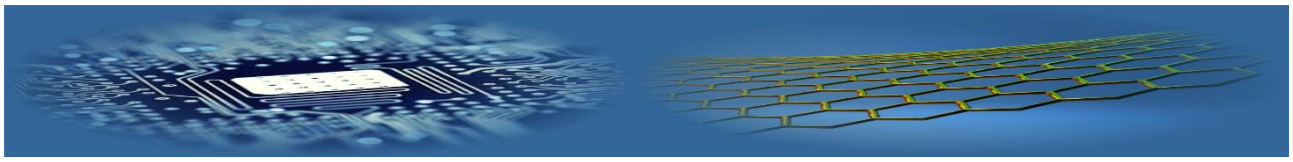

Cognitive evolution in software development life cycle through design thinking

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Received 29 May 2017, www.cmnt.lv

Abstract

Software engineering is methodical, well-organized and proven approach to the advancement, operation and maintenance of the software. Agility moves toward compact set of process activity. Design thinking is an organized, intellectual process in which designers ideate and validate notion for solving the given problem whose outcome and function fulfills clients' objectives or users' needs under specified set of constraints. This paper describes cognitive impact of design engineering process on software development life cycle (SDLC) in agile development community. The paper also depicts correlation between various design engineering canvases and phases within software development lifecycle in agile models.

Keywords:

Mind Mapping,
Design Thinking,
Agile Methodology,
Storytelling,
Prototyping

1 Agile practices

Software engineering deals with the systematic and qualitative approaches for software development [1]. Traditional process models focus on carefully defined practices, in detail documentation, comprehensive planning and management. Agile practices focus on effectual informal communication among all stakeholders, and iterative enhancement of implementations. Agile practices have introduced prototype move in software development [2]. Agile methods center on quick development of software along with the concerns to flexibility, quality and speed. These methods incorporate valuable increase in responsiveness to the customers. The agile development requires backbone knowledge and skills of developers as well as changes in requirements as well as developing and targeted environment. The agile practices include various models such as Extreme Programming, SCRUM, DSDM, Adaptive Software Development, Crystal, Feature-Driven Development, pragmatic Programming [3]. Extreme Programming (XP) proposed by Kent Beck in 2004 [4]. XP is a way of software development based on the values of communication, feedback, simplicity, courage, and respect. SCRUM is a software development method initially planned by Schwaber and Beedle in 1990 [5]. SCRUM development method divides the whole set of changing requirement in terms of packets. The current work unit is defined as sprints, which is a stable set of requirement. Sprints are derived from Backlog. Backlog is a set of an existing but changing set of requirement.

Dynamic Systems Development method (DSDM) is introduced by UK based Consortium of organizations [6]. DSDM is an agile software development approach that provides a structure for software development and maintenance for time critical high quality business requirements.

Adaptive Software Development (ASD) projected by Jim Highsmith (2000) [7]. ASD introduced complex software development through three phases- speculation, collaborations and learning.

Crystal is a family of process models proposed by Cockburn and Highsmith [8, 9]. Crystal process models allow frequent delivery, close communication and reflective improvement [9].

Feature-Driven Development (FDD) proposed by Peter Coad et al [8]. FDD is an object-oriented software engineering process model. FDD defines various client valued functions as features to be implemented in short span of time.

2 Design thinking for social needs

"Design is a process especially suited to divergent thinking-exploration of new choice and alternative solutions"- Tim Brown, President and CEO of IDEO.

The core of Design Thinking is innovating through the perception of the end user. It invigorates in-the-field research that builds empathy for people.

It is the requirement of the hour to observe what the people need, what technology can do (through agile development) and what is profitable.

To come up with an innovative solution that really matters to the mass, we ought to change our mindset of exploring the pain points of the user in the society. It would be unethical to hypothesize (like traditional software development strategies) the people's problems and try to fit in solutions that do not really matter.

Hence, Design Thinking is one methodology that is paving a way towards this endeavor.

The five-step framework for Design Thinking is:

1. **Empathize** – Empathy is the foundation of a human-centred design process [10]. It is to be noted that the problems that you are trying to solve are rarely your own- they are those of particular users.
2. **Define** – The define mode is the unpacking and coalescence of empathy findings into conclusive needs and perception. It deals with defining clear and meaningful challenge to be met. What it aims is focus on the user and the context of the user and then come

up with practical and applicable problem definition.

3. **Ideate** – The purpose of ideation is to focus on the exploration of solutions for the problem identified for the users.
4. **Prototype** – The main aim of developing a prototype is to get ideas and explorations out of the head into the physical world. The most fruitful and successful prototype constructed is the one that when people can experience and interact i.e working prototype.
5. **Test** – The refinement of solutions and to learn further about the users can be carried out in the form of feedback. Testing is the chance to get feedback on the solutions for its betterment.

3 Design thinking canvases

AEIOU Design Thinking Worksheets developed by Mark Baskinger and Bruce Hanington [11] is an interrelated framework that guides designers in thinking through a problem or scenario from a variety of perspectives: activities, environments, interactions, objects and users. They are useful in organizing thoughts, observations and ideas into distinct categories.

