the phrase credited to Margaret Wolfe Hungerford - "Beauty is in the eye of the beholder."<sup>2</sup>

### 2.1.2 Ethnography

When problems and solutions involve people, design thinkers need to understand the human dimension in addition to any relevant technical, scientific, economic, financial or business considerations. Ethnography is a research discipline interested in studying the behavior of people in specific social situations and eliciting from these people their interpretation of their behavior. For example, "Sir, we see you chose Brand X of tomato soup, why did you?" By investigating the behavior, feelings and thinking of the sub-population of people who experience the problem and who may adopt the solution the design-thinking team is exploring, the team is much more attune to the people being affected. The team is able to adjust their empathic understanding of the situation with greater accuracy.

Some common ethnographic data collection techniques are survey, observation and interview. The survey can be on paper, online or scripted live question-and-response formats. The statistical integrity of survey research can be managed in terms of variables like respondent selection and number of respondents needed. Surveys are able to provide representative data describing the population of interest. Survey tools lack the ability to explore the reasoning behind each response. Was the response given because of confusion, appeasement, disinterest / interest? Response options cannot capture the nuances of their choices. For example, a "satisfactory" response was provided, but it would have been "most pleased" if the tenth and most recent time of buying/using a product had not been so frustrating.

Observation allows design thinkers to see the human dynamics as well as the environmental context (ex. stationary/mobile, crowds, weather, lighting levels and types, distractions, social norms, regulatory or legal impact (ex. no audio, photography, or video recording permitted in the court room)) related to the problem. Observation as a tool can be difficult to scale up and can suffer from variation that interferes with formal statistical analysis. Observation alone does not allow the design thinker to recognize the "internal condition" (ex. thinking and feelings) of those observed unless it can be accurately interpreted from visible actions, body language and utterances.

The interview helps address the design thinkers' need to understand motivations, evaluation process, concerns, feelings, goals and other thinking a stakeholder is having or performing.

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<sup>2</sup> source: <https://www.phrases.org.uk/meanings/beauty-is-in-the-eye-of-the-beholder.html>  
(last accessed 9/2018)

Stakeholder receptiveness to being interviewed may limit the number and variety of people within the interested stakeholder population. Candid and honest stakeholders are authoritative with respect to their own thinking and feelings, but they are only representative of themselves. Candid stakeholders may not know how they arrived to a decision or may be unable to explain their feelings and concerns. Often interviewers ask prepared questions but are allowed the freedom to follow up answers with probing questions that may not be uniform from interview to interview. Unlike surveys, the interviewee is free to express themselves in their own style. This combination of question and response variation makes normalizing answers challenging. It is necessary to evaluate the interviews to determine what has been learned. Did Interviewee 1 and Interviewee 2 answer question A with the same or similar answer? What are the patterns and commonalities among the interviewees? Interviews are a powerful investigative tool but fraught with analytical challenges. Without formal experimental design and execution, interviews are weak statistically but produce rich insight into the people and their thinking and feelings.

People can be readily measured for weight, height, temperature, and blood pressure with precision, accuracy and objectivity; however, personality, feelings, goals, values and rationalizations are of greatest interest to the design thinker. Ethnography as a research discipline is the principal means by which design thinkers uncover these items of interest.

### 2.1.3 Divergent Thinking

Divergent thinking is an expansive mode of thinking. Design thinkers seek to understand the problem beyond current understanding or assumptions. Solution candidates are often used to bring to light dimensions and nuances of the problem. In order to understand known unknowns and uncover unknown unknowns, it is often necessary to consider variety in the manner solutions are explored and as well as putting forward multiple solution candidates. This often requires team members to offer diverse points of view, creativity, imagination, empathy and collaboration. Beyond the contribution to framing the problem accurately, often innovation requires a result that does not exist within the collection of the usual existing solutions. Divergent thinking is necessary for the team to arrive at a solution that is novel.

Brainstorming, referred to as ideation among designers, is the most widely known type of divergent thinking. Not all ideas come about on schedule or in the heat of a brainstorming session. Having been primed to entertain new ideas, the mind keeps mulling over the challenge. Inspiration may strike at unusual moments in life like while walking the dog, cleaning the bathroom, or falling asleep.

It is important to recognize that requirements and ideas in this context are not the same thing. Requirements do need to be identified at some point, but often the objective of ideation is to generate ideas. With respect to divergent thinking, an idea is a feature or function or a means to achieve a goal for the stakeholder. Requirements are objectives to which a solution must comply, such as, carbon neutral, lightweight, maintain patient privacy or non-toxic.

As later sections will discuss, design thinking does not start immediately with ideation. A level of understanding of the problem and of the stakeholders is needed. Without a frame of reference for the design team, ideas generated tend to lack relevance and substance when nothing but speculation grounds the ideas. For example, if we seek ideas for crossing a distance, we need to know attributes like: how far, the obstacles, the desired speed, level of safety, and the health condition of stakeholder. Without this context the suggestions may be: to crawl, take a rocket, swim, jump, take a sailboat, sports car or to walk. These are very different ideas, and some though imaginative are not likely relevant. Early in the design-thinking process there is an expectation that the design-thinking team does not fully understand aspects of the problem, but an initial framing of the problem needs to be understood in order to propose early solution iterations.

#### 2.1.4 Convergent Thinking

Convergent thinking is essentially the converse of divergent thinking. Instead of expansive thinking, this type of thinking consolidates or reduces the number of ideas being considered. Within design thinking, convergent thinking follows divergent thinking in order to synthesize (i.e. refine, filter, integrate and assemble) collections of ideas into a limited number of concepts, plausible cohesive viable collections of ideas, for further development and evaluation.

Within design thinking, convergent thinking relies on decision-making based on systems thinking, engineering, science (natural and social), aesthetic, business and financial principles as well as logic and probabilistic thinking. This is a crucial process whereby the subject matter expertise within the design team informs the sorting of fantasy from ingenuity and proceeds to synthesize concepts that will lead to prospective solution candidates. Within some design-thinking approaches their authors propose criteria and objectives for convergent thinking, such as Lewrick, et al.'s "vision prototypes" [B2] and Liedtka and Ogilvie's "concept development." [B1] Although convergent thinking is most visible after ideation or brainstorming, convergent thinking is applied repeatedly in the design-thinking process as the project reaches the goal of one innovative solution.

#### 2.1.5 Visual Thinking

Among the five senses of touch, taste, smell, hearing and seeing the dominant forms of communication involve hearing and seeing. Touch is often used as a substitute for seeing if seeing is not available. Touch is rarely used as a distinct primary means of conveying concrete and abstract ideas. With computer controlled haptic interfaces and physical instantiation (ex. designer's models, product samples), touch can augment what is sensed using hearing and/or seeing. Audible communication often relies on linguistic forms of expression. Non-linguistic audible communication like music, environmental sounds (ex. car traffic, baby crying) and sound effects are inadequate to convey complex ideas with precision. Language based communication requires that all those communicating share a common language. These course materials were originally written in English, but you may be reading them in languages like Farsi, Mandarin, German, Urdu or Swahili. Linguistic communication relies heavily on the language's vocabulary to express established ideas and fashion new ones. When fashioning new ideas the communicator often depends on cultural common ground and common experiences in order to extrapolate from established ideas to a new idea. For

those listening, they must be able to follow the line of idea progression in order to understand. This requires the listener to understand the words used in the same way as the speaker intends. Trouble is that new ideas may not be fully formed, and the words used and their order may be spontaneous and poorly chosen as the speaker struggles giving the idea verbal form.

Visual communication may be the most flexible form of communication. Linguistic and non-linguistic forms of expression as well as their combination may be utilized. The expression “a picture is worth a thousand words” captures the significance of visual non-linguistic communication only in part. There may be no manageable combination of words that can completely substitute for what is being expressed or depicted. This is why designers and design thinkers communicate visually and rely heavily on non-linguistic forms of expression. As effective as relying on non-linguistic expression to communicate is, it is often supplemented with verbal or linguistic communication in written or audible form. Language is often needed to convey contextual information. By harnessing parts of the brain’s visual cortex (location where scientists believe mental imagery is occurring), substantive idea understanding occurs by the recipient exercising visual thinking.

For visual thinking to succeed, all those engaged in communicating visually must be thinking visually. In the context of design thinking, visual thinking relates to communicating ideas through what is seen or experienced. By using mental images or representations, design thinkers can understand an idea and think beyond the visible literal forms and color to achieve an understanding. One may say that imagination is used to fill in the gaps in detail. Triggered by the initial image, visual thinkers may take their initial understanding and enhance or substitute the initial mental image with other details of their own. This in turn is externalized with additional non-linguistic forms of expression. Designers use sketching heavily for its speed and range of expression. Schematic diagrams and photography are other forms. By using metaphors and analogies design thinkers can depend upon past experiences to inform the mental model of the idea being formed. Storyboarding is able to place ideas expressed through combinations of drawing and text into time sequence allowing visual thinkers to appreciate what cannot yet be experienced literally. Guided imagery relies heavily on both mental imagery and audible linguistic expression to imagine without actual experiencing an event.

### 2.1.6 Assumption Testing

According to the New Oxford American dictionary an assumption is “a thing that is accepted as true or as certain to happen, without proof.” Assumptions are at the foundation of much of our thinking. They are necessary in order to cope and make decisions without having all the facts. There are facts and events that are or will occur that are unknowable or of unknowable certainty. According to the same dictionary, inference, a type of assumption, is “a conclusion reached on the basis of evidence and reasoning.” By concluding a particular cause or influence based on accepted scientific principles or laws is deduction, which is a reasoned assumption. Assumptions may be based on reason, experience or on prejudice. Assumptions are inherently uncertain in their truthfulness or relevance.

Assumptions within design thinking are vulnerabilities or weaknesses within a line of reasoning that may cause significant misalignment between the team's understandings of the problem with the actual problem. Solutions may fail when assumptions prove to be false or on occasion are contradicted. It is necessary for the design-thinking team to identify assumptions and evaluate their significance if they fail to be correct. Assumption testing is a deliberate process to determine the reliability of high impact assumptions. It may be necessary to accept assumptions that may not hold on occasion. The frequency of assumption failure may need to be estimated and an acceptability threshold set. Recasting the problem by changing the targeted problem (ex. changing from worldwide market to only the South American market) may sufficiently reduce the frequency of assumption failure.

### 2.1.7 Prototyping

Consistent with concepts of visual thinking and prompt (re)making, prototypes are an essential part of design thinking. Prototyping is the process of making prototypes. Prototypes are preliminary models or representations of a concept or solution approach. The goal is to manifest a solution candidate so it can be experienced and understood within the design team and by valued stakeholders. In other words, the objective of prototyping is often to initiate evaluation, reflection and learning. As the design-thinking project progresses the number of alternative candidates reduces, and typically a single mature prototype is passed on for pilot level sales or implementation. In some approaches the pilot phase is part of the design-thinking project. The final prototype and specification will only go to production or to operations teams after a successful pilot run.

Prototypes take on various forms and are of various levels of fidelity. Fidelity in this context relates to realism and consistency with the final operating condition. At the early stages of design thinking, prototypes may involve sketching, Legos, modeling clay, foam board, balsa wood, pipe cleaners, storyboards or storytelling. During project stages when the team desires the greatest level of conceptual involvement by stakeholders, low fidelity or early stage prototypes are desirable. It is often too early to make significant investment in concepts that will be discarded. Early stage evaluation benefits from the rough presentation in that stakeholders are more likely to see the opportunity for their contributions to make a difference. A polished prototype may be seen as nearly complete, thus suggesting that the team would be unwilling to make significant adjustments based on stakeholder feedback. Software based products can be initially emulated on paper by having a design team member function as the program and provide responses and change drawings consistent with the concept. As the concepts mature, learning objectives for prototype evaluation become more sophisticated and require closer approximation to the final state of the solution. Investments in these prototypes will be more significant, but even after the pilot it may be learned that what has been designed does not address the targeted problem. Ultimately the stakeholders may be excited and happy, but the product or service may not be deliverable or sustainable given conditions like the market, suppliers, partners, regulation and business model. The designed innovation may be too early or too late to market. For example, while Internet streaming of movies, television, and music is popular in the targeted market, providing the same content on physical media (ex. CD, DVD, vinyl records, holographic cubes) may not succeed.

Keep in mind; prototypes within design thinking are learning tools. The goal is not to justify solution concepts to stakeholders but to explore how a particular concept can be adapted or enhanced to be more beneficial to the stakeholder. In one non-design-thinking context, prototypes are used to verify that specified functionality or properties are indeed present and reliable. In that context, prototyping is part of a quality control system. Where products or services involve multiple teams or disciplines, prototypes are built to ensure each team's contribution integrates and functions together as a whole. As a product development project converges on a solution there will be a need to evaluate supply chain requirements and alignment with the business model. To some degree these prototyping objectives are necessary when producing high fidelity prototypes within a design-thinking project. As the team desires more realistic performance, experience or interaction between the prototype and the stakeholder, a minimum level of quality and functional integration is necessary. However, for design thinkers the prototype need only be good enough to elicit reliable and useful feedback. This feedback may cause relatively significant change in the solution concept, which means that some engineering outcomes related to quality and integration as well as supply chain considerations may be effectively reset. The goal of design thinking is to solve the problem and not be overly committed to an interim solution.

### 2.1.8 Time for Learning and Validation

Following a user-centered design approach using ethnographic tools to achieve deep insight often results in data that cannot be relied upon as representative of a target stakeholder group. The collection of stakeholders who have evaluated interim prototypes is stating personal preference and opinion. When taking up design thinking, the expectation within the design team and those sponsoring their efforts should be that there is business value in learning insights even though they may not be generalizable market data. This learning will inspire ideas, expose unknowns and challenge assumptions. A relevant quote attributed to Aristotle is "The more you know, the more you know you don't know."<sup>3</sup> As consequence, this learning will raise investigative questions not previously considered. One or several stakeholders' low or high opinion of a solution feature is not on its own validation or proof. A stakeholder's feature change suggestion may not be a positive outcome for a majority of the targeted market or audience. However the insights gleaned by stakeholder involvement inform ongoing solution concept evolution that will be evaluated by future stakeholders. Similar to brainstorming dynamics, a stakeholder evaluating a later prototype will be influenced by previous insights, and may provide input that builds upon the team's understanding and improve solution validity and value.

Diversifying the stakeholder group as the project progresses, and embarking on co-creation (discussed in section 3.2.10) with insightful stakeholders will enhance confidence that a solution is approaching validity. By utilizing a managed pilot/"soft launch" prior to transferring the solution to the production or operations teams, the team's understanding reaches the highest level maturity it can have without a potentially costly and highly visible commitment to enter the market or go live

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<sup>3</sup> Source: <https://www.goodreads.com/quotes/526642-the-more-you-know-the-more-you-know-you-don-t> (last accessed 9/2018)



formally. It is important that stakeholders not involved in the preliminary design stages provide the basis of pilot's data collection and analysis. Their lack of initial involvement is consistent with the market, and their commitments, ideally financial, will be based on the merits and relevance of the solution that they will determine independently. This also allows for marketing campaigns as well as relevant production and logistics to be tested. However, true validation of the solution requires the solution be fully subjected to market or operational challenges and constraints. Although most design-thinking approaches do not guarantee market acceptance, the risk of the delivered solution being rejected or failing to meet feature expectations has been significantly reduced.

## 2.2 Design Thinking Resources

In order for design thinking to succeed, the right ingredients need to be assembled. In the coming section, the human component will be explored. Soon to follow are sections that discuss the desirable workspace, the materials often used in design thinking, and finally the needed integration and cooperation between the design-thinking team and the greater organization.

### 2.2.1 People

Not surprisingly, the people working on a design-thinking project are critical to its success. The qualities of the individuals and the emergent team need to be carefully considered.

The individuals that are needed are those who are willing and able to adopt the design-thinking mindset. These individuals come from a diverse range of formal training and professional experience. These people are experts in a system or field or area of the business. They are observant and they listen. They have the ability to frame problems and solve them. They can think strategically and execute tactically. They are both creative and analytical. They are communicative and comfortable with visual thinking and visualization. In order to be effective collaborators they need to be empathetic with their colleagues and stakeholders. They encourage others to share and consider the contributions from others respectfully. Many will need to be able to lead as well as follow. Team members need to be organized but also flexible. With each member being essential, they must be willing and able to make and honor commitments to the team.

The team that emerges from assembling these highly qualified people should have a spirit of shared purpose, flexibility, collaboration, urgency and mutual support. Qualified people should be selected and as such each person is respected for their past accomplishments and the potential they offer to the team. The team should be an enjoyable and safe group to work within. By fostering security and goodwill, each member is encouraged to take personal risk that arises from sharing their work products, ideas and their willingness to fail in order to learn. The team needs to adopt an attitude that each individual succeeds when the team succeeds. The dynamics of the targeted problem and the collective stakeholders are the arbiters of truth not the team or any individual. In other words the team possesses a keen but humble collective intelligence.



