Pre-development & Iterative Design Activities in SCRUM:

An Approach to Agile Software Development

Neville Ko

Corel Corporation, Neville.Ko@Corel.com

Abstract: The foundation of this research study is built upon SCRUM, an agile software development process. The research methodologies encompass a literature review, review of case studies, and 14 months of participant observations of five SCRUM teams. The SCRUM process allows development teams to adapt to ever changing requirements; however, its benefits to designers are limited as it is chiefly software engineer driven – ignoring pre-development and iterative design activities. The finding of this research highlights the importance of evolving the SCRUM process to integrate pre-development and iterative design activities in order to deliver products of optimal user experience. A model known as SCRUM'D is proposed to illustrate how pre-development and iterative design activities can be integrated into the SCRUM process.

Key words: SCRUM, agile software development, design process innovation, user experience

1. Introduction

In 1986, Takeuchi and Nonaka [18] proposed a new agile software development process that is widely considered to be more holistic and flexible when compared to the Waterfall model. Since then, many modern software companies around the world of varying sizes, from Microsoft and IBM to Corel, have all adapted a version of the process [4, 7]. This agile software development process, known as SCRUM, borrows its name from the sport, rugby. The name comes from the action used by rugby players passing the ball back and forth between teammates to overcome obstacles and to advance in an assiduous manner. Similarly, SCRUM, in the agile software development environment, requires members of its cross-functional team to work closely together in a tightly knit unit to overcome unexpected impediments.

From the start of a simple business proposal to the deployment of Gold Master build, a SCRUM process emphasizes heavily on the need of continual team interaction where business and development decisions are discussed and goals are agreed upon. Subsequently, activities to achieve these goals are clearly defined and executed in short predetermined timeframes known as sprints. Once a sprint is complete, the team collectively reviews their progress by evaluating the results of a sprint, which are "shippable" working increments. This cycle of business and development goal identification, small-scale planning, and shippable product evaluation is repeated as necessary until a project is considered complete.

The aforementioned is a brief overview of the SCRUM process where the goal is to heighten transparency of communication, thus allowing the development team to adapt to ever changing business and development needs. Unfortunately, the SCRUM process, as described, has limited benefits for designers in the development team as it is chiefly software engineer driven. Close examination of the SCRUM process reveals issues that hinder proper integration of pre-development and iterative design activities that are vital to the success of creating a product

with positive user experience. Therefore, even though the SCRUM process may be highly valuable to the development team as a whole, the final product may be lacking in refinement as design improvements cannot be addressed.

This qualitative research is the first part of a multi-part series. The methodology is based on literature review, review of case studies, and a 14 month participant observation of five SCRUM teams in a software development environment (Corel Corporation). In the 14 months of this study, Corel has been practicing the SCRUM process with minimal modification as a way to gauge the effectiveness of SCRUM as prescribed by its main advocates. The three objectives of this research is to emphasize the continual need to evolve the SCRUM process as to thoughtfully integrate pre-development and iterative design activities to software development:

1) Highlight major deficiencies of the SCRUM process from the perspective of a User Experience Designer in a software development environment.

2) Provide recommendations on how to best integrate pre-development and iterative design activities into the SCRUM process in a model.

3) Raise important questions to the academic and professional communities for future research.

2. SCRUM, Pre-development Design Activities, and Iterative Design Activities
2.1 Essence of SCRUM – Agile Software Development

SCRUM is an agile software development process that focuses on delivering "shippable" working increments in a minimum time period of two weeks. The main roles of a SCRUM team consists of a product owner, a SCRUM master, and a development team of three to nine members. The product owner is accountable for representing the best interest of the user and delivering value to the business by creating and prioritizing user stories. A *user story* is a concise description of user needs and wants by answering who, what, when, where, why, and how. Additionally, a user story can be accompanied by supplementary information like rough sketches and reference material to help communicate intent.