Empathy Mapping is the means by which one can extract what the client is thinking. It is a highly collaborative exercise that involves all the stakeholders who hold concern. A product or service without users is worthless. Unless the entire team is crystal clear as to how and why the users might want to use the product and service, it would not get much propulsion among the audience.

The empathy mapping is carried out by observing the following four traits of the end-user as you review your notes, audio and video from the fieldwork [11]:

SAY: What are some quotes and defining words your user said?

DO: What actions and behaviours did you notice?

THINK: What might your user be thinking? What does this tell you about his or her belief?

FEEL: What emotions might your subject be feeling?

Ideation

3.1 PRODUCT DEVELOPMENT CANVAS

The product canvas describes the big picture and the product details [12]. It encompasses user interaction, the functionality, the design, and operational qualities such as performance, robustness, interoperability and security. This canvas is designed to work in tandem with Scrum, Lean and Startup. It depicts and captures the UX, and supports a user-centered design approach.

4 Agile models and design thinking

Ken Schwaber in [13] introduced SCRUM, which produces prototype, which is responsive in current and additional requirement revealed during the constant development. SCRUM has sprint phases where analysis, design, and development of current customer requirements are performed with flexibility at concern. This leads to the development of prototype of current requirement.

Broderick Crawford et al., in [14] introduced creative thinking in extreme programming. Extreme programming embraces the change at any phase in agile mode. The agile mode allows the direct interaction of development team with customers that is a user centered approach. User centre approach causes implementing creativity required for customers requirement satisfaction.

Design Thinking is an innovation process with a fundamentally human-centered approach. However, it is not simply about doing what the customer tells you, but watching and observing what the customer is facing and solving that problem [15].

Its value is not only how well an individual develops the problem solving skills to create "products" but also how he/she can begin to develop higher-order thinking skills to solve some of society's greatest system challenges [15].

Inquire, Ideate and Rapid prototyping are the main stages of Design Thinking. Identify and define a problem or challenge and reframe it into an opportunity which can then be used as the basis for a design project. Ponder on these questions to obtain a clue - What Is? What If? What Wows? What Works? [16]. Through a range of ideation design strategies come up with potential solutions to the identified challenge. Get the feedback for the ideas and based on these feedbacks choose and select one idea to begin the prototyping of the potential solution. Rapid prototyping is used as a tool for testing and redefining ideas. The prototype has to be constructed within a limited timeframe to propel to action rather than thinking [16].

"Design Thinking is a critical mix of Storytelling and prototyping"- Mark Zeh, former IDEO design leader [17]. Communication of knowledge is not through raw data but through data in context that construct a story. Knowledge is captured in stories. Building narratives is how communication is carried of customer's problem to others in the product team. Storytelling is used throughout the Design Thinking activities. Prototypes are the props. A prototype is something that you can engage with physically. It is a tool to help us communicate and test ideas. Putting the prototype into the hands of the customers actually causes them to think differently than simply talking about the concept. By iterating through prototypes with customers, designers can learn what product features are needed and what design constraints exist [16].

5 Discussion

Requirement Gathering is always a challenging phase in software development. The traditional requirement gathering techniques are too stringent and involves a handful of people. It does not focus on collaborative exercise of all the stakeholder involved in the interest of the product or service. This leads to a product or service that may not satiate the needs of the end-user.

Today innovation is the need of the hour for many organizations to survive in the competitive race. Innovation deals with discovering solutions that are novel and at the same time resolves the pain areas of the end-user.

To achieve this we need a methodology that empathizes and not only understands the end-user's pragmatic requirement.

Visualizing ideas is the most influential way to communicate to others. Therefore, *mind mapping* is one such strategy that facilitates in drawing our ideas on paper and connects the dots. This is a highly effective technique that accelerates the requirement gathering in agile software

development. It is a highly collaborative task that may involve business experts, end users, programmers, product owners, business analyst, testers, database experts, system administrators. It is an effective tool for seeing the whole story on a high-level**.** Mind mapping helps the agile development to extract the most imperative requirements cognitively.

Designing a more fruitful shopping experience for a value seeking customer: - The design is influenced by observation of the purchasing process of someone that goes to the shopping mall(offline shopping) on a "need to go" basis. The key insight learn is that -consumers are busier and have less free time to shop in stores; smart phones, tablets, conference calls, email, social network and video streaming all help provide efficient communication and more; and consumer preferences are shifting toward what can be done quickly and efficiently.

These insights drove the creation of prototypes using the Agile Story Mapping mechanism.

Story Mapping is an engaging activity where all participants are involved in the process of building a product backlog on a wall versus writing a dull 100-page requirement document. It is a top-down approach of requirement gathering and is represented as a tree. It starts from an overarching vision which is achieved via goals. Goals are reached by completing activities. To complete activities user needs to perform tasks. These tasks can be transformed into user stories for software development [19].