There are a number of roles that need to be performed. Some roles are long running and others are temporary. An individual may assume more than one role as well as some roles may be assigned to more than one individual. There will be a need for a project manager to manage communications, resources, planning, monitoring, and work assignments. Many collaborative design-thinking activities require a facilitator. Analysts will be needed to yield insights from the data collected. Subject matter experts are needed to contribute their knowledge and skills to interpret, evaluate and contribute to the solution's evolution. The team will need someone to recruit stakeholders and coordinate their involvement. Given the sensitive nature of innovation investments, the recruiter may likely need to ensure stakeholders accept and sign non-disclosure agreements. The stakeholder recruiter may need to coach the team not to disclose more than what is necessary. The stakeholder recruiter may need to ensure compliance with ethical standards in human subject research. The team will need ethnographers who will perform interviews or observations. These ethnographers may administer surveys or run a focus group. The team may need a liaison to provide communications between the team and the organization. Prototype builders with technical expertise will be needed as the prototypes approach realism. With so many artifacts being produced, some sort of management is required. A curator role would ensure that important artifacts are preserved and are accessible. It is important to maintain the conceptual provenance of the prototypes produced. Key hypotheses and assumptions tested with each prototype need to be preserved and traced, and the corresponding adjustments to subsequent prototypes need documented linkages as well. The curator is in part a historian maintaining the team's collective understandings and experiences. The curator can function in a quality control capacity by ensuring the team's documented outcomes are faithful to the learning process and iterative progress. Depending on your organization, designer skills may not be pervasive. If this is the case, locating and designating the designer role may be valuable. Although initial prototypes need not be aesthetically perfected, they do need to communicate the concepts the team is considering. Although this list of roles is fairly long, it is not exhaustive; the team may find they need to specify other roles.

Often the team consists of core members and is enhanced with extended members. A core is necessary to maintain continuity throughout the project. However the core may lack the diversity needed for brainstorming or may need subject matter experts to contribute at certain stages. When establishing the core team the expense and impact of capturing human resources that may be underutilized at various stages should be considered. Design-thinking projects are often given aggressive milestone dates. The time to locate and commit the extended team is at the project's beginning. Schedule risk due to resource availability issues should be avoided when possible. The introduction and possible re-introduction of current project state with extended team members is a disadvantage of having temporary members. If it appears that an extended member is likely return to the project repeatedly, the individual or their desired background may need to be included into the core-member set.

The significance of personnel acquired and the team they form cannot be overestimated with respect to the likelihood of a successful design-thinking project.

### 2.2.2 Place

A space needs to be located that facilitates collaboration and imagination. Ideally this space is dedicated to the project or can be reserved for the project for extended periods of time. Design thinking produces many physical artifacts. These artifacts are most useful when they are accessible and visible. There is a persistent need to put ideas into context and recognize the current state of understanding. Being able to juxtapose these artifacts facilitates new perspectives that can yield valuable insights. Visual thinking and visualization require the content under consideration be visible. This translates to the need for stationary and mobile whiteboards, pin boards on rollers, display screens, easels, rolling shelves, storage caddies and large surfaces on which to hang things.

It is tempting to ban seating and large horizontal surfaces and allow the space to be an idea gallery. However, the team needs to be able to sit and use creative tools and materials while being present with the artifacts as they produce new ones. Some suggest unusual furniture design to stimulate creativity. Flexibility of the furniture is essential. The tables should fold and roll away and seating should stack. If space permits, it would be useful to have storage nearby this creative space to locate unneeded furniture. It may not be practical to have workstation grade computers, 3D printers, plotters, tabletop laser cutters and other space consuming technology and tools in the creative space. Lewrick, et al. recommend that 5 m<sup>2</sup>/55 ft<sup>2</sup> per participant be used as a sizing parameter for this type of space. [B2] Space, like time and money, is often a scarce resource. The actual size of the space may become a limiting factor on how large the team and collaborative activities can be.

Often lighting provided by the standard grid array office lighting is not flexible in terms of placement and brightness. The color temperature of creative space light should approach sunlight especially if natural light is not available in the creative space. The ambient light color affects mood and influences the observed color of the artifacts in the space. If options are available, consider indirect lighting. This type of lighting reduces the glare produced by many downward facing light fixture designs. If additional creativity stimulation is desired, consider using other colors of light, adjusting brightness as well as directionality. Ideally these options are available throughout the project as opposed to working with an initial static design.

Teams have been known to use the space as visual history of the project. A person entering the space can scan from the project's inception to the current state. Key decisions and their effects can be seen. Stakeholder quotes, photographs and personas are often presented. This space can be used to be an immersive experience for the team and visitors. Visual task assignment, project status, impromptu ideation and communication schemes can be assigned a location within the space.

Design thinking is often oriented around physical proximity and presence. Design thinking has been used with virtual teams. Virtual teams use collaboration tools that emulate some of the essential properties of a physical collaboration space. It is beyond the scope of this course to discuss the effects of adapting design thinking to virtual teams.

### 2.2.3 Materials

If you visited a well-stocked design-thinking team's creative space, you might get it confused with an art supply store, office supply store or an early childhood developmental classroom. Unlike a kindergarten, you would find paper guillotines, scalpels and adhesives you would not entrust a 6-year old with. Making and visual idea transfer are essential elements of design thinking, and to that end, the materials needed go beyond pens, notepads, laser printer toner and laptops. Some items you may find are idea stimulators (ex. garden gnome, plastic pink flamingo) or empathetic/cultural icons (ex. piece of the Berlin wall, stethoscope, cane, pivotal period newspaper clipping, a popular 1970's movie poster, photograph).

Although sophisticated computer aided design tools and output devices (ex. 3D printer, laser cutter, stereolithography) may be used, they are not essential. What is essential is that the media and tools be natural to the users in that they enable thinking and communication and not become obstacles as the technical tasks impede thought flow. Sketching and diagramming with pencils and markers on whiteboards, sticky notes, flip chart paper or tablet computers can go a long way in terms of idea expression. By using a means of communication that is swift and relatively effortless, thoughts unfold as sketching occurs and can stimulate additional thinking in response to what is manifested visually. The medium becomes essentially an extension of the thinker's visual cortex. Speed and effort are often associated with emotional commitment. Something difficult and time consuming to perform is harder to abandon independent of its objective value or quality.

Visual expression and prototyping are the two most significant uses of design-thinking materials. In this context, visual expression is broader and potentially spontaneous. Think of visual expression as casual as greeting someone with "Good Morning." Visual expression is a multimedia communications mechanism. As team members share ideas, they utilize materials to complement their verbal exchange. The benefit of visual expression is that it is in many respects self-documenting. A portion of an idea exchange persists beyond the moment. This tangible result is a memento that may help participants to recall the idea exchange. Digital photography and scanners are a means to capture visual expression that needs to be archived or relocated.

Prototyping is also a form of visual expression, but is the result of more deliberate and considered effort. Prototypes are manifestations of solution concepts. Prototype fidelity (discussed in section 2.1.7) varies as the project progresses. The materials used may be paper, play dough, popsicle sticks, Lego blocks, pipe cleaners, and foam core. At initial conceptualization, paper is often a viable medium. If it is important to be able to touch, rotate and view a concept from multiple perspectives it may be more effective to construct a simple 3D replica using versatile materials like play dough, pipe cleaners or Lego blocks. As prototype fidelity increases, it may not be necessary to have custom enclosures, mechanical and electronic components developed. Off-the-shelf or creatively repurposed commercially available components may be sufficient. Having access to or utilizing a consultant who has a workshop equipped with mechanical and electronics tools and instruments will likely be necessary as physical product prototypes increase in fidelity.

Here is a quick list of materials typically needed: whiteboard markers, colored pencils, sticky notes of various shapes and colors, colored adhesive dots, string, colored sheets of paper, pipe cleaners, flip charts, large rolls of paper, tape (cellophane, masking), glue, Lego blocks, scissors, and index cards.

While on the topic of tools and materials, ethnographers will need audio and video capture capability. These records are vital for data capture and analysis. Moreover, the non-linguistic aspects of encounters like intonation and body language are helpful for the team to better empathize with the target population.

## 2.2.4 Organizational Fit

Design thinking, as of 2018, is not exactly a fringe or avant-garde approach to systemizing innovation. Your interest in this design-thinking course may have been influenced by your business's interest, a well written business article or you may have come to realize learning about design thinking is a prudent professional development investment. Integrating design thinking into standard business conversations and operating approaches remains a challenge in many organizations. Internal stakeholders beyond the design team may find the process and objectives off-putting or possibly threatening. Some design-thinking authors suggest embracing parts of design thinking on initial low-risk well-aligned projects or simply avoid the term "design thinking" at first. Liedtka and Ogilvie mention that design thinking at Proctor & Gamble was introduced without even telling the initial teams they were following a design-thinking approach. [B1] Successful projects resulting from design thinking, albeit not widely known, will establish credibility for the approach within your organization. The necessary initial experiences of executing design-thinking projects will build confidence and valuable skills and knowledge for more significant projects.

An important aspect of any project is managing expectations and keeping project sponsors, investors, partners and managers informed. Liedtka and Ogilvie have four suggestions for "managing up." [B1] The first is to tell "human-centered" stories. Human-centered stories help make ideas and progress feel real. The anecdotes and images of potential users involved in the design process allow external parties to feel that intermediate outcomes are tangible and relevant. The second tip is to incorporate data (ex. cost of old approach vs. design-thinking approach, size and impact of the problem) into the stories. Data provides necessary information for their consideration but also reinforces the story's credibility with analytical data. Their third suggestion is to provide transparency. Avoid the burden of project status communication by inviting senior leaders to visit the team's workspace, and encourage them to look at the visible visual outcomes of the process. The active creative space can be used as a live status report. The last suggestion is to share project results. A project that yields unambiguous financial or business value is a clear winner. However, the business still gains value by developing insights even from an endeavor that does not produce a viable innovation. By failing and learning from it, the business is better positioned to succeed the next time.

Gaining recognition for the value of attempting innovation and learning regardless of the commercial outcome may be a significant hurdle to overcome within businesses. Innovative businesses recognize the significance of a “return on learning” and are willing to invest financial capital for “comprehension capital.” Disruptive innovation often requires addressing a hard problem. Solutions for these problems require deep and diverse skills and knowledge. Locating and accessing those people may require the organization to permit the functional structure to relent and allow enterprise benefit to supersede business unit objectives. Lewrick et al. suggest businesses should center themselves on the customer, which will cause the business to organize in a more flexible manner in order to promote positive customer experiences and support the necessary ecosystem. [B2] This potential restructuring and repurposing of the business may yield an innovate powerhouse, but it may not be necessary in order to utilize design thinking in your organization. However, some solutions may not be viable from a delivery and business value recognition standpoint because of the organization’s structure and business model.

## 2.3 Design Thinking Processes

This section is a survey of several well-known design-thinking processes. It is valuable to recognize that multiple approaches exist in order to anticipate differences in approach as you learn more about design thinking and practice design thinking professionally. In some respects, design thinking is a personal way of reasoning through a challenge. Given the nature of most relevant challenges, answers require time, people, coordination, materials and funds. Design thinking requires project management, which will also be discussed in this section.

### 2.3.1 Numerous Approaches

Prior to the adoption of designerly ways to solve business challenges, scholars have attempted to describe how designers and design centric organizations (ex. engineering firms) design and manage design. These process models helped inform the models adopted in design thinking. Initial process models described a linear (forward non-deviating) progression through the design process. These were considered simplistic and alternatives suggested iterative workflows as well as attempted to consider the complexities related to suppliers and product business ecosystems (ex. manufacturing, marketing).

The Design Council, a United Kingdom charity with focus on design, has performed and published design research. Their report titled “Eleven lessons: managing design in eleven global companies - Desk research report” provides a brief history of design process models. [R1] One finding they raise is that no best practice design process model is likely to emerge. Two notable factors for this they raise are: 1. With the world changing so quickly, an “ideal” approach would not be relevant long enough to be established, 2. Businesses need to adapt design processes to their needs. In light of this, the Design Council suggests businesses need the ability to respond quickly by investing in flexible infrastructure, foresight and intelligence. [R1] Although there is no “one size fits all” process model, the Design Council suggests that there is a positive relationship between business success and a business formalizing their design processes. [R1]

Design related processes have been introduced into service design, experience design, organizational structure change, marketing, and business culture change. The customer or user has become a critical if not central component of many design process models. Per the Design Council report, Philips Design has developed a user- or human-centered approach called the High Design Process with goals of creating value for customers, shareholders and society. [R1] The Design Council's research report titled "Eleven lessons: managing design in eleven global companies - A study of the design process" investigates how eleven businesses (ex. BT, LEGO, Microsoft, and Starbucks) perform design. [R2] In this report they organize their findings around the "Double Diamond" process model, which the Design Council developed (see section 2.3.2). The report finds that business culture and business model strongly influence each business's approach to design, but overall there are common themes across the processes.

The design process models explored in this course are well known within the design-thinking community. They are generic process models, and the process model developers have established tools and methods that are tailorable to the project. What is common about them is they recognize that the end solution will unlikely appear in a single pass through the process. Iteration is necessary to refine understanding and successively approach a reasonable solution. Multiple solution approaches should be explored prior to settling on one. Showing a concept is more valuable than talking about it. "Good enough" is the quality standard as it relates to prototypes prior to user evaluation. Speed to understanding is essential. The allotted timeline of projects should be aggressive, but tailored to the challenge and constraints.

### 2.3.2 Double Diamond Process

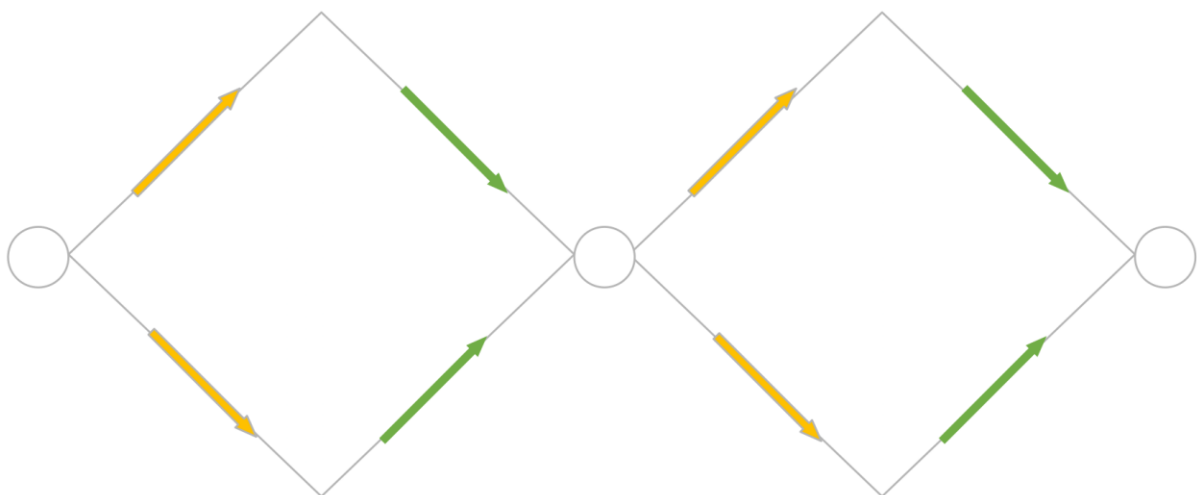


Figure 2-1: Double Diamond process model

The Design Council, a United Kingdom charity with focus on design, was founded in 1944 to understand and promote design in order to improve businesses within the United Kingdom.

Through their research they developed the Double Diamond process model. [WR2] The name comes from the visual that depicts the process model. In Figure 2-1, each diamond is initiated with divergent thinking followed by convergent thinking.

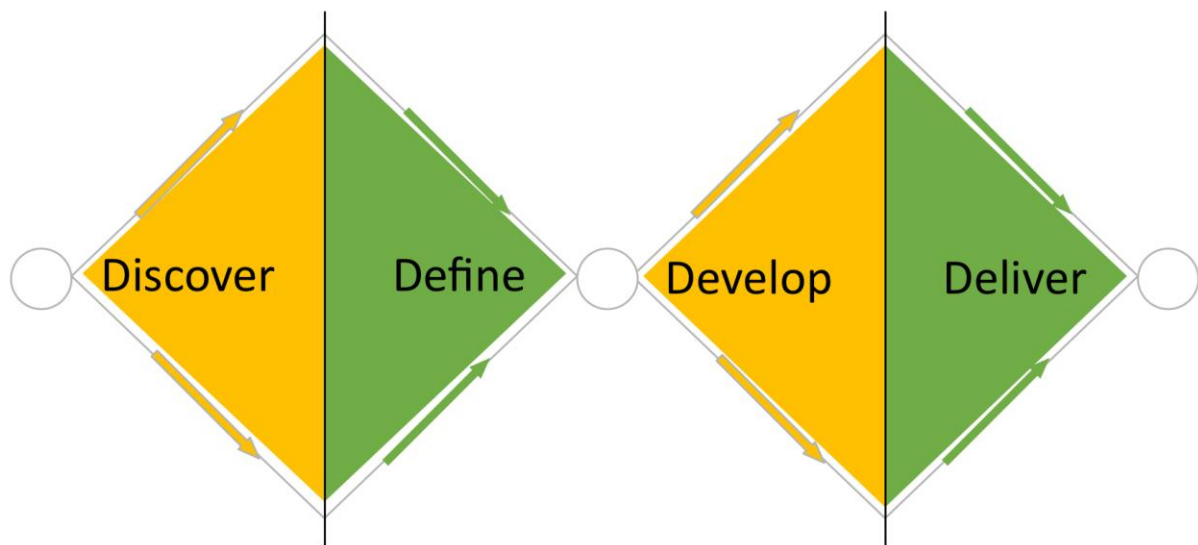


Figure 2-2: Double Diamond process stages

There are four stages, which the Design Council calls “steps,” in this model. [WR2 - WR6] As shown in Figure 2-2, the stages are Discover, Define, Develop and Deliver. Iteration is recognized as a necessary dynamic in good design, but this process flows primarily from left to right. Iteration is expected to occur within the stage. As shown in Figure 2-3, there are three primary artifacts in this process. The first is an initial description of the problem or hypothesis to provide focus to the Discover stage. The second is the formal definition of the problem that results from the Define stage, which is captured in a document called the design brief. The design brief establishes the foundation for solution development performed in the Develop stage. The Deliver stage produces a solution resulting from a final design, which is produced and introduced to customers.