The SCRUM process consists of backlog grooming, sprint planning, daily SCRUM, sprint review, and sprint retrospective meetings. Figure 1 depicts the SCRUM process. Before the process begins, a product owner would present the SCRUM team with the vision. The *vision* is typically rudimentary but it should provide sufficient information to communicate intent to answer what the return on investment is to a business, how it can fit into a product strategy, and what the user benefits are. Closely after, the *backlog grooming* meeting would take place where the SCRUM team would add development and design details, provide estimates of approximately how much effort is required, and prioritize each user story against one another so that the most important user stories can be completed first. In a *sprint planning* meeting, a product owner, a SCRUM master, and a development team would come together to plan which user stories to work on and how to allocate development resources to complete the user stories in a two week sprint. Once a sprint has started, *daily SCRUM* would take place on a day-to-day basis to communicate activities in the past and next 24 hours. The goal is to synchronize activities within a SCRUM and gauge the team's overall progress. Throughout the duration of a sprint, the product owner would create user stories for upcoming sprints. User stories are considered groomed when sufficient development and design details have been added to communicate a clear user intent. As a sprint comes to an end, there would be an adequate amount of user stories to satisfy work that is needed for the development team to complete an upcoming

sprint. In a *sprint review*, the SCRUM team would communicate the results of a sprint by demonstrating "shippable" working increments to stakeholders and clients. This is an opportunity for stakeholders and clients to suggest any necessary changes and modifications. Lastly, the SCRUM would evaluate the success or failure of the preceding sprint during a *sprint retrospective* where changes to improve the process can be suggested. Once a cycle has been completed, a sprint planning will commence to prioritize new and incomplete user stories against one another for the upcoming sprint.
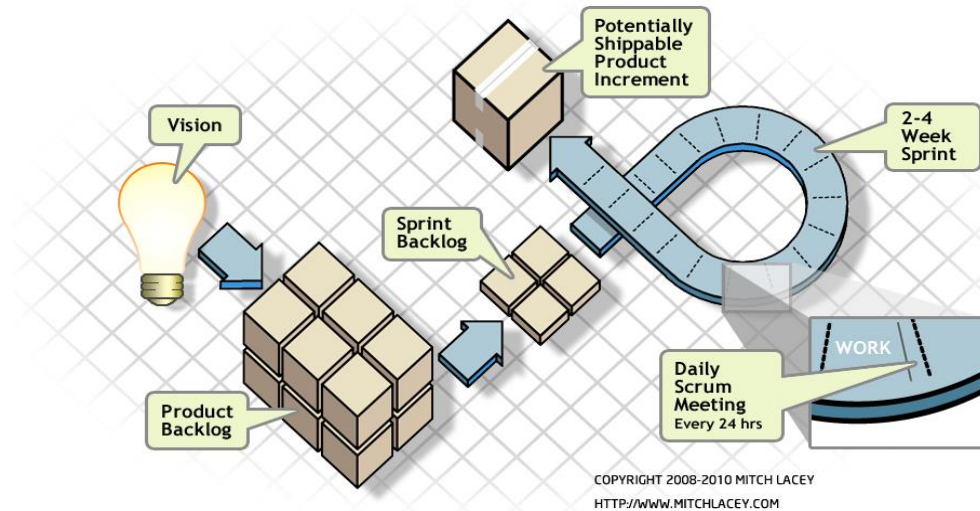

Figure. 1 Model of the SCRUM process

2.2 Essence of an Iterative Design Process – Pre-development & Iterative Design Activities

It is well documented that some of the most successful designs are created under a rigorous process whereby, firstly, *design requirements* such as user benefits, user requirements, and usability goals are determined and analyzed. Design requirements is a result of pre-development activities, such as user research, persona identification, ideation, brainstorming, storyboard creation, and contextual inquiry [1, 9, 19]. Secondly, based on design requirements, conjecture design solutions are generated, scrutinized, revised, and the process is repeated until the desired outcome has been achieved. The former allow designers to clearly define crucial usability goals, which form a basis for the development of conjecture design solutions. Usability goals help guide designers achieve a common design objective and construct a positive user experience. Usability goals may include [13]:

- Effectiveness of use
- Efficiency of use
- Utilitarian of use
- Ease of learnability
- Ease of memorability

The latter component describes an iterative process that allow designers to refine their conjecture design solutions that are initially abstract, conceptual, and unfinished. Designers build upon positive attributes and eliminate negative aspects of the conjecture design solutions; thus, constructing a strong, meaningful, and usable end product over numerous repetitions [8, 10, 6].