Goal > Activities > Tasks > Stories

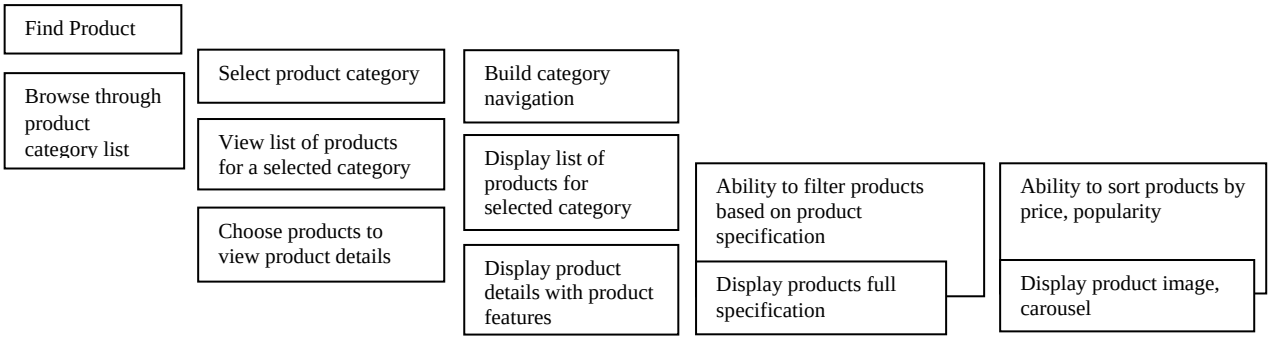

FIGURE 1 Story mapping

Goal- As shown in figure 1 "Find a Product"
Activities -

1. Browse through the product categories
2. Free text search
3. Promoted products

For Activity 1, following are the tasks

1. Select product category
2. View list of products for a selected category
3. Choose product to view product details

TABLE 1 Design thinking to agile methodology- a roadmap

Design Thinking	Agile Methodology
It is a human-centered approach to defining and solving problems.	It involves the end-users from initial to completion stage of the product development.
It is suitable in situations where the problem itself is not clear.	It embraces uncertainty and is suitable for projects where requirements are subject to change (Extreme Programming).
Ad hoc conversations to discuss particular ideas and solutions.	Conversations are the engine room of shared understanding where breakthrough moments can occur.(SCRUM)
A critical mix of Storytelling and Prototyping.	Story telling leads to feature specification and implementation(SCRUM)
A limited time frame for rapid prototyping to propel action rather than thinking.	Content is more important than representation (AM model)
It encourages a multitude of possibilities.	Focuses on a model of purpose and permits multiple models (AM model)
Divergent thinking to form creative ideas	Convergent thinking to come up with a product from a prototype
Rapid prototyping	Rapid implementation
Uses mind mapping technique for requirement gathering to identify and define problems and challenges.	Stories with priorities

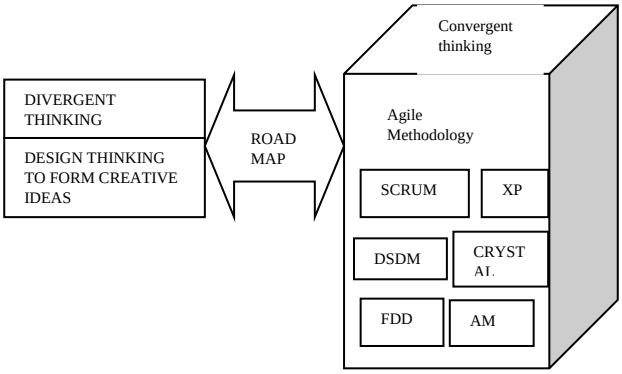

FIGURE 2 A Road map from DT to agile methodology

Table 1 and Figure 2 show the roadmap that connects design thinking and agile methodology cognitively. Human-centred approach in design thinking leads divergent thinking that is formation of creative ideas for defining and solving user problems which enriches end user involvement in agile methodology intellectually. Design thinking has ideas to deal situations where problem itself is not clear. This can lead to a continuous change in requirement. This change as well as uncertainty in requirement is embraced by Extreme Programming technique of agile development model. Design thinking and agile methods such as SCRUM are always welcoming the informal, face-to-face, ad hoc conversation between various stakeholders of the project. Story telling in

design thinking clears the problem statement which guides to feature specification (user stories) in agile development (SCRUM). A limited time frame for rapid prototyping in design thinking results to proper action which cognitively leads to Agile modeling where content (immediate end product) is more important than representation. Design thinking has rationale of rapid prototype and this rapid prototype can be implemented rapidly by agile methodology. Moreover, mind mapping techniques for requirement gathering in design thinking can be converted to user stories with priorities of agile methodology.

6 Conclusion

Agile development culture can be enhanced using Design thinking mindset/tactics cognitively. Design Thinking helps us to understand our customers- getting to the 'why' behind what they do and then exploring crazy ideas that might lead to a unique offering that our customer will love. Design thinking serves to understand a need and generate a creative solution which can be implemented and deployed with software engineering lite that is agile methodology. Thus the agile culture overlaps perfectly with the prototyping stage of design thinking.

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