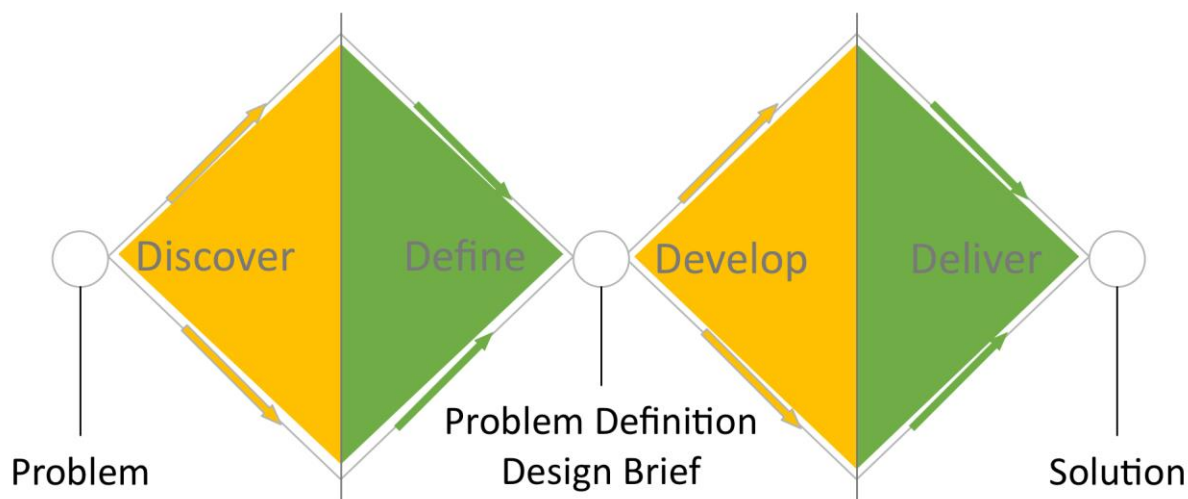


Figure 2-3: Double Diamond primary artifacts

In the Discover stage, design thinkers expand on the initial problem description by using design methods that expand understanding, get different points of view, and notice things about the problem they had not earlier considered. The Define stage is where the design-thinking team builds a coherent understanding informed by considering the insights obtained in the Discover stage. The team prioritizes aspects of the problem in terms what should be acted upon first. They consider feasibility as a criterion. The goal is to develop the design brief that will be the basis of upcoming development efforts. The next stage, Develop, is dedicated to the creation, testing and refinement of solution concepts and prototypes. The final stage, Deliver, signifies the selection and final adjustments of the solution. The solution is manufactured or implemented and made accessible to the targeted population.

In the second half of 2018, the Design Council's website aligned 25 design methods to the four stages. [WR2 - WR6] These methods are documented with brief descriptions, purpose and how-to information. URLs to these web pages are provided in Chapter 4.

### 2.3.3 5-Stage d.School Process

The Stanford d.School, more formally called the Hasso Plattner Institute of Design at Stanford, is an academic collaboration between the Hasso Plattner Institute in Potsdam, Germany and Stanford University in Stanford, California. The Stanford d.School was one of the first d.Schools or Design Schools formed around design-thinking approaches to design. Their process model has changed from a 6-stage model of Understand, Observe, Point of View, Ideate, Prototype, and Test to a 5-stage process model of Empathize, Define, Ideate, Prototype and Test. [LA1] The stages of Understand and Observe were consolidated to Empathize according to Lewrick et. al. [B2] The stage titled Point of View was adjusted to become Define in the current model.



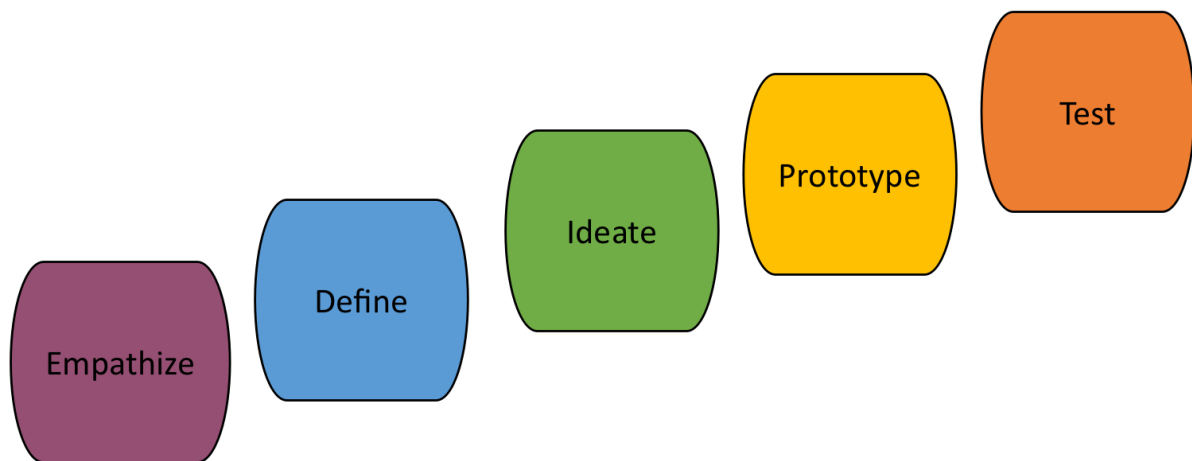


Figure 2-4: Stanford d.School 5-Stage process model

Unlike the Double Diamond the visuals associated with the 5-stage process model are not firmly set. Given the power of visual thinking, the variation seen in Stanford d.School supplied materials implies there is inherent variation in how design thinking occurs from their perspective. Older drawings show non-sequential flows between stages and returning flows with return flows from Test and Prototype to what is now called Define. As shown in Figure 2-4, there is a dominant progression from left to right, but new information causes the problem and the potential solutions to be reconsidered. In Figure 2-5, the author's interpretation of possible stage dynamics is depicted. Iterative transitioning between stages is expected. After initial testing has started, iteration between Test, Define and Prototype (possibly Ideate as well) is expected.

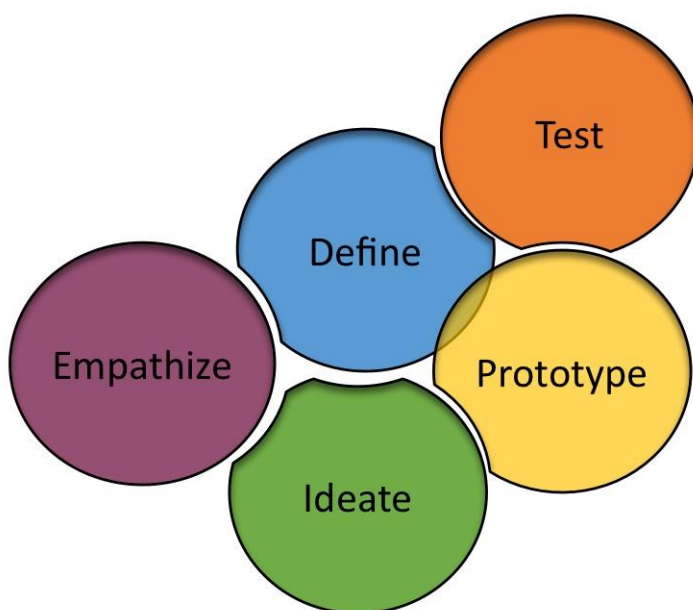


Figure 2-5: Stanford d.School 5-Stage process model stylized to show a possible stage dynamic

Beyond suggesting the 5-stage process model, Stanford d.School advocates for six attributes of the design-thinking mindset: human centered, bias toward action, radical collaboration, culture of prototyping, show don't tell, and mindful of process. Human centered is the idea that design thinkers should identify with the user's challenges and develop solutions that address their needs. Bias toward action directs design thinkers to solve problems instead of finding additional ones. Team members should prototype to learn insights instead of expressing self-important personal opinion. Radical collaboration suggests breakthroughs come from a team consisting of members with diverse viewpoints, education and experiences. Culture of prototyping is related to the notion that solutions will arise from trying out concepts and getting user input early and often. "Show don't tell," emphasizes the need to communicate visually rather than verbally. Mindful of process encourages teams to be aware of which stage the project is in, and what needs to be accomplished (ex. divergent thinking during Ideate but convergent thinking during Define) in the current stage.

In the Stanford d.School's process model, the stages have the following objectives [LA1]:

- Empathize - The stage is oriented towards understanding the intended users and the problem from their viewpoint by observation, engagement and immersion.
- Define - At this stage the needs and insights discovered in Empathize are transformed into an actionable problem statement or design vision tailored for the users.
- Ideate - Within the context of the problem statement, the team generates many "radical" design alternatives that explore the solution space.
- Prototype - At this stage, promising design alternatives are made tangible with which the team, users and others will experience and interact.
- Test - Prototypes are placed into appropriate contexts of users' lives with the goal of gathering thoughtful feedback, learning and refining solutions.

Stanford d.School has made many training resources freely available. Their "Design Thinking Bootleg" is presented as a deck of cards that explain their process model and describe over 30 methods that help with accomplishing each stage. [LA1]

### 2.3.4 Designing for Growth Process

The "Designing for Growth" (or Growth) process model was introduced by Jeanne Liedtka and Tim Ogilvie in a book published in 2011. [B1] At the time of writing the book, Jeanne Liedtka was a member of the University of Virginia's Darden School of Business. Tim Ogilvie was the CEO of an innovation strategy consultancy called Peer Insight. The book has a related website with information about this book and its companion book. [WR1]

The Growth process model consists of four stages that are framed as questions: What is?, What if?, What wows?, What works? The general flow through the process model aligns with the order of the questions. The authors describe ten tools that align with their process model. They also recommend the use of four project management aids. The visual associated with the Growth process model is unique and is similar to the Double Diamond in that it aligns the use of divergent and convergent thinking to the process. The original depiction of the Growth visual can be found at

the website mentioned in the previous paragraph. Figure 6 shows an interpretation of their visual. The intensity of colored fill indicates the intensity of divergent and convergent thinking occurring within each stage. The What if stage is the most intense in terms of divergent and convergent thinking followed by the What wows stage, What is stage and finally the What works stage

With respects to iteration and the expected flow through the Growth process, the expectation is that an actual project utilizing the Growth process model will not flow smoothly from left to right and that iterative design is critical to closing in on a viable solution. In Chapter 3, a visual guide is provided that maps the common application of ten tools into context of the process model. Liedtka and Ogilvie caution that these tools may align slightly differently depending on the needs and opportunities within your project.

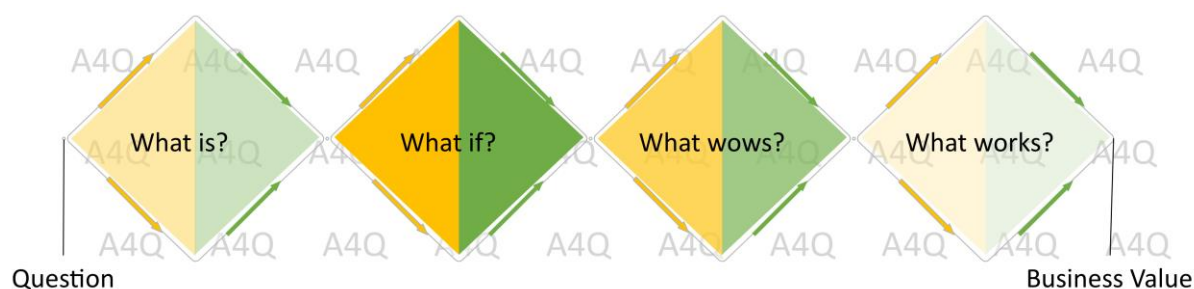


Figure 2-6: Growth process model – an interpretation

In Chapter 3, this process and its tools will be discussed in greater detail. For purposes of comparison, a brief description of each stage is provided below:

- What is? - The design-thinking team in this stage investigates and seeks to understand the users and their current needs, wants and pains related to the problem.
- What if? - In this stage, the team imagines and conceives possible future solutions.
- What wows? - In this stage, the team selects and focuses on concepts that wow, which requires testing assumptions and prototyping.
- What works? - In this stage, users have an opportunity to experience the prototype and make creative suggestions. The most promising prototype is transformed into a nearly final product/service and rolled out to a test market.

### 2.3.5 Role of Project Management

According to the Project Management Institute's Lexicon of Project Management Terms - Version 3.1, a project is "[a] temporary endeavor undertaken to create a unique product, service, or result." The lexicon does not have the term "innovation" defined, but a possible definition with the help of the Lexicon could be - A temporary endeavor undertaken to create an unusual unfamiliar pioneering product, service or result. The project management term "progressive elaboration" sums up the essence of design-thinking based innovation. Depending on the process model and the methods used, a project charter that attempts to encompass the entire innovative effort will more likely provide aspiration as opposed to concrete direction. A program, a coordinated group of related projects and program activities, may be better suited to manage innovation from a project management perspective. At the outset of innovation, beyond having a general strategy of using design-thinking approach and tools, no one really knows what and how the final result will be produced. In some organizations, a program may be a helpful means to break up innovation progression into steadily more definable projects. Agile software development project management approaches have a very similar tone with design thinking in terms of iteratively and aggressively approaching an acceptable outcome. However with innovation there is a higher level of uncertainty, unfamiliarity and inexperience related with a pioneering objective. Innovation aligns closer to research than it does with development with respect to project attributes like initial deliverable requirements and needed resources.

Like research, design thinking devotes considerable focus on testing hypotheses. When testing hypotheses, researchers are concerned about identifying and separating signals from the noise of random influences and misleading data. It is essential that the learning objectives for a particular prototype test be understood during prototype development and during actual testing. It would be a lost opportunity if a prototype fails to be relevant to a necessary hypothesis or a test activity fails to investigate it. A project management challenge will be prioritizing the hypotheses to be tested. This judgment will rely heavily on the team's understanding of: the problem, solution options and the design-thinking process.

Design thinking operates on a sense of urgency. The Agile development term "sprint" has been adopted into some design thinkers' vocabulary and tactical approach. Sizing the duration of the sprint will rely heavily on resource availability, complexity of the problem, complexity of the prototypes and access to stakeholders and/or relevant data. Sprint durations may change as the innovation effort approaches the final result.

It is important that the team feels progress is being made at a brisk pace. An expectation of energetic participation and progress helps the team to focus and promotes a sense of purpose. When the learn-make-evaluate loop is perceived to be operating sluggishly, tentative decisions may unintentionally become firm, because over time team members are diverted to other design aspects, or by virtue of age these decisions gain stature, or possibly they became antecedents to a significant line of effort. By returning to the stakeholders, especially new ones, these decisions may eventually be exposed to stakeholder consideration. However, the signals related to these decisions may get lost under the clutter of hypotheses being deliberately investigated at the time. There is also risk related to the learn-make-evaluate loop's effectiveness if it runs faster than the team can support. Beyond the issues of inadequate learning, making and analysis, stakeholders and their goodwill are scarce resources, which should be utilized when the team is prepared, and when the team is able analyze the results with adequate care. While on the subject of pace, Liedtka and Ogilvie recommend that time be available for the team to step back and see if new relationships and ideas emerge - see the forest from the trees. They also recommend that time be available for disagreement. The power of diversity is in part the range of available viewpoints.