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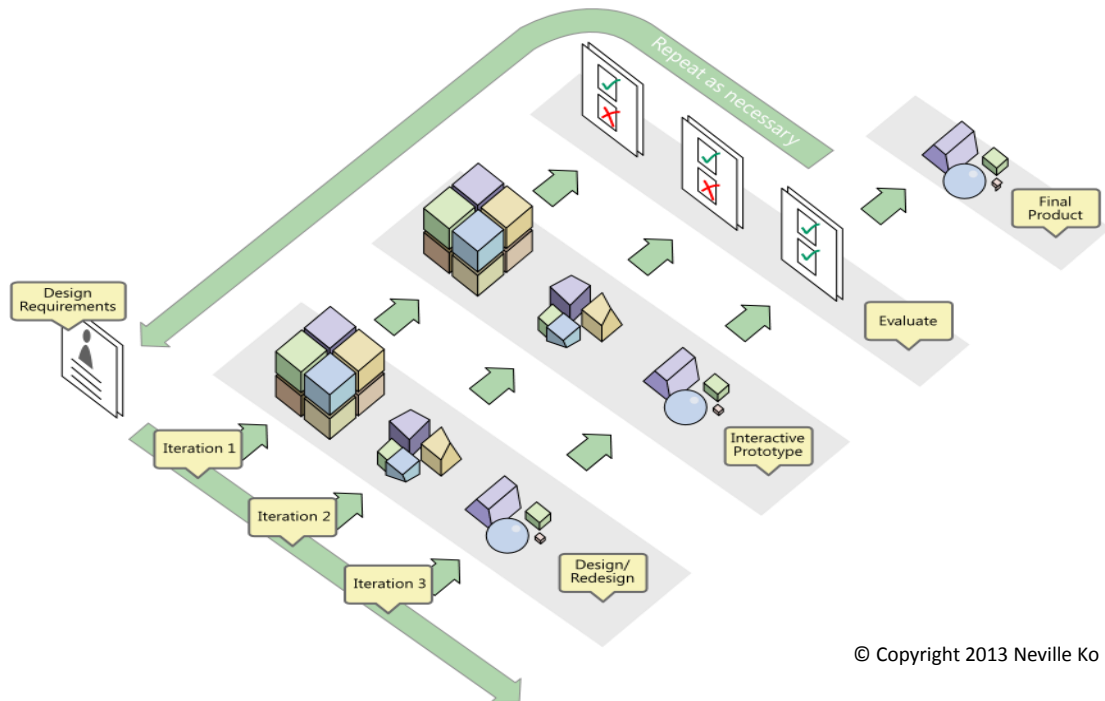
Figure. 2 Model of Iterative Design Process

Figure 2 illustrates a basic model of an iterative design process. Design/redesign stage is where designers would take business, product, and design requirements to explore conjecture design solutions with low-fidelity prototypes, which permits designers to visualize and communicate many potential solutions very quickly [11, 15]. Testing of low-fidelity prototypes validates conjecture design solutions and is effective in gaining feedback with a relatively short amount of time, however keeping in mind that it is heavily dependent on the complexity and/or thoroughness of testing scenarios [14]. Test results are then analyzed as a way to evaluate the effectiveness and to justify the validity of potential solutions. Using insights gained from test results, the (re)designing and testing exercises are repeated until the final design inherit as many benefits from conjecture design solutions as possible; thus completing iterative design activities that sum up an iterative design process.

2.3 Absence of Pre-development & Iterative Design Activities in SCRUM

As briefly identified, pre-development and iterative design activities are vital in delivering a positive user experience with good usability in mind. Without adequate consideration to undertake pre-development activities, design requirements that accurately represent the best interest of the intended end user would not emerge. Likewise, without iterative design activities to allow the repeated practice of (re)designing, testing, and refining of conjecture design solutions, costly design issues will not be caught prior to coding resulting in potentially expensive fix or poor user experience.