In a fast and fluid environment it is important to have anchors along the way. Process documents are needed to ensure the team's outputs are being orchestrated. These documents assist the team align task objectives with past learning and strategic design decisions. These documents may function as deliverables that mark key milestones along the innovation process. The design brief or design vision is a document that sets the direction of prototyping in the Double Diamond and Stanford d.School 5-stage process models. The "Designing for Growth" process model introduces the design brief at the very beginning of the process. "Designing for Growth" process relies on three other types of documents that Liedtka and Ogilvie call project management aids. The document called "design criteria" is the result of the What is stage. The "napkin pitch" is available at the end of the What if stage. The last is the "learning guide", which is produced prior to the What works stage. These aids provide guidance to the subsequent stages. These aids also enable continuity and

formalize decisions. Liedtka and Ogilvie provide templates for these project management aids in their book. [B1]

At times it may feel as a project manager that you are managing chaos and standing at the edge of a deep impossible chasm. By trusting your team and the design-thinking process, you will succeed in at least knowing what does not work. Thomas A. Edison, inventor of the phonograph and long lasting incandescent light bulb, said “Many of life's failures are people who did not realize how close they were to success when they gave up.”<sup>4</sup>

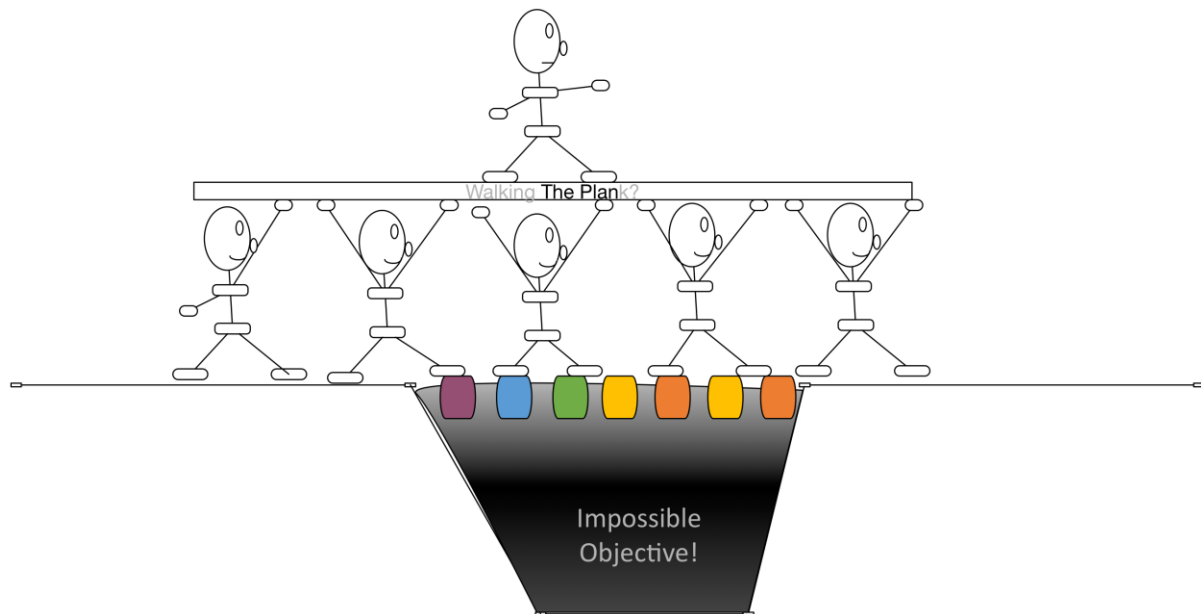


Figure 2-7: Trust your team and the process

<sup>4</sup> [https://www.goodreads.com/author/quotes/3091287.Thomas\\_A\\_Edison](https://www.goodreads.com/author/quotes/3091287.Thomas_A_Edison) (last accessed 9/2018)

## Chapter 3 – Design Thinking in Practice

### Keywords

archetype mapping matrix, archetype persona, assumption testing, brainstorming, competitive advantage, concept development, customer co-creation, design brief, design criteria, execution, journey mapping, learning guide, learning launch, mind mapping, Minimal Marketable Feature (MMF), Minimal Viable Ecosystem (MVE), Minimal Viable Product (MVP), napkin pitch, project management aid, scale, value, value chain analysis, visualization

### Learning Objectives for Design Thinking in Practice

#### 3.1 Process Stages of Designing for Growth

- DTFL-3.1.1 (K3) Practice "What Is" process stage activities to develop a product
- DTFL-3.1.2 (K3) Practice "What If" process stage activities to develop a product
- DTFL-3.1.3 (K3) Practice "What wows" process stage activities to develop a product
- DTFL-3.1.4 (K3) Practice "What works" process stage activities to develop a product

#### 3.2 Design Thinking Tools and Methods

- DTFL-3.2.1 (K2) Explain the need to use tools and methods purposefully in alignment with the design thinking process
- DTFL-3.2.2 (K2) Explain visualization as a means to facilitate design thinking projects
- DTFL-3.2.3 (K2) Explain journey mapping as a means to facilitate design thinking projects
- DTFL-3.2.4 (K2) Explain value chain analysis as a means to facilitate design thinking projects
- DTFL-3.2.5 (K2) Explain mind mapping as a means to facilitate design thinking projects
- DTFL-3.2.6 (K2) Explain brainstorming as a means to facilitate design thinking projects
- DTFL-3.2.7 (K2) Explain concept development as a means to facilitate design thinking projects
- DTFL-3.2.8 (K2) Explain assumption testing as a means to facilitate design thinking projects
- DTFL-3.2.9 (K2) Explain rapid prototyping as a means to facilitate design thinking projects
- DTFL-3.2.10 (K2) Explain customer co-creation as a means to facilitate design thinking projects
- DTFL-3.2.11 (K2) Explain learning launch as a means to facilitate design thinking projects

#### 3.3 Design Thinking Application

- DTFL-3.3.1 (K4) Apply design thinking to product development

## 3.1 Process Stages of Designing for Growth

In section 2.3.4, the Designing for Growth process stages are briefly introduced. This section will discuss the stages in greater detail. The book, [B1], by Liedtka and Ogilvie was the primary reference used in the development of this section.

### 3.1.1 What Is

This first stage is essential to the design-thinking project's success. This stage forms the basis on which the subsequent innovation effort is grounded. This stage helps answer in large part the following questions: What problem are we solving?, Who are we trying to help?, Why do we think this problem needs to be solved?, What is going on now?, What is wrong with the current state?, Within what set of limitations or conditions must any solution work?, and What does success look like? These questions set the origin of the innovation journey on which the design team will embark. Some of the answers will help set broad coordinates of the destination.

As mentioned in section 2.3.5, this stage starts by having a design brief prepared and ends with the completion of the project management aid called design criteria. The design brief has sections titled: project description, intent scope, exploration questions, target users, research plan, expected outcomes, success metrics and project planning. Liedtka and Ogilvie emphasize the design criteria document does not specify how or what is being produced. Rather, the design criteria document describes the qualities of the ideal solution and serves as an extension to the design brief. The design criteria document contains the following sections: design goal, user perceptions, physical attributes, functional attributes and constraints. For more details about these two documents, please refer to the book written by Liedtka and Ogilvie. [B1]

Several tools are commonly used to help the team to develop the design criteria document. The tools that Liedtka and Ogilvie suggest to be used during this stage are: visualization, journey mapping, value chain analysis and mind mapping.

### 3.1.2 What If

The What-is stage is about current state. In contrast, What-if stage is about the future. What does the design-thinking team want the future to be? At this stage the team goes from tearing off into a number of exciting directions to end the stage with concepts that are sufficiently formed to build prototypes and the team considers viable to produce or operate. This stage has the most intense level of divergent thinking. As a consequence, convergent thinking is equally exceptional. An innovative concept is going to coalesce from incorporating unusual ideas and/or unusual combinations of ideas. Although the objective of this stage is to move forward with several promising solution concepts, the tendency of being a conservative realist needs to be set aside at first. The broadest possible view of the solution space needs to be identified before being critical. Do you remember the design-criteria document? That document frames the boundaries of the solution space during ideation. For example, swimming the English Channel with 150 Kg. / 330 lb. in



tow will hopefully not be suggested for a family of four going on a holiday excursion from the UK to Spain.

This stage starts with the design criteria document guidance and ends with a document called the “napkin pitch” prepared for each solution concept the team plans to explore. The napkin pitch summarizes a solution concept’s intended audience, their unaddressed needs, and the reason why the solution may be valuable to users in some unusual and exciting ways. The napkin pitch is commonly organized in a 2 x 2 table. The sections listed from left to right and top to down are: need, approach, benefit and competition. For more details about the napkin pitch, please refer to the book written by Liedtka and Ogilvie. [B1]

The tools that Liedtka and Ogilvie suggest are used during this stage are: visualization, brainstorming and concept development.

### 3.1.3 What Wows

The goal of this stage is to select solution concepts that will truly impress users and business leadership. The selected concepts will receive further investment and user assessment. Solution concepts articulate and highlight extraordinary features. Inadequate features within the concepts are afforded opportunities to steadily improve. This stage iteratively answers two interconnected questions: Are our concept related assumptions valid? What really is this concept? Answering the first question requires assumptions related to a solution concept be identified and evaluated. The second involves making the concept tangible through prototyping. Assumption testing in this stage is done with thought experiments and internal evaluation using available data. Answers will inform prototyping and hopefully avoid preventable errors in judgment prior to having stakeholders interacting with prototypes.

This stage starts with several napkin-pitch documents that summarize the most promising solution concepts. Each napkin pitch gives each corresponding solution concept similar representation. It is important that the design team keeps an open mind and avoids committing to or avoiding a solution concept before assumption testing has completed. The napkin pitch helps the team keep the targeted users in sight, and it functions as a summary of a concept’s features and benefits for the prototyping team to address as they solidify the solution concept. If the team anticipates an aggressive response from the competition, the prototype design can explore product or service differentiators that are challenging to emulate.

The tools that Liedtka and Ogilvie suggest are used during this stage are: visualization, assumption testing, and rapid prototyping.

### 3.1.4 What Works

This stage is centered on stakeholder feedback. A significant portion of this stage feeds into the iterative loop of learn-make-evaluate. The early part of this stage can repeat many times. The last portion is essentially the grand finale of the design effort. The design-thinking team test markets the

most viable solution under realistic conditions. The results of this test are passed on for decision makers to determine the fate of the solution, and the design-thinking effort is closed out.

This stage starts with constructing a learning-guide document that helps align customer co-creation sessions with necessary learning objectives. This document is updated as prototype fidelity increases and prior to running a learning launch. The learning-guide document acts as a running repository of hypotheses or assumptions that require validation through stakeholder evaluation. The learning guide has the following sections: strategic intent, remaining key assumptions to be tested, in-market test plan, and financial capital to be expended. While multiple solution concepts are actively being considered, a learning guide should be established for each concept. For more details about the learning guide, please refer to the book written by Liedtka and Ogilvie. [B1] This stage ends after the learning launch has completed. During the learning launch, there is a risk that serious weaknesses may be discovered that would jeopardize success of the concept as is.

No formal project management aid is specified for the end. However, results of the learning launch should be conveyed to decision makers, so they can decide what to do next, which may be to: “table”, “kill”, “design further” or “transition to production.”

At the end of the What Works stage with the help of the learning guide, a sophisticated understanding of the problem, stakeholders and the solution concepts has been achieved. In order for the organization to benefit from this knowledge capital, it is necessary this understanding be captured and shared. Beyond tangible prototypes, this understanding is a significant outcome that helps justify future design-thinking efforts. In the event the innovation effort is tabled or returns to design, the captured understandings and artifacts will be essential to concept continuity.

The tools that Liedtka and Ogilvie suggest are used during this stage are: visualization, customer co-creation and learning launch.

## 3.2 Design Thinking Tools and Methods

This will section will explore the tools developed for the Designing for Growth process model. Before delving deeper into each tool, it is important to keep the process in mind and understand how each tool aligns with the process model stages as well as the types of thinking on which these tools rely. The book, [B1], by Liedtka and Ogilvie was the primary reference used in the development of this section.

### 3.2.1 Purposeful Use of Tools and Alignment with Process

In the Designing for Growth process model, ten tools are introduced that support the goals of answering the four questions: What is?, What if?, What wows? and What works? Use the following list of tools as the key when translating the numerical labels used in Figures 3.1 - 3.4 into tool names. These ten tools are:

1. Visualization
2. Journey Mapping
3. Value Chain Analysis
4. Mind Mapping
5. Brainstorming
6. Concept Development
7. Assumption Testing
8. Rapid Prototyping
9. Customer Co-creation
10. Learning Launch

Figure 3-1 shows the relationship between the ten tools and the process model. The numerical labels provide a general sense of order of execution. Although this figure is linear, actual execution may not be. Figures 3.2 - 3.4 explore possible iterative dynamics and minor reordering of the tools. By being told which tool works best when, we get a sense of the purpose, dependency and limitation of each tool. For instance, without first using tools 2, 3, 4, 5, 6 and 7 it would be challenging to develop a prototype with tool 8.

Tool 1, visualization, is a universal tool. It is used throughout the design-thinking process. It is located in the center of figures 3-1 to 3-4. to represent how central it is to the design-thinking process. In Figure 3-1, the common visual element behind the four stages represents tool 1.

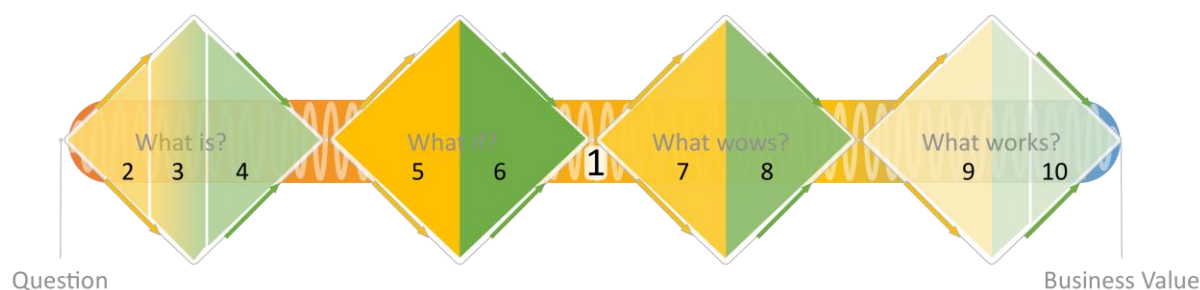


Figure 3-1: Aligning tools to the Designing for Growth process model

Iterative repetition of the tools 5 through 9 can be practical and necessary. The level of effort or time using a particular tool within an iteration may not be consistent when compared across

iterations. It may be that a prototype adjustment under tool 8 is simple to perform while helping answer an important question at the next opportunity to involve customers with tool 9.

Some of the tools can be useful in more than one stage. When the tool is used outside of its commonly considered stage, the tool remains fairly consistent in terms of how it is executed, but the objectives for the tool align with the intention of the stage in which it is being utilized. You will notice none of the tool sequences shown introduce repetition at the ends of the process model. Repetition within the What is stage would require a reset or delay of the subsequent stage outcomes in order to be consistent with a revised outlook of the current state. This implies the original problem is being abandoned or has undergone major revision. Starting an independent design-thinking project to explore the new problem may be a better choice than to start over from within an existing project. The learning launch is a tool that is rarely repeated within a design-thinking project. Subsequent revision and additional market delivery would occur in either future design-thinking projects or by business units who have taken on the task of scaling up marketing, manufacturing and delivery of the innovative solution.

Iteration is based on the learning, making and evaluating loop. Although the team will evaluate their work continuously based on their empathetic understanding of the problem and their prior experience, the only truly authoritative source of assumption validation and hypothesis testing is the customer. This collaborative customer interaction is enabled by tool 9. All iterative loops depicted require customer input (i.e. tool 9) to initiate a return to a previous tool for concept refinement.

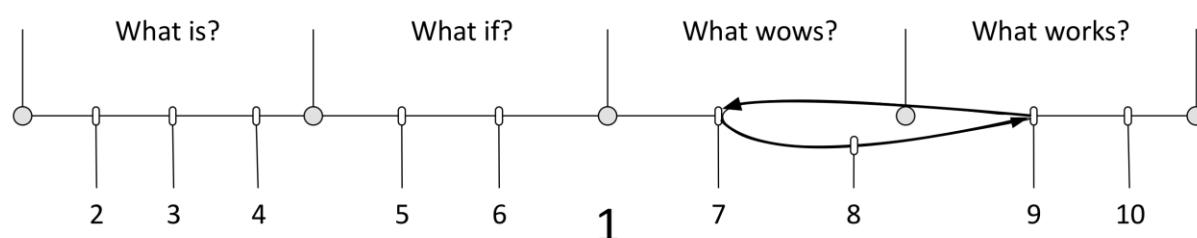


Figure 3-2: Sequence 1: Sequencing tools to the Designing for Growth process model

The primary difference between Figure 3-2 and Figure 3-3 is moving tool 9 out of the What works stage. The change simplifies the figure, and it may in practice be useful to consider tool 9 a part of the What wows stage. Moving back and forth between the two stages may be challenging for those who may see each stage as a milestone. Part of what constitutes the What works stage is the learning guide. This is an important document to maintain in order for the assumptions being tested are documented. In order for the team as a whole to learn from these iterations, results from assumption testing need to be documented. Although tool 9 has been removed from the What works stage, the learning guide should be updated on each pass through the loop.

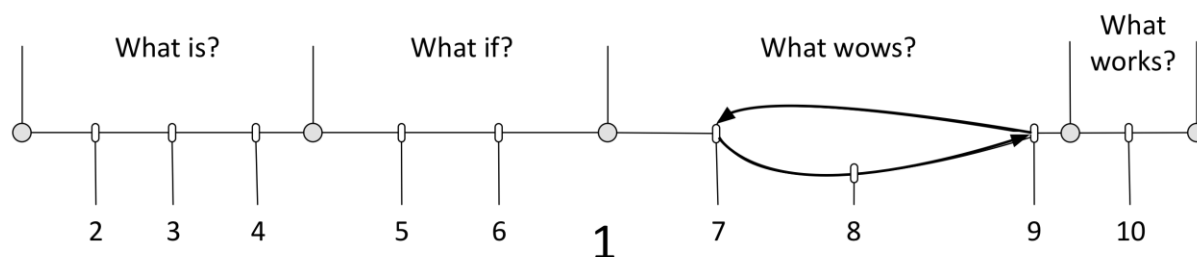


Figure 3-3: Sequence 2: Sequencing tools to the Designing for Growth process model

Figure 3-4 shows iterative cycles within the What if stage. If one strictly complies with the purpose of each stage, prototyping only occurs within the What wows stage. By iterating within the What if stage, progress to the prototyping effort is delayed. If one blends a little Stanford d.School mindset into the discussion, the team should be biased towards action and prototyping as early and as often as they can. In this situation, customer co-creation will rely on visualization to explore solution concept formation with stakeholders. When is iterating within the What if stage a good idea? The answer is when the risk of leaving the What if stage with inadequate solution concepts is significant. Some questions that might help the team spot this risk is: What is the degree of misalignment between the problem and the team's collective expertise? What is the degree of potential change between current and future states? Does the team believe that the gap between present and future states cannot be safely overcome without stakeholders directly involved in concept development? How costly and/or time-consuming will prototyping get for this project? Stakeholder input during concept design can improve validity and credibility of concepts and improve confidence for further investment. Getting stakeholder involvement during the What if stage delays customer co-creation of tangible prototypes, but getting earlier input may be wiser than investing in solution concepts that are too far off target. Iterative design is a "hill climbing" optimization approach that starts with a solution attempt and makes relatively minor changes to reach the best possible answer for a given starting point. Iterative design will yield a "best" answer, but it may not be the right or compelling or preferred answer. This is one reason why the design-thinking goal early on is to identify a wide range of solution concepts that have little overlap.

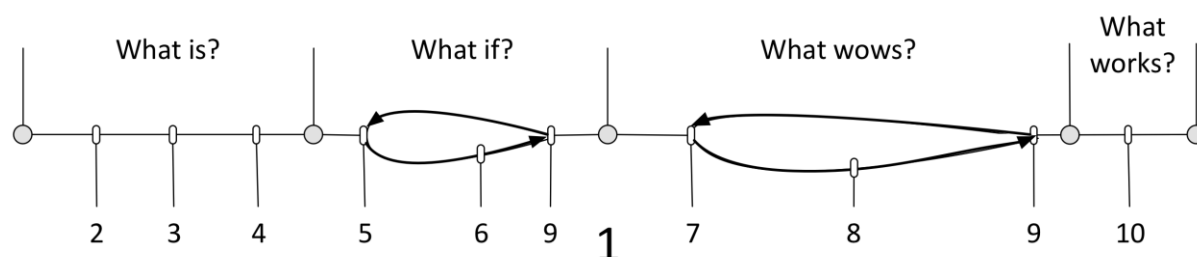


Figure 3-4: Sequence 3: Sequencing tools to the Designing for Growth process model

### 3.2.2 What Is: Visualization

The concept of visualization has two definitions in the New Oxford American Dictionary, and both meanings are relevant to design thinking. The first definition is “the representation of an object, situation, or set of information as a chart or other image.” The second is “the formation of a mental image of something.” Design thinkers are most effective in communicating new ideas when they represent their ideas visually. Language is an important complement, but often it is insufficient for a team to achieve a common understanding. Language alone is subject to misinterpretation. For example, if someone were to say “My spouse and I just bought a new home for \$500,000.” to three listeners.” What would they think that person just bought with that amount of money?

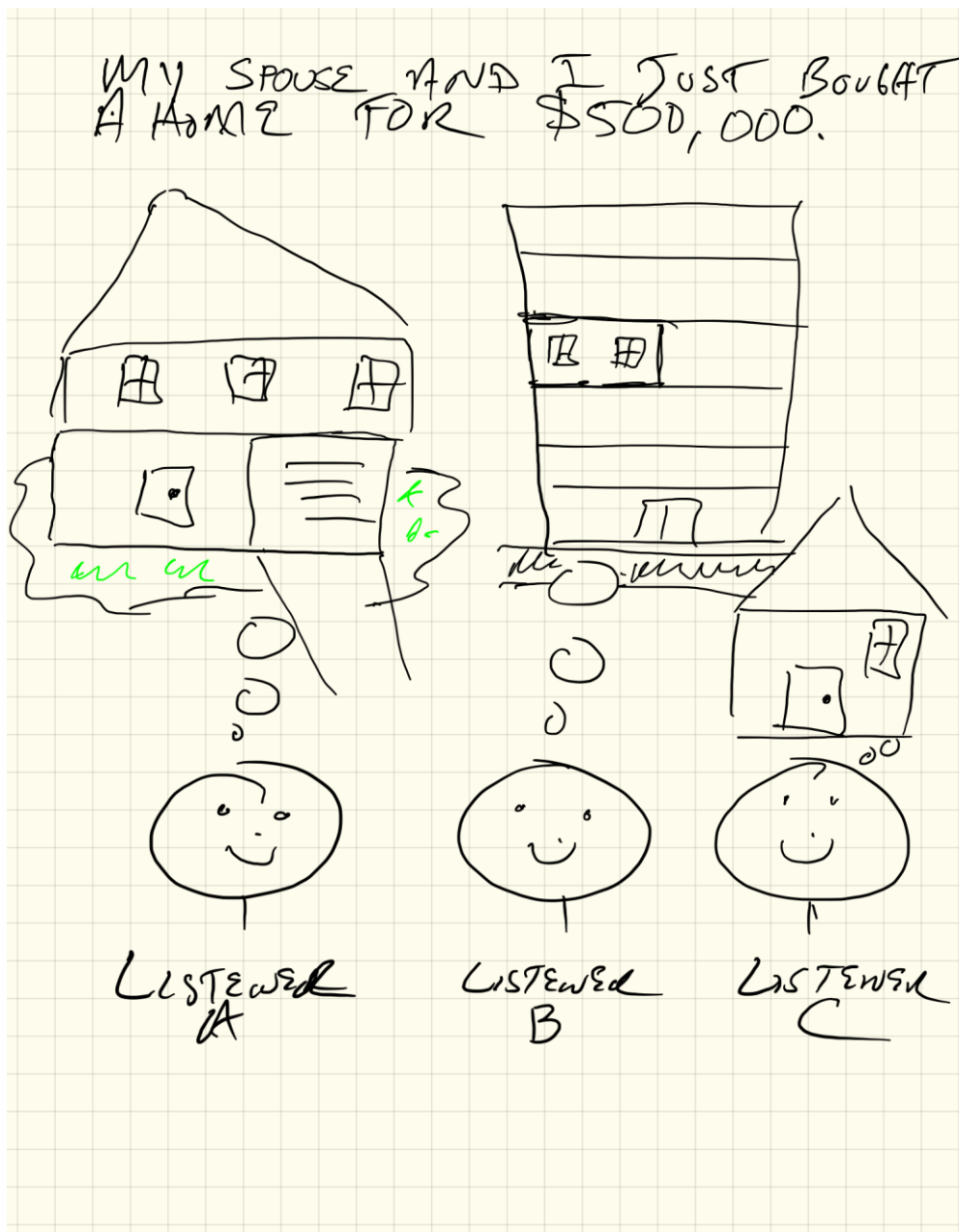


Figure 3-5: Interpreting verbal description

Figure 3-5 shows the potential for inconsistent understanding in absence of greater detail. There are times during the creative process of design when ambiguities are desirable. Listener B may think of a common urban challenge of home owning. Listener A may be thinking about landscaping and cleaning gutters. Listener C may be so happy with the thought of a small quaint home, and start thinking about interior decorating. We would not want them building a home together based on their own mental imagery, but for home improvement ideas we have three very different ones. Notice that by seeing the drawing of the scenario we know what the three listeners are visualizing.

Under the Designing for Growth process model, visualization should be used in every stage of the process model. Team members will represent their ideas, observations, solution concepts, prototype ideas and customer feedback as images and charts so that the team forms a common understanding, and so that stakeholders can appreciate what the team has in mind.

Design thinkers should encourage stakeholders to share their thinking visually. By seeing what is being proposed, stakeholders can more easily seek clarification and offer refinement as a natural part of the exchange. These artifacts will require less translation and be less reliant upon recall when the team as a whole is introduced to the stakeholder's thoughts.

There are a variety of visualization techniques. Some techniques rely on the transmitter of an idea to produce physical images while others invoke mental images within the receiver's mind without relying on physical images to accomplish the effect. As the level of abstraction communicated by the transmitter increases the reliance on the receiver's mental imagery increases as well as the inconsistency or incongruence of understanding between the two parties. Some useful visualization techniques are:

- Sketching - Often performed using pens, markers or pencils to draw line drawings to convey ideas. Speed of use is a dominant benefit to sketching. Rough and simple depictions are often sufficient and possibly desirable for this style's sense of transience or flexibility. Color should be used purposefully to convey meaning based on cultural convention or use specific conventions. Simplicity also applies to the number of ideas or attributes being expressed in a single image. Multiple simpler drawings in same visual plane may be more effective than a single dense and possibly difficult to discern drawing.
- Relating to metaphors and analogies - Metaphors and analogies are effective cultural devices used in physical and mental images. They are often necessary for interpreting the meaning of icons and symbols. They can be used to convey a sense of dynamic or sense of use within a still image. For example, what does "+" or "-" mean to you when associated with attributes of volume, brightness, temperature or speed? It may be that an approach seen in nature or in other disciplines can act as analogies on which to base innovation in a different domain. For example, George de Mestral invented Velcro (a hook-and-loop fastener) after he observed under a microscope how burrs catch onto dog hair.
- Photography - Photographs and video are often used to capture reality in detail. When this visual style preserves real life it is interpreted literally. This medium is very effective for the team to learn about stakeholders, the environment, their thinking, their feelings and the

constraints, which a solution must address. Video documentation of stakeholder response to prototypes allows the team to carefully evaluate the encounter. On occasion, the team may use photography to convey metaphor and simulated concepts in order to communicate prototype ideas and make ideas or emotions more memorable.

- **Storyboarding** - This is a sequence of related drawings that convey activity across a panel of images. This is essentially sketching to tell a narrative not just to convey a static idea. Graphic novels and comic books are published storyboards that span across many more pages than is commonly needed in design thinking. Like sketching, storyboards need not be elaborate in terms of color use, extraneous detail or drawing sophistication.
- **Personas** - These are often fictional characters that design thinkers use to consider what, why and how their stakeholders may be affected by a solution. These fictional characters are sufficient in factual detail to be believable. The details come from known intended stakeholders' demographics as well as from specific people who the team encountered in their ethnographic activities. Personas are given names and may have a drawn or photographed face. They are often prominently displayed within the design-thinking space in order for the design team to be mindful of whom they are serving through their solutions.
- **Story telling** - This is potentially a mixed-media delivery of a persuasive narrative by combining relevant facts. Stories can be accurate retellings of observed events or possibly extrapolations grounded in facts and observations that allow listeners to imagine an idea or solution concept. This is most effective when the narrative is reliable in terms of emotional and analytical integrity. There are numerous forms of live and recorded story telling using combinations of text, speech, images, simulation, props and acting.
- **Guided imagery** - This technique relies entirely on the listener to establish a mental image of a possible future or current reality. This can be used to rehearse procedures or techniques used in medicine, sports or other disciplines. This can be used to evaluate possible outcomes and responses to those outcomes.

Visualization is a powerful means of communication that will enable divergent, convergent, systems and analytical thinking that are needed for the tools and objectives within the Designing for Growth process model.

### 3.2.3 What Is: Journey Mapping

A product or service that does not satisfy customer needs or wants will perform poorly in the market. How do we learn about a customer's wants and needs? There is a disconnect between what people say they value (ex. privacy) and what actions and decisions they make in relation to their claimed value (ex. sharing photos of family events on social media). Understanding of actual decisions and behaviors is more valuable to designers than what is described by customers when asked out of context. Journey mapping as envisioned by Liedtka and Ogilvie is based on anthropologic techniques used to record what anthropologists see and hear within a natural setting. Design thinkers are encouraged to understand the current interrelations between customer and product and/or service in order to identify possible changes that may improve customer



experiences. The terms “journey map” and “journey mapping” are not unique to Designing for Growth toolset. For the purposes of disambiguation, this section is focused on the intentions, outcomes and approaches Liedtka and Ogilvie recommend as effective for their process model.

Journey mapping produces a graphical representation of the customer’s point of view as they interact with a business’s product or service. The tool can be used in the stages of What is?, What if? and What wows? The difference is in the objective of the tool’s use. During the What is stage the goal is to understand what the customers are currently experiencing as they seek to benefit from a product or service. Journey maps can describe the future state of an experience, which may be helpful when brainstorming alternatives during the What if stage. Journey maps can function as an overview of a solution concept’s intended customer experience resulting from use of a product or service prototype. Under the What is stage, journey mapping is a research tool that attempts to identify actual experiences. Under the What if stage and the What wows stage, the highs and lows of a customer’s experience are extrapolations or forecasts that are hypotheses until confirmed in the What works stage.

Liedtka and Ogilvie raise medical research that puts forward the notion that people are feeling beings that think. Prior to any higher order interpretation of sensory stimulation (ex. reading this syllabus, tasting a warm beverage, listening to a story), the brain has interpreted the stimulation emotionally. Beyond seeing letters, words, sentences and thoughts on this page, your brain is adding an emotional hue to what you understand as you read. The emotional overtones within a customer’s experience shape customer satisfaction of current products and services. Low emotional points within an experience are opportunities for innovation. Conversely, essential emotional high points should not be harmed by a solution concept.

Ten steps to perform journey mapping are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Identify and research the types of customers whose experiences are of interest.
2. Attempt to identify and sequence a complete set of steps within a customer’s journey, which should include steps that the business does not have responsibility for or influence over. The experience path may vary by customer type.
3. Identify a small number (12 to 20) of customers who represent the variety of demographic attributes that are of interest to the team.
4. Interview a few of these customers in order to correct and refine the customer journey proposed in step 2.
5. Build an interview questionnaire that seeks to elicit experienced emotional lows and highs along the customer journey. Interview the remaining customers using this questionnaire.
6. Analyze interview data looking for important challenges customers face as well as common themes found within the data.
7. Identify dimensions of human needs that underlie the common themes. The Center of Nonviolent Communication (<http://www.cnvc.org/>) has curated a list of universal human needs, which are also listed in [B1].

8. Select two of the most insightful dimensions, and construct a 2x2 archetype-mapping matrix with those dimensions in order to start building archetypal personas.
9. Map each interviewee into one of the archetype quadrants. By using demographic information and the human needs captured from each interviewee, develop a rich differentiated description for each of the four archetypes represented by their respective quadrant.
10. Combine the emotional data collected from the interviewees assigned to an archetype, and plot each archetype's emotional state along each step of the journey.

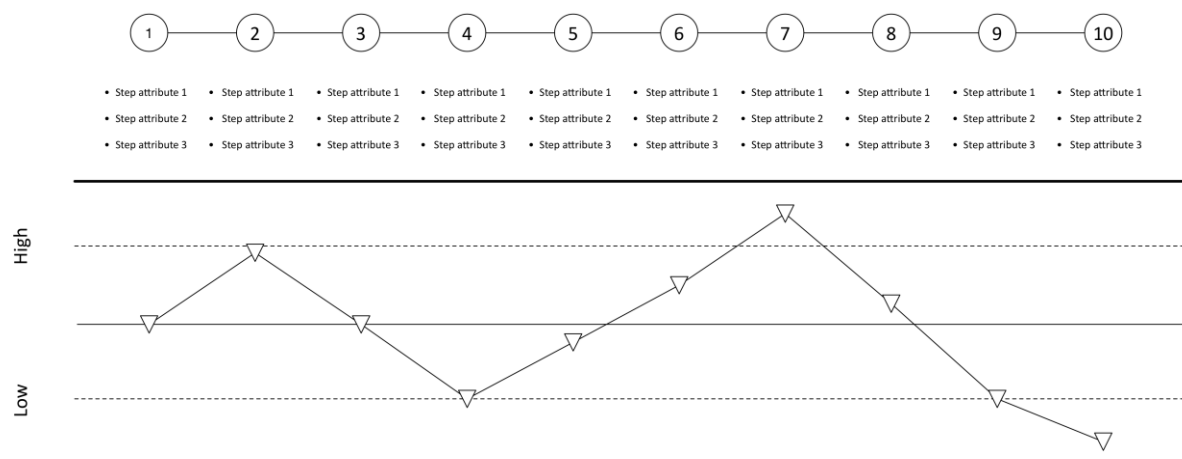


Figure 3-6: Sample journey map for one archetype

Figure 3-6 shows one approach to drawing a journey map. More than one archetype could be plotted to see what highs and lows are in common across archetypes. Another option would be to plot current and future state on the same graph.