Upon scrutinizing the SCRUM process through this literature review and putting the process into practice, it is not evident that the process take into consideration the amount of time and effort that is required to undertake these two vital design activities. The following two examples shows it is inconceivable how:

1) a product owner, upon sharing the vision, would be able to answer what the return on investment is to a business, how it can fit into a product strategy, and what the user benefits are only to expect that the

SCRUM team to provide sufficient development and design details to successfully groom user stories. Specifically, without pre-development design activities to determine design requirements, it is highly probable that the vision has targeted a completely inaccurate user group. Moreover, without clear definition of the end user, it is almost impossible to validate a design's user experience accurately.

2) designers or usability experts would conduct thorough user testing during a sprint, analyze the findings, reiterate the design, then provide the details needed for an upcoming sprint. Thorough user testing of multiple methods is resource intensive and it requires a significant amount of time [12]. In a sample case of Xerox's 'Star Office workstation, it required over 15 distinct tests, involved over 200 subjects and lasted over 400 hours [3].

3. Research Methodology

3.1 Literature Review & Case Studies

The literature review examines many writings regarding the SCRUM process from published material to blogs by professionals and experts who are practicing SCRUM in the software development industry. It is essential to thoroughly understand the strengths and weaknesses of the SCRUM process in order to provide an informed critique from the perspective of a design professional. Valuable resource have been disclosed through the review of literature and case studies as it has not only laid the foundation for this research but the integration and adaptation of SCRUM into Corel Corporation's development process.

3.2 Participant Observation & Analysis

The participant observations were 14 months in duration and it was undertaken at Corel Corporation by a User Experience Designer who is a Certified Scrum Product Owner. A total of five SCRUM teams were observed where each SCRUM duration was approximately 14 weeks with two week sprints. For the purpose of learning the advantages and disadvantages of SCRUM, changes to the SCRUM process as described by Schwaber, Sutherland, Beedle and Cohn's writing were avoided where possible [2, 16, 11]. The intention is to practice SCRUM as described by the original contributors of the process then make the necessary changes as needed.

The information gained from the participant observations aided in the construction of a software development model that integrates pre-development and iterative design activities into the SCRUM process. The goal of the participant observations is to highlight real world problems of SCRUM and to provide recommendations to strengthen future practices and encourage further research.

4. Results & Interpretations

4.1 The Field Site

The five SCRUMs in this study comprised of a single product owner (the author), a SCRUM master and five independent development teams of four to six members in each SCRUM. The average development time was 14 weeks, which breaks down to two week sprints to a total of seven sprints. For the purpose of this paper, the results communicated are summarized to provide an overview and highlight areas of major concern.

4.2 The Vision & Initial Backlog Grooming Before a Sprint

At the beginning of a project, a SCRUM team would work together to scrutinize the vision which comprises of business requirements, product strategies, and user benefits as presented by the product owner in the form of user stories. In this meeting, a SCRUM team would determine what work needs to be completed and how much time it would take to complete each user story, with the highest priority user stories to be worked on above all else. Development and design details are added to each user story where necessary and whenever possible.

In practice, even the most elaborate vision and detailed user stories have failed to fully convince a single SCRUM team in Corel Corporation made up of experienced veterans. In the absence of pre-development activities, which involves user research to clearly define design requirements, it has proven to be a major challenge to justify user benefits based on a vision. Consequently, the development teams have expressed the lack of clarity to vaguely fashioned user stories to be a cause of confusion and frustration when attempting to add development and design details.

4.3 Sprint Planning

In principle, a sprint planning meeting is eight hours in duration where the primary objective is to prioritize groomed user stories to fulfil the duration of a sprint. It is important that any design activities should be completed by this meeting. In the first four hours, the development team would scrutinize the user stories by questioning its purpose and meaning. Additional development and design details may be added to help further define user stories but should be kept to a minimal. The last four hours would allow the development team to formulate a plan to execute user stories.

In practice, an eight hour time frame represents a serious problem. As mentioned earlier, the role of a SCRUM team is to determine how to accomplish the business requirements, products strategies, and user benefits by delivering "shippable" working increments of the software with positive user experiences. A key component that is missing are design requirements which are determined by pre-development activities. Without design requirements, it is extremely difficult to design positive user experiences and bring value to intended users. Consequently, it is also challenging for a product owner to respond to the development team's scrutiny toward the user stories. When valid questions arise, it is almost impossible to provide answers based on research. Lastly, a four hour time duration does not provide adequate time for designers and the development team to make any meaningful changes to a backlog full of user stories.