### 3.2.4 What Is: Value Chain Analysis

In order for innovation to be beneficial to a business, resulting solutions need to bring value to both the customer and the business. For many businesses, the ideal measure of value is profit. Liedtka and Ogilvie recommend value chain analysis be performed as a contrast with the customer journey. This analysis may recognize opportunities for and vulnerabilities to sustained value for the business and its partners. Independent from journey mapping, value chain analysis may result in innovative insights into ways to change the current business model to capture more value. By understanding how value is currently or could be captured along the value chain, design thinkers can frame the problem in ways that allow the business to be the primary beneficiary of the innovation.

Value chain analysis studies a business's interactions with its partners to produce, market, distribute and sustain the business's products or services. Value chain analysis is an established business management tool. In the context of Designing for Growth, value chain analysis should be completed within the What is stage. This effort should be performed by the core team. For the purposes of disambiguation, this section is focused on the intentions, outcomes and approaches Liedtka and Ogilvie recommend as effective for their process model.

Seven steps to perform value chain analysis are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Starting from the end-user receiving benefit from a good or service, work backwards identifying the sequence of necessary activities to achieve the end-user's benefit. This sequence of activities forms the structure of the chain. It may require multiple rounds of analysis to assemble activities into manageable levels of abstraction. Consider the competition's equivalent activity streams in this context. In reality, the activity sequence may consist of multiple activity streams and activity order may vary between passes through the chain.
2. Identify the key players who perform the identified activities and their relative market share.
3. Identify the essential strategic capabilities necessary for each activity to produce the value being provided.
4. Determine the bargaining power and influence of each player by answering questions like: Who determines performance? How difficult is to substitute an activity provider for another? How much perceived value does the end-user assign to each contributor along the value chain?
5. Explore possibilities of improving the business's influence and profitability along the value chain.
6. Evaluate the business's vulnerabilities within the value chain. How might a partner's shift in focus or its expansion of interests affect the business's value capture?
7. Identify reoccurring observations from the analysis as they relate to topics like: capabilities, influence, dependency, disruption, opportunities and risk.

### 3.2.5 What Is: Mind Mapping

In order to close out the What is stage and move forward to the What if stage, a great deal of synthesis and convergent thinking is needed to extract and leverage the solutions intelligence buried within the data collected in the What is stage. The objective at this point of the process is to develop design criteria that will guide the What if stage. In order for the core team to be effective going forward, mind mapping helps them form common understandings about the stakeholders, the problem and desirable solutions. By formally orienting the design process around data about and from the stakeholders, design team members and influencers outside the team are less inclined to promote designs or design attributes based on preconceived notions and personal attachments that do not align with the problem.

Liedtka and Ogilvie use the term "mind mapping" for their process of crowd sourcing insights from the collected data. During this exercise, ten to 50 people briefly expand the team. As for the auxiliary players being enlisted, their diversity of thinking will help spot patterns that may not be apparent to the core team. Moreover, there is a strategic value in having a broader cohort of

colleagues committing mindshare, developing a mild sense of ownership, and investing time into the project's direction and success.

Mind mapping is a pattern analysis process that takes in all collected data and puts forward noteworthy facts, understandings, themes, insights and design criteria. Although convergent thinking is needed throughout the Designing for Growth process model, this particular technique is best suited for the What is stage. The trigger for the start of this exercise is often the project schedule. The desire for more and better data is never truly satisfied, but the effort needs to proceed. Some design-thinking advocates suggest the most valuable lessons will only occur after prototypes have been built. From their point of view, there is limited value in dwelling in a stage like the What is stage beyond the time necessary to develop informed opinions and hypotheses to be tested in subsequent stages.

Eight steps to perform mind mapping are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Layout the collected data physically in an art gallery fashion. Visualizations, photographs, stakeholder quotes and other data should be readable by someone standing in front of it. The occupied walls and other vertical surfaces may extend past a single room. Participants will need space to feel comfortable and have time to absorb the information at their own pace.
2. Invite ten to 50 thoughtful people to come share their insights for a day or half a day. Participants are assembled into small teams as they arrive. Each participant should be given a marker, two packs of medium sized sticky notes in two different colors, a stack of large sticky notes and a clipboard.
3. Kick off each event by asking participants to tour the gallery. If they are unfamiliar with the process or the presentation formats used in the gallery, team members may need to offer to briefly explain the process and the visuals.
4. Ask each participant to browse the gallery on their own and make note of any data, analysis, finding or anecdote that may lead to new ideas. Each note should be written on a separate medium-sized sticky. Per Liedtka and Ogilvie, this process typically generates 20 or 30 notes per participant. Any important data a participant finds are missing should be noted on separate sticky notes of a different color
5. Have participants rejoin their teams and spend five minutes sorting their notes and clustering them by theme on their own. Next have each team work as a group to combine each participant's clusters into shared patterns and themes on a large surface like foam-core board.
6. As a team, participants should look for insights related to each cluster and look for relationships between the clusters. Each insight is written on a large sticky note and placed above the relevant cluster.
7. Synthesize insights and connections into design criteria. This is commonly done by presenting the team with a framing question like "Based on what you have learned, if

anything were possible our design would...” [B1] Each criterion is written on a flip chart assigned to each team.

8. Consolidate design criteria into a common list by having teams browse the flip charts developed by each team. As a large group, discuss the criteria and work towards consolidating the various criteria into a single set that the ideal design will meet.

In case you are looking for mentions of mind maps or spider diagrams, they are not directly relevant to this tool. However, It may be that design team members chose to visualize previous analysis in the form of mind maps or spider diagrams. These visual artifacts would be part of presented data collection the exercise participants would consider.

### 3.2.6 What If: Brainstorming

Having learned what is and equipped with ideal design criteria, the design team is ready to design the future. Design thinking is oriented towards designing a remarkably different future, and not suggesting a fresh coat of paint on what already is. To that end, the design-thinking team needs to generate ideas that will lead to designs that have the potential to redefine the status quo. Brainstorming is the tool to do just that. The design team needs to enter the What wows stage with several diverse solution concepts. To get to that point, the brainstorming tool needs to generate many different raw ideas.

Brainstorming, as a tool within the Designing for Growth process model, is used during the What if stage. The tool depends on utilizing the capacity and ability of diverse groups and teams to suggest fresh and far ranging ideas. It is critical not to be critical in this process. This should be a divergent and generative exercise. The concept development tool will sort out the weird, insane, implausible, ridiculous and goofy ideas. Alan Turing and Gordon Welchman’s bombe used to break the German Enigma cipher was considered implausible and ridiculous by some, if we are to believe the social setting in the movie titled “Imitation Game” was historically accurate<sup>5</sup>.

Brainstorming is used by many people for various objectives. For the purposes of disambiguation, this section is focused on the intentions, outcomes and approaches Liedtka and Ogilvie recommend as effective for their process model.

There are seven ingredients recommended by Liedtka and Ogilvie to achieve a disciplined brainstorming session that yields useful results. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. People: Build a small diverse group of people who will extend the conceptual reach of the core design-thinking team. The team should be no larger than 12 people. Consider assembling cross-functional teams and inviting stakeholders and other outsiders. Multiple brainstorming sessions are preferred over having one large scale exercise. These sessions can last from a half to a full day.

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<sup>5</sup> <https://www.imdb.com/title/tt2084970/> (last accessed 10/2018)

2. **Challenge:** At each session, the group must focus on an understandable challenge. The design criteria and the design brief often provide valuable context in which to frame the challenge.
3. **Mindset:** Participants should be open to every idea and refrain from criticism. They should seek opportunities to add to or expand upon previous suggestions. There should be ground rules on how each person participates. Rules like: one speaker at a time; show don't tell; don't be a critic; and enjoy yourself.
4. **Empathy:** The group will be more effective if they understand who they are helping. Use personas based on What is information. Each persona should have a name, age, specific likes and dislikes, and other relevant characteristics (ex. children, profession, disabilities).
5. **Stimulus:** Prepare and use framing questions throughout the session to stimulate new ideas. A good framing question describes the constraints and an aspect of the problem on which to focus. For example, a pre-ordered grocery pick up service question might be - "What are the common cold or frozen items a busy professional in Toronto, like Alicia, would purchase in the summer?". Multiple framing questions will be needed and should be sequenced purposefully.
6. **Facilitation:** Facilitation should seek to build confidence within the group, maintain an appropriate pace, and alternate how participants contribute to the process.
7. **Follow-up:** After the brainstorming sessions, results need to be vetted and transformed into solution concepts using a tool like concept development. Beyond forming viable coherent concepts, these concepts need to be implemented and evaluated using the remaining tools within the Designing for Growth toolset.

Preparation for brainstorming is necessary to improve the likelihood of identifying ingenious ideas. Brainstorming is only the beginning of the process of designing the future. The ideas must be brought forward into concepts and then transformed into prototypes to be evaluated by stakeholders. Otherwise, the brainstorming sessions produced more heat than enlightenment.

### 3.2.7 What If: Concept Development

Convergent thinking is required once again, in this instance the objective is to take the raw ideas from brainstorming and formulate solution concepts. This involves taking the most promising ideas, integrating them and infusing each resulting assembly with relevant business model context in order to align each solution concept with the business. Liedtka and Ogilvie suggest that 200 ideas will likely result in 12 concepts. Of the 12 only three will be explored with stakeholders, and of the three only one may reach the end of the design-thinking process. It is much too early to know which will be the "one" or the "three." Each solution concept proposed at this point should be afforded equal care in terms of development and positioning. Think of each solution concept as an educated guess as to what might be effective. Only when the stakeholders are given a range of options can they help direct the team in promising directions.

Concept development should be done as soon as the brainstorming activities have been completed within the What if stage. This effort should be performed by the core team. Those that engage in

this activity will need to commit an intense level of effort and possess deep project-context understanding.

Four steps to perform concept development are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Gather the key ingredients for this effort: brainstorming results, the design criteria, and the core team.
2. Arrange the brainstorming results and design criteria in a gallery fashion similar to mind mapping. This process requires awareness of each idea and the ability to spot patterns and envision interrelationships. In order to aid visualization, remove redundant ideas, cluster similar ideas, suggest ideas that are missing, formulate themes that describe observed patterns, impose analytical priorities based on the design criteria, and visually indicate those ideas and intermediate thoughts considered essential.
3. Identify central principles or select domain relevant design patterns, such as in retailing: customer loyalty program, self service, full service and personal shopper. These principles or patterns may be analogies of successful patterns taken from other domains. Patterns form constructs or recipes with which to arrange ideas and recognize missing elements. Liedtka and Ogilvie recommend five to 12 of these principles/patterns be selected to help form the distinct solution concepts.
4. Formulate concepts by selecting ideas that align with chosen principles/patterns and as combinations provide new significant customer value and fit within the business model. Reusing an idea for multiple concepts is fine as long as the resulting concepts are sufficiently different.

Well-choreographed brainstorming will present many intriguing ideas. Synthesis of these undisciplined ideas requires the team to have an outlook or lens with which to view these puzzle pieces that have no predefined answer key, and assemble them into cohesive concepts. The core team's committed understanding of the stakeholders, stakeholder challenges and outstanding, possibly tacit, stakeholder needs will enhance their judgment that guides their choices and decisions.

Although the napkin pitch (mentioned in section 3.1.2) is not formally an outcome of concept development, this document needs to be constructed prior the What wows stage for each solution concept. The team may find it convenient to develop the napkin pitch soon after each concept is developed in order to take advantage of the team's fresh understanding of each concept.

### 3.2.8 What Wows: Assumption Testing

Having entered the What wow stage with nearly a dozen fresh solution concepts, this is now the opportunity to identify fatal or major but repairable flaws in each of these concepts. All initial solution concepts are flawed in some way, but show-stopping issues should be addressed by repairing or discarding solution concepts while it is cheaper and timely to do so. Significant sources of concept flaws are the assumptions on which the concept rests. During assumption testing, the



design-thinking team evaluates each concept objectively searching for fundamental weaknesses. Every successful innovation satisfies four business criteria: value, execution, scale and competitive advantage. During assumption testing, the team will do their best to evaluate the concepts against these criteria with currently available data or are reasonably accessible.

There are two high-level steps to assumption testing: 1. Identify and state assumptions within each solution concept, 2. Test these assumptions with either stakeholders or conduct tests based on analytical reasoning or simulation relying on existing data collections. Stakeholder evaluation will be addressed with tool 9, customer co-creation. The premise of this tool is based on the hypothesis that reasonably reliable assumption testing can be performed using known data, which will be quicker to perform and avoid exposing concepts to the market prematurely.

Assumption testing is most relevant after solutions concepts have been described. There is no design benefit to waiting to evaluate assumptions after completing concept development. This is the rationale for sequencing this tool early in the What wows stage. Liedtka and Ogilvie suggest that this tool may be used during What works and within What is. The value of assumption testing during What is stage is related to identifying hypotheses and biases that ethnographers should consider. From a personnel perspective, the core team is effective in performing this exercise. However, one exception might be the need to add analysts who are skilled in seeking out flaws that others may miss and help with mitigating those flaws.

Assumption testing is a common concern among design-thinking process models. For the purposes of disambiguation, this section is focused on the intentions, outcomes and approaches Liedtka and Ogilvie recommend as effective for their process model.

Eight steps to perform assumption testing are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Identify generic business tests each solution concept must “pass.” The objective is to determine the qualities each concept must possess to be an interesting and viable innovation. These tests are statements centered around one of the business criteria: value, execution, scale and competitive advantage. These tests draw out the necessary assumptions made by each concept in order to satisfy the general business criteria.
2. Identify business tests that each solution concept must “pass” that focus on the team’s sponsoring organization. These tests evaluate alignment between the concepts with the sponsor’s strategic goals. These tests draw out the necessary assumptions made by each concept in order to achieve these strategic goals.
3. Ensure assumptions made to satisfy each business test are documented as clearly as possible. The goal is to write assumptions in a form that can be tested.
4. Identify each assumption that is critical to a solution concept’s appeal. Often there is not enough time to test every assumption; this helps ensure the critical assumptions are vetted within the time allotted. Liedtka and Ogilvie suggest that value based assumptions are most important. This is followed by execution, scaling and competitive-advantage assumptions.



This step will benefit from having designated contrarians who will seek out the most damaging assumptions.

5. Identify data needed to test these critical assumptions. This step is not concerned about what data is available, but focuses on what data are needed.
6. Classify your data needs into three categories: what data you have, what data you do not have and cannot obtain (known unknowns), and what data you do not have but can get. Remember to consider what may be “known as fact” may actually be a well-established assumption or may be based on anecdotal evidence.
7. Determine how you can quickly get the data categorized as unavailable but obtainable. This may require assembling data sets from sources not specifically designed to supply this data or possibly fielding new surveys of existing customers.
8. Design and execute thought experiments with special attention to those that will prove assumptions wrong. Karl Popper, philosopher of science, argued that a theory can never be proven but it can falsified. In this context, building tests that will reject or invalidate an assumption is more valuable than attempting to prove the assumption as valid. Failing to falsify an assumption does not prove the assumption. What you know is that the assumption resisted your best efforts to refute it given the time, skills and data available. Assumptions that fail to be disproven should be considered reasonable for the time being. However, the design team needs to be vigilant of these assumptions going forward.

Not all solution concepts can be brought forward. This testing tool is an effective means to evaluate the viability of each concept. Concepts can be ranked by the tests they pass and the assumptions made.

### 3.2.9 What Wows: Rapid Prototyping

The team has identified several vetted solution concepts that are worth bringing farther along the design path. Prototyping is the next necessary step. Solution concepts need stakeholder feedback as early and as often as possible in the design process. Prototypes are the most effective means by which stakeholders can understand what the design team intends. Prototypes provide points of reference from which to base constructive feedback. Prototyping as a creative tool requires the design team to clarify a solution concept’s intentions and make decisions regarding what the concept is and is not. By being forced to shape the solution concept into something that can be experienced, constraints and dependencies of logical flow, time and space, human dynamics, and other principles and conventions force concepts to transform into designs. Prototyping causes the solution concept to evolve before the first stakeholder encounter.

Rapid prototyping is performed immediately after a solution concept is deemed worthy. Once rapid prototyping has commenced within the design project it is revisited repeatedly until all the design options are retired or one is passed on as input into the learning launch tool (tool 10). Within the process model, rapid prototyping is only performed during the What wows stage. Prototype fidelity is discussed in Section 2.1.7. At the initial low fidelity prototyping stage, the core team should have the necessary tools and talents to produce the prototypes. However, as greater fidelity is required,

it may be necessary to enlist the help from auxiliary members, partners, consultants and contractors. Liedtka and Ogilvie emphasize the notion that rapid prototyping is about stakeholder-based learning not quality control or engineering. They suggest prototyping be considered an affordable loss calculation, which is determined in part by answering these questions: How much is learning worth to the business? How much is learning something your competitors do not know worth? It is necessary for the design team to seek to minimize time and capital investment into each prototype in order to learn quickly and be able afford to explore multiple design options. However, consider that attempts to optimize consumption of time and money can be at cross-purposes. Underfunding may cause delays in prototype development and stakeholder evaluation due to lack of readily available funds for materials, equipment, qualified labor and travel.

Rapid prototyping is very similar to prototyping used in other design-thinking process models. For the purposes of disambiguation, this section is focused on the intentions, outcomes and approaches Liedtka and Ogilvie recommend as effective for their process model.

Five steps to perform rapid prototyping are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Build simple and low cost prototypes at first. The team does not know yet what to build, so it is too soon to invest in learning how to build. Rough prototypes that support essential hypotheses testing are preferred in the beginning. Stakeholders will see the team is uncertain or uncommitted to what the design option should be. This unstated flexibility will encourage stakeholders to share impactful ideas and suggest ways to fill in the design gaps.
  2. Every concept is a story or exists within a contextual story. Determine what the story should be. Visualize the story with techniques like sketches, storyboards, videos or flowcharts. Try to avoid words as much as possible. Increase the level of detail within the story as the concept evolves.
  3. Give the concept a visible form that will draw the stakeholder into the concept and experience related feelings. Prototypes at first can be sketches, diagrams, paper/pipe cleaner/ Lego mockups, stories or short videos.
  4. Provide stakeholder options of how a concept may take form. While prototyping fidelity is relatively low or the prototyping medium used is flexible, be willing and able to adjust the prototype to allow the stakeholder's feedback to take near immediate effect. Stakeholder thinking is itself iterative while they seek what works best for them.
  5. Ensure that each prototype enables stakeholders to clarify essential assumptions at the current point of design evolution. Only stakeholders can validate a design. Essential assumptions are potential traps that should be resolved when it is possible to do so. The team should strive to address untested essential assumptions while corrections are easier to perform and less investment has been made. The design team should think their prototypes are reasonable guesses but not attempt to defend them as being right or finished.
- According to Liedtka and Ogilvie, Stanford d.School provides the following advice - "Treat your prototypes like they are right and your assumptions like they are wrong." [B1]

As a concept is transformed into design the freedom or potential of the initial concept diminishes as the result of necessary decisions. Team members may feel a sense of loss. Step 4 of the rapid prototyping process addresses this consequence to some degree. Some concepts may be able to take on seemingly limitless physical forms, but reality forces the team to focus on the several that the team can create in the time available. The chosen forms may not be the theoretically “best” among the potential realizations, but without stakeholder testing there is no right or best. The team may be able to draw from the concept’s specific solution space again in response to subsequent stakeholder input.

### 3.2.10 What Works: Customer Co-Creation

Got prototypes, now what? The team is ready to engage stakeholders. The team needs to know what works and what does not in order to improve the designs. It is nearly a certainty that each prototype is significantly flawed at first. By knowing that upfront, the team should be eager to learn what may be wrong and how. Selecting the right stakeholders is important. The team needs stakeholders who can communicate what does not work for them, and are able to assist in improving the design by explaining how it does not align to their abilities, domain constraints (ex. home has low ceilings or no dishwasher or no automobile parking; corporate policy; regulations; contractual obligations), their thinking, their goals and/or practices.

The primary use of customer co-creation is to elicit market feedback on designs. This necessarily places customer co-creation after rapid prototyping in the tool usage sequence. In terms of stages, customer co-creation is most often located in the What works stage, but it can be performed as the last tool within the What works stage. An alternate use of customer co-creation is during the What if stage where the team seeks market insights on their solution concepts. In this case customer co-creation must follow concept development. Customer co-creation is a form of human subjects based research. Core team members who engage stakeholders in co-creation should be prepared to facilitate this research and document these exchanges. Liedtka and Ogilvie suggest that co-creation may be performed in about three rounds of stakeholder engagement. In each subsequent round, the prototypes have been changed according to input from previous rounds.

Nine steps to customer co-creation are outlined by Liedtka and Ogilvie. Their book should be consulted for further explanations. The steps listed are not described verbatim but are interpretations.

1. Enlist stakeholders who want to see you succeed. These stakeholders should be trustworthy, eager for the innovation being explored, and willing to be open, honest and sincere with their criticisms and suggestions.
2. Locate stakeholders from a variety of potential customer groups. The innovation may turn out to be relevant to a number of target customer groups. It may be that expertise within one group may improve the design for use by other target groups.
3. Co-creation sessions are for learning. The stakeholder should be the dominant speaker during the session. Liedtka and Ogilvie suggest that the stakeholder talk 80 percent of the time.

4. Structure each co-creation session around one stakeholder at a time. This allows the stakeholder to express themselves without social dynamics caused by multiple research subjects sharing their thoughts.
5. Provide multiple concepts to be explored. Allow the stakeholder to select the option that appeals to them. If time permits, direct the stakeholder's attention to a second option. When selecting the concept line-up, include options that you guess will not be chosen. You do not know which concept is preferred until it is selected from a collection of alternatives.
6. Early prototypes should be kept rough in order to encourage the stakeholder to imagine how it will benefit them in the future. Gaps and shortcomings can encourage the stakeholder to provide creative suggestions as well as encourage the stakeholder to share their expertise.
7. Encourage the stakeholder to communicate visually. Provide the stakeholder with the means to draw, annotate, highlight and arrange their thoughts. One possible approach could be to encourage stakeholders to fill in unfilled speech bubbles on storyboards.
8. Make time for discussion at the end of the session. Stakeholder questions, concerns and thoughts that have been forming up to this point are valuable. Questions may be an opportunity to learn what the stakeholder believes are reasonable answers or approaches. The stakeholder has undergone an intense period of learning, and it may take the entire session for these thoughts to be coherent enough to be expressed.
9. Follow-up with stakeholders after the session, sharing with them what you did with their feedback. By doing this, you recognize the goodwill and energy they shared with you. Beyond courtesy and respect, maintaining a positive relationship with these stakeholders supports the brand and keeps open the option for future co-creation.

Borrowing from Stanford's toolkit, Stanford suggests that "extreme users" be involved in stakeholder feedback sessions. Extreme users come from the fringes within the domain in which you are innovating. Stanford d.School depicts this idea as two shaded regions at the far ends of a bell curve of people's involvement in a particular domain. On the far left end, people on this part of the curve have no or negligible involvement in the domain. On the far right, the people are fluent/expert/professional in the domain. Both types of stakeholders have intense needs and have developed methods to overcome limitations that currently exist. Their needs and workarounds are often relevant to the wider target market. Applying this notion of extreme users may help with identifying appropriate stakeholders for your design-thinking projects.

When considering the significance of what concept options stakeholder's pick you need to consider the influence of bias on this choice signal. Bias on the part of the stakeholder may be part of the domain and should be accommodated. Bias originating from the design team may take the form of inconsistency between prototype presentations. For example, one prototype is a black pencil sketch, and another is drawn in color. Another case could be where one prototype is a storyboard and another is a Lego mockup. A participant's choice may be influenced by the order in which options are observed. There is psychology research that shows that serial position of items within a list influences a person's thinking. In this circumstance, participant's who select the last or first prototype presented may be making a choice in part because of the order of presentation, and less

so as a result of the compelling nature of the prototype. Randomizing the order in which each prototype is presented between participants reduces the effect serial position may have on the prototype preference signal. Team members conducting the session may be consciously or unconsciously telegraphing their preference in some way. The bias challenges are similar to a witness picking a criminal suspect from a photo array or lineup. Being aware of the influence of bias is the best first step to mitigate it. Other actions will translate into prototype consistency and planning co-creation session procedures.

Customer co-creation is the most informative tool within the toolset. The most promising prototype will emerge as the last round of sessions end. Chances are that more useful refinements will be suggested before the learning launch. Be careful not to allow too large of a fidelity gap to exist between the last round of co-creation and learning launch. The multitude of decisions made to implement a near production quality prototype should not proceed to learning launch without co-creative feedback on a majority of them. A risk in this situation is that learning-launch participants are less satisfied than they could have been had the co-creation stakeholders evaluated a very similar prototype beforehand.

### 3.2.11 What Works: Learning Launch

This last tool is meant to transition the design-thinking project to a market rollout. This is the last attempt to get the market to speak to the remaining critical assumptions regarding value, execution, scale and competitive advantage. Armed with these answers, business leaders can make informed decisions regarding the future of the concept within the firm. The design team will field a truly working prototype for customers to use on their own for a limited but extended period of time (much longer than a co-creation session). It is important to know how enthusiastic customers will be about the concept by having them purchase and use the prototype in their lives. A common unknown is whether customers beyond co-creation collaborators value what has been put forward. Do they use and benefit from the solution the way the design-thinking team thought they would? Will customers actually spend money to use this concept? As realistic as a learning launch may be to a market rollout, the goal is not to sell but to learn. Customers willing to spend money are demonstrating a level of commitment that is a strong indicator that they intend to seek to benefit from the concept.

The customer co-creation effort was not intended to yield insights that are general to the intended markets. Analyses relying on historical data to anticipate market interest for an innovative offering are weakened by their dependency on extrapolating from past behavior. The learning launch provides a viable view of the state of the market by actually testing the market with a relatively low cost exploration. While the learning launch reduces uncertainty about market acceptance, uncertainty will likely remain. If the prototype fails (i.e. disproves the value assumption) this is a strong indicator of market interest. However, by using a design-thinking process, the prototype is much more likely not to be an outright failure. By not having disproven the value assumption, there still is a possibility that market performance during a full market rollout will not be consistent with the learning launch results. Moreover, what is learned from the learning launch is perishable. The

combination of market dynamics within a domain (ex. home appliances, personal communications, petrochemicals, online dating services) and the delay between learning launch and full rollout raise the possibility the learning achieved during the learning launch is less reliable.

Chapter 2 introduced the idea of a pilot occurring at the end of or as a follow-on to a design-thinking effort. What a pilot is depends on those calling for or managing the pilot. Liedtka and Ogilvie clarify that the learning launch is not a pilot. From their perspective, a pilot is usually intended to be an initial stage along the progression to a full commercial launch. In this situation, a pilot is intended to give various teams an opportunity to refine their supporting processes and materials. The offering itself would not be permitted to change much beyond defect repair. As a possible of contradiction by Liedtka and Ogilvie, despite limited learning-launch investments into the prototype and supporting processes, the design-thinking team and the customers are meant to treat the learning launch as a true launch. In order to get valid market data, customers need to experience the offering as if the as-is offering was fully supported by the business. On the issue of expected change, even though the learning launch prototype has been engineered to be functionally robust, the goal beyond answering critical assumptions is to be able to offer a last set of market driven feature change suggestions to the teams taking the offering to the next level. This notion that the learning launch prototype is not the last iteration (as it would be for a pilot, per Liedtka and Ogilvie) and limited market testing results directly influences a near future iteration is very similar thinking to Agile software development.

The learning launch is the last tool to be used within the Designing for Growth process model. This tool provides the best answers to the question, what works? A prerequisite of this tool is to have a prototype that has undergone customer co-creation influenced refinement. Another prerequisite is that the last iteration of the learning guide be prepared with the most complete and current information. Critical untested assumptions up to this point must be used to frame the last prototype iteration and all the supporting processes that contribute to the learning launch. Answers to these assumptions are the ultimate deliverables of this tool. The core team may need to be augmented by staff who can implement and operate the supporting processes. For instance, customer and technical support requests must be routed to the right people.

Beyond specifying the purpose of the learning launch, Liedtka and Ogilvie view much of the effort to be common project management. They however offer six success principles to consider. Their book should be consulted for further explanations. The principles listed are not described verbatim but are interpretations.

1. Set a narrow scope for the learning launch. Launch variables, such as duration, geography, number of customers, features, partners should be limited to formally agreed upon limits. Customers must understand their use of the prototype will end at a set date.
2. Focus on the key assumptions to be tested and ensure the prototype reflects these assumptions. Specify specific metrics used to test the assumptions. Define mechanisms to generate and collect needed data. Identify data that will disprove key assumptions. Align the launch budget to the value of affordable loss.

3. Recruit a team that is both disciplined and adaptive. Assuming the core team doesn't already have the following, the team should have: innovators, skeptics, financial analysts and a project manager. Very similar to a small start-up, team members should be willing to take on various roles as situations dictate. Learning launches behave differently from traditional projects when underway. Getting an experienced learning launch leader is advised.
4. Expect surprises and be ready to respond quickly. This is essentially a dress rehearsal, especially at the beginning of the launch. For instance, the prototype could experience unintended or unexpected use cases.
5. Make sure the launch feels real to customers, partners and the launch team. Assumption tests depend on reliable data. The reliability of the data will be suspect if those involved believe the launch is ridiculous, inadequate, meaningless, unrealistic or foolish.
6. Be ready with contingency plans for everything launch related. Given the need for prompt awareness of issues and rapid responses to unusual situations, space flight mission control may be a useful analogy for launch-operations management. The prototype design and build team may want to do Failure Modes and Effects Analysis (FMEA) to anticipate problems and workarounds.

### 3.3 Design Thinking Application

Design thinking has been applied to many human oriented business challenges. Up to this point, the syllabus has attempted to be challenge agnostic when possible. Design thinking's likely most prevalent application is in innovating in the area of product development. This last section explores practical nuances related to product development in a design-thinking effort.

#### 3.3.1 Design Thinking Applied to Product Development

Up to this point the terms end-user, user, customer, stakeholder have been used interchangeably. For the most part, the terms have been used to refer to the person who is going to be using the product. Implied is the notion that this person will purchase the product for his or her own use or as a gift. This usage ignores the relationship between the design team and the entity selling the product. In reality, design teams may view their customer as a client of their services. The team's client in this situation is the business that manufactures and/or distributes the product. This is when the term stakeholder takes on a broader meaning to include representatives from groups that may not actually use the product designed. Stakeholders who are not users, but are partners, suppliers, product manufactures and distributors have an important voice in the design as it relates to execution, scale and competitive advantage. These business needs will influence value. The design-thinking team will need to envision how these needs might influence value especially as the prototype reaches maturity similar to the learning launch prototype in the Designing for Growth process model. Not all design elements that affect execution, scale and competitive advantage influence user experience, but architectural decisions that address these objectives likely will. For instance, the dominant smart speakers (in the 2018 U.S. market this would consist of the Amazon



Echo Plus, Google Home Max, Apple HomePod) are architected to be tethered to an Internet service. Much of the value these smart speakers provide is not provided locally on the device. In a sense, they are intercoms between the user and an artificial intelligence based assistant operated by the product vendor. If a design-thinking team did not introduce the idea of a backend system providing features to their end-user collaborators, the design-thinking findings and market launch response would not likely agree. It is important to engage product stakeholders who can influence a design's execution, scale and competitive attributes, but the value assumptions can only be resolved by end-users.

Going back to Designing for Growth process model, discussed in section 3.1 and 3.2, it essentially ends at the point business leaders receive results from the learning launch (section 3.2.11). In the event the business takes on the concept and the last prototype's design, there is a risk that much of the institutional knowledge obtained from the design-thinking project will be ignored or be lost in translation. A product prototype designed for the learning launch is unlikely to have been engineered to the standards of the teams who are responsible for a commercial launch. The iterative approach, budget, staff, time constraints and volume of units had significant influence on the prototype's design. Going forward the teams may need to redesign to satisfy partner needs, quality, cost of goods, minimum order quantities, manufacturability and supportability requirements imposed on a commercial offering. Organizations seeking to realize the benefit of design thinking in their commercial offerings will want to ensure the empathetic and market understanding achieved from design thinking informs the design in later stages of commercial development.

There are product design thinkers who have found synergy between “lean” software and business development concepts and design thinking. They have found “lean” concepts helpful as an approach to minimize investment, minimize time to market/evaluation, and achieve prompt market adaptation. These are three hierarchical concepts when measuring product/prototype readiness for customer exposure. The first level within this logical hierarchy is Minimal Marketable Feature (MMF). The second level is Minimal Viable Product (MVP). The third level is Minimal Viable Ecosystem (MVE). Figure 3-7 depicts this hierarchy. A feature is composed of qualities and/or capabilities that result in functionality that offers benefit to the user. Minimal Marketable Feature relates to releasing a feature with the fewest capabilities and least acceptable quality that the market will recognize as beneficial. Products are essentially a bundle of integrated features. A Minimal Viable Product is an outcome within a product's or prototype's development cycle that possesses the smallest set of necessary and sufficient integrated features to satisfy the expectations of target user groups or is adequate for a customer evaluation round within a learn, make and evaluate cycle. Each feature that is integrated within an MVP is ideally an MMF. Integration of information processing and communications has become every more pervasive in tangible products and software systems. If we think of an ecosystem in terms of entities exchanging data and offering processing or actuation services (services that cause a mechanical or real space activity to occur), Minimal Viable Ecosystem describes the least amount of collaboration and integration between products and/or services, which may be designed, owned or operated by different legal entities, that in combination provides emergent value that meets the needs or desires of target users. The products within the MVE are all ideally MVPs. Relating this discussion to design thinking in general,



MMF, MVP and MVE can be considered guiding criteria during planning for when a prototype is sufficiently complete for customer co-creation and soft launches.

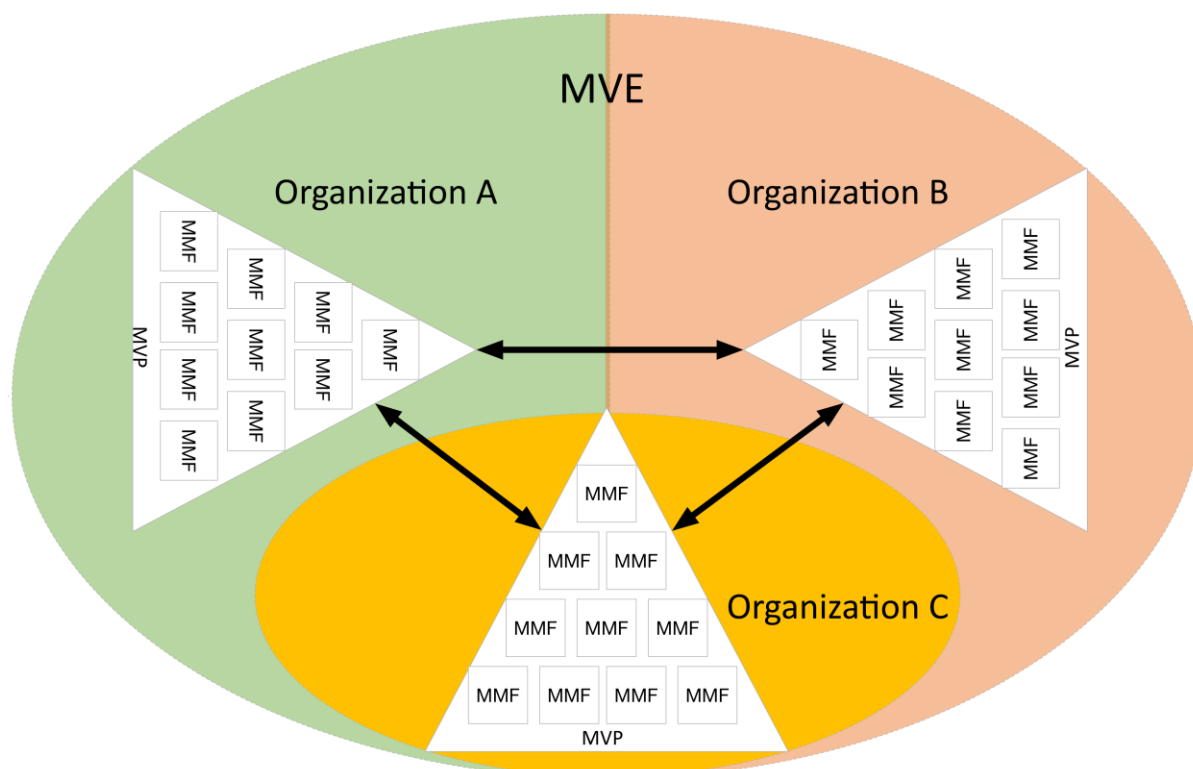


Figure 3-7: Relationships between MMF, MVP and MVE

There is a consumer products orientation with many well-known design-thinking projects. If your employer is a producer of products like bulk chemicals, fasteners, integrated circuits or 3-phase transformers it is difficult to see how design thinking may be relevant. Each member of a supply chain adds value to be passed on to the next step. How emotional does the person or robot installing a fender along an automobile-assembly line get? Assuming the human fender installer does get annoyed with installing the fender, does it matter? How much influence does the fender installer have on the purchase or the design? Chances are the fender is being built to a specification detailed by the automobile designers not by the fender producer. Producers of products that are utilized early within the supply chain may not see much value in using design thinking for their products. Suppliers are in effect service companies in the sense their customers need interact with their suppliers to facilitate purchasing, product specification agreement, product quality verification, delivery and payments among other tasks. Design thinking may be helpful in the service side of the business. With innovative thinking, it may be that design thinking will translate to the product side of the house.

As previously mentioned, many documented products designed with design-thinking approaches are consumer products. Is design thinking relevant to commercial products? Would aircraft design benefit from design thinking? Would enterprise software benefit from design thinking? Would assembly line robots benefit from design thinking? To answer these questions with a question... Are

humans involved in using, operating, implementing, maintaining or directly benefiting from these products? The answers to these questions are yes. A passenger aircraft design, for example, affects the lives of passengers, flight crew, maintenance crew, fuel crew, baggage crew, catering, gate staff, onboard cleaning staff, airport maintenance, airport operations, airspace control and probably a few others. Design thinking would probably benefit aircraft design. An aircraft is designed in stages. The manufacturer (ex. Boeing, Airbus) designs the vehicle fairly generically, and allows their customers (ex. Lufthansa, Delta) to customize parts of the infrastructure (ex. engine type) as well as the interior. One challenge with designing complex systems like an aircraft is that there are so many “users” of the vehicle. The design approaches described in the syllabus would be overwhelmed by the complexity. A business considering designing complex products with design thinking will likely need to customize an approach that preserves design-thinking principles while dealing with tangled needs of so many roles that are influenced by the product’s design. The needs of various roles will be influential in robot design and enterprise software.

If an innovative product is subject to market acceptance, chances are design thinking would be a reasonable approach to derisk the design investment.

## Chapter 4 – References and Resources

### 4.1 Articles

Label	Description
A1	"Cross-cultural and user-centered design thinking in a global organization: A collaborative case analysis.", by Abildgaard, Sille Julie J., and Bo T. Christensen., <i>She Ji: The Journal of Design, Economics, and Innovation</i> 3.4 (2018): 277-289.
A2	"Design thinking: A method or a gateway into design cognition?.", by Gabriela Goldschmidt, <i>She Ji: The Journal of Design, Economics, and Innovation</i> 3.2 (2017): 107-112
A3	"Design thinking: past, present and possible futures.", by Johansson-Sköldberg, Ulla, Jill Woodilla, and Mehves Çetinkaya., <i>Creativity and innovation management</i> 22.2 (2013): 121-146.
A4	"Wicked problems in design thinking.", Richard Buchanan, <i>Design Issues</i> , Vol. 8, No. 2, (Spring 1992), 5-21

### 4.2 Books

Label	Description
B1	"Designing for growth: A design thinking tool kit for managers", by Jeanne Liedtka and Tim Ogilvie., 2011, ISBN 978-0-231-15838-1
B2	"The design thinking playbook: Mindful digital transformation of teams, products, services, businesses and ecosystems", by Michael Lewrick, Patrick Link, Larry Leifer., 2018, ISBN 978-1-119-46747-2
B3	"Presumptive design: Design provocations for innovation", by Leo Frishberg and Charles Lambdin., 2016, ISBN: 978-0-12-803086-8
B4	"Systems thinking: Managing chaos and complexity: A platform for designing business architecture.", "Chapter Seven: Design Thinking", by Jamshid Gharajedaghi, 2011, ISBN 978-0-12-385915-0

### 4.3 Learning Aids

Label	Description
LA1	"Design thinking bootleg", by Scott Doorley, Sarah Holcomb, Perry Klebahn, Kathryn Segovia, and Jeremy Utley., Hasso Plattner Institute of Design at Stanford, 2018, <a href="https://dschool.stanford.edu/resources/design-thinking-bootleg">https://dschool.stanford.edu/resources/design-thinking-bootleg</a> . (last accessed 9/2018)

## 4.4 Reports

Label	Description
R1	"Eleven lessons: Managing design in eleven global companies - desk research report." by Design Council, <i>Design Council</i> (2007). <a href="https://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_DeskResearchReport_0.pdf">https://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_DeskResearchReport_0.pdf</a> (last accessed 9/2018)
R2	"Eleven lessons: managing design in eleven global brands. A study of the design process 2005.", by Design Council, Design Council (2007). <a href="https://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20%282%29.pdf">https://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20%282%29.pdf</a> (last accessed 9/2018)

## 4.5 Web Resources

### 4.5.1 Designing for Growth

Label	Description
WR1	"Designing for Growth Books", <a href="http://www.designingforgrowthbooks.com/">http://www.designingforgrowthbooks.com/</a> (last accessed 9/2018)

### 4.5.2 Double Diamond

Label	Description
WR2	"The Design Process: What is the Double Diamond?", <a href="https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond">https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond</a> (last accessed 9/2018)
WR3	"Design Methods Step 1: Discover", <a href="https://www.designcouncil.org.uk/news-opinion/design-methods-step-1-discover">https://www.designcouncil.org.uk/news-opinion/design-methods-step-1-discover</a> (last accessed 9/2018)
WR4	"Design Methods Step 2: Define", <a href="https://www.designcouncil.org.uk/news-opinion/design-methods-step-2-define">https://www.designcouncil.org.uk/news-opinion/design-methods-step-2-define</a> (last accessed 9/2018)
WR5	"Design Methods Step 3: Develop", <a href="https://www.designcouncil.org.uk/news-opinion/design-methods-step-3-develop">https://www.designcouncil.org.uk/news-opinion/design-methods-step-3-develop</a> (last accessed 9/2018)
WR6	"Design Methods Step 4: Deliver", <a href="https://www.designcouncil.org.uk/news-opinion/design-methods-step-4-deliver">https://www.designcouncil.org.uk/news-opinion/design-methods-step-4-deliver</a> (last accessed 9/2018)

## Appendix – Glossary of Design Thinking Terms

**archetype mapping matrix:** A tool used to assign archetypal personae to stakeholders who were interviewed to build journey maps.

**archetype persona:** A character or role that represents a typical person who shares a noteworthy trait among the people of interest.

**assumption:** A thing that is accepted as true or as certain to happen, without proof. (source: New Oxford American Dictionary)

**assumption testing:** A process of determining if an assumption is false or reasonable.

**brainstorming:** The process used by a group of people to bring about new ideas.

**competitive advantage:** A business criterion related to the condition or situation that puts a business in a superior or beneficial position relative to its competition. Liedtka and Ogilvie focus on defensibility of a solution with respect to competition. Competitive advantage is diminished if a solution is vulnerable to competitive emulation. By seeking new business value from a solution, the business considers vulnerability, but looks beyond to identify opportunity.

**concept development:** The process used to construct a coherent integrated idea from a set of diverse ideas.

**convergent thinking:** A type of reasoning that reduces the number of possible options from a larger set of choices using logic, knowledge and/or other evaluation criteria. Generally, a common outcome is to select a single "best" or a most likely correct option from among the choices (ex. multiple choice exam question).

**curator:** A person or role responsible for looking after a collection. Museums are probably most notable for employing curators.

**customer co-creation:** The process of seeking validation and suggestions from those people who will use the solution being designed.

**design brief:** A common document within design-thinking approaches that guides solution design. Design-thinking approaches that rely on the design brief assign it various purposes.

**design criteria:** A design-thinking document recommended by Liedtka and Ogilvie that describes the ideal qualities of a solution, which is used to frame brainstorming and concept development.

**design thinking:** A collaborative approach that uses designerly methods to solve problems and innovate with the help of the end-user. A single more precise definition has not been agreed upon.

**design thinking mindset:** A frame of mind that is beneficial to design-thinking methods used to solve challenges and innovate. This frame of mind applies to individuals on a design-thinking team and for the team as a whole.

**Designing for Growth approach:** A four-stage design-thinking approach developed by Jeanne Liedtka and Tim Ogilvie with emphasis on business challenges related to growth by innovation.

**disruptive solution:** An answer to a known issue or previously unexplored challenge that upends the current state of affairs within a business, market or society. In terms of business, the disruptor is often rewarded with first-to-market advantage.

**divergent thinking:** A type of reasoning that expands on the number and variety of available ideas often seeking uncommon and unusual ideas in order to fashion alternative ideas/approaches/attributes/reasons for consideration.

**Double Diamond approach:** A four-stage design-thinking approach developed by the Design Council based on design research they conducted.

**empathy:** The ability to understand and share feelings of another. (source: New Oxford American Dictionary)

**ethnography:** The scientific description of the customs of individual peoples and cultures. (source: New Oxford American Dictionary)

**execution:** The business criterion related to the ability of an organization to implement/manufacture, sustain and manage a designed solution. Liedtka and Ogilvie use the term "doable," which is synonymous with this term.

**facilitator:** A person who shapes and guides a social dynamic, and leads the people through an established process to achieve worthwhile outcomes.

**human-centered design:** A design approach that focuses a design on the end-user's needs, wants, limitations, sensibilities and goals. This design approach seeks to learn directly from prospective end-users, and elicit responses and design suggestions by showing transitional design artifacts.

**hypothesis:** A supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation. (source: New Oxford American Dictionary)

**journey mapping:** The process of visualizing the steps taken by a user and their emotional impact on a user as they seek to use or benefit from a service or product.

**learning guide:** A design-thinking document recommended by Liedtka and Ogilvie that describes the hypotheses or assumptions being evaluated, test plans and available financial capital for in-market testing. This document guides customer co-creation and learning launch efforts.

**learning launch:** A preliminary market test that deploys a fully-functional prototype and relevant business processes with the objective of testing remaining critical assumptions by collecting data that is more representative of actual market conditions than prior stakeholder testing within the Designing for Growth approach.

**mind mapping:** A collaborative approach to synthesizing current state information collected earlier within the What is stage of the Designing for Growth process model, and determining its significance with regards to designing a future state.

**Minimal Marketable Feature (MMF):** A feature with the fewest capabilities and least acceptable quality that the market will recognize as beneficial.

**Minimal Viable Ecosystem (MVE):** The least amount of collaboration and integration between products and/or services, which may be designed, owned or operated by different legal entities, that in combination provides emergent value that meets the needs or desires of target users.

**Minimal Viable Product (MVP):** An outcome within a product's or prototype's development cycle that possesses the smallest set of necessary and sufficient integrated features to satisfy the expectations of target user groups or is adequate for a customer evaluation round within a learn, make and evaluate cycle.

**napkin pitch:** A brief description of a solution concept for use during the What works stage of the Designing for Growth process model.

**progressive elaboration:** The iterative process of increasing the level of detail in a project management plan as greater amounts of information and more accurate estimates become available. (source: Project Management Institute's Lexicon of Project Management Terms, Version 3.1)

**project:** A temporary endeavor undertaken to create a unique product, service, or result. (source: Project Management Institute's Lexicon of Project Management Terms, Version 3.1)

**project management aid:** Document templates designed by Liedtka and Ogilvie to facilitate the Designing for Growth design-thinking process. These templates identify and organize information

useful for subsequent activities and stages.

**prototyping:** The process of building intermediate manifestations of a solution as the solution undergoes design iterations.

**scale:** A business criterion related to a solution-design's potential and an organization's ability to implement/manufacture, distribute and support the solution designed at a pace and volume related to a successful market rollout and market growth. Liedtka and Ogilvie use the term "scalable," which is synonymous with this term. Liedtka and Ogilvie are concerned that a particular design will lose its appeal as an organization adjusts it in the scale up process. An analogy would be trying to preserve the charm of grand mom's cookie recipe while scaling up to commercial cookie distribution.

**social norm:** The rules or expectations that determine and regulate appropriate behavior within a culture, group, or society. (source: Open Education Sociology Dictionary, [sociologydictionary.org/norm](http://sociologydictionary.org/norm))

**sprint:** A sequence of repeated design or development activities applied to the previous result of a prior execution of these activities with the objective of incrementally achieving the overall project result. The effort expended is often brief and intense.

**Stanford d.School 5-Stage approach:** A five-stage design-thinking approach developed at Stanford Design School.

**user-centered design:** Synonym of human-centered design

**value:** A business criterion related to a product or service providing sufficient benefit that an end-user is willing to pay for it. End-user payment is not necessary for a solution to have this quality if the business model for this product or service does rely on end-users paying. It is important that the end-user believes the agreed upon compensation for the product or service is appropriate to the benefits perceived. Liedtka and Ogilvie use the term "valuable," which is synonymous with this term.

**value chain analysis:** An evaluation of how relevant business offerings fit within their respective supply chains. Objectives are to determine new opportunities to capture value and the potential to lose value within the supply chain.

**vision prototype:** An initial manifestation based on the simplest design that captures the most promising ideas and features, ideas borrowed from other domains, compelling insights, and an initial user experience. This prototyping approach is suggested by Lewrick et. al. [B2]

**visual thinking:** A means of reasoning by forming and manipulating non-linguistic conceptual objects in memory and those externalized through the use of a medium (ex. pencil and paper, play dough, paint and canvas).

**visualization:** 1. The representation of an object, situation, or set of information as a chart or other image. 2. The formation of a mental image of something. (source: New Oxford American Dictionary)