4.4 Daily SCRUM

During each day of a sprint, a SCRUM team would meet for 10 – 15 minutes to undertake activities of a daily SCRUM. The goal of the daily SCRUM is to communicate what each member has done since the day before, what each member intends to do on the day of, and if there are any impediments. Generally, daily SCRUM meetings have been the most successful and desirable part of the SCRUM process. It has proven to be beneficial at Corel Corporation.

4.5 Backlog Grooming During a Sprint

During a sprint, grooming meetings are for a SCRUM team to refine preliminary user stories until the acceptance criteria is clear, understandable, and obtainable. It is crucial that each independent user story is

achievable at the end of a sprint since the goal is to deliver "shippable" working increments. During this meeting, designers can take the opportunity to ask for feedback from the development team. As a result, designs that are captured in user stories become more refined as they are groomed.

The grooming meeting is an ideal opportunity to gather feedback from members of the development team who represent a variety of domain knowledge. In practice, there is an obvious problem in the SCRUM process where it limits designers' ability to make sensible design decisions. First and foremost, designers and the development team are making design judgement based on what they *think* will be delivered by the end of a sprint. Without immersive interaction with the "shippable" working increments that are being developed concurrently, designers and the development team are making design/development decisions and building on each other's interpretation and not factual accounts of each other's interaction with the working increments. Secondly, in the absence of an immersive interaction with the working increments, it is apparent that user testing cannot be conducted or prepared adequately to gain meaningful feedback from a respectable subject size. Furthermore, working increments tend to grow in quantity near the end of a sprint as user stories are completed, which typically means that the functionality and the experience of the working increments becomes more obvious and cohesive as a sprint comes to an end. However, the remainder of a sprint would not provide sufficient amount of time for user testing and test results to be analyzed to determine design modifications. Consequently, it is impossible to iterate a design under such circumstances.

4.6 Sprint Review

Once a sprint is complete, a SCRUM team would review the results of the "shippable" working increments in a four hour meeting. Any incomplete user stories would be reprioritized for upcoming sprints. The review is typically organized as a formal product demonstration where all relevant stakeholders and clients are encouraged to attend. By the time of a sprint review, user stories and design details would have already been groomed based on the intended behavior of the "shippable" working increments.

In principle, a sprint review meeting is extremely useful as it allows all stakeholders to review "shippable" working increments. In practice, sprint review meetings presented a number of problems to Corel Corporation from a design perspective. As mentioned earlier, groomed user stories are intended for an upcoming sprint and are based on interpretations of how the "shippable" working increments are expected to behave. Since a sprint review may be the first time that designers would have the chance to interact with a full set of "shippable" working increments, it does not allow sufficient amount of time for meaningful iterative design activities to take place. These design activities, which include low to high fidelity user testing and creation and modification of conjecture design solutions are vital to the successful evolution of a product. Without these activities and the opportunity to incorporate feedback, the final user experience could be undesirable.

4.7 Sprint Retrospective

The purpose of a sprint retrospect is to allow a SCRUM team to reflect on the past sprint. Members are encouraged to express challenges that were presented in the process. For the purpose of this study, SCRUMs at Corel Corporation avoided to make any changes to the SCRUM process as prescribed by Schwaber, Sutherland, Beedle and Cohn.

4.8 Repeat Steps 4.3 to 4.7 as Necessary

After the sprint review and sprint retrospective meetings, a SCRUM team is expected to undertake a sprint planning meeting. User stories are groomed and readily available for a SCRUM team to plan for the work of an upcoming sprint. The steps listed in 4.3 to 4.7 are repeated as necessary until the desired outcome has been achieved or if development time is over.

5. Discussion

5.1 Omissions in the Absence of Pre-development & Iterative Design Activities

Evidently, the main activities that allow the SCRUM process to heighten communication between a cross-functional to deliver "shippable" working increments can benefit from thoughtful integration of design activities. From a design perspective, the SCRUM process have omitted three crucial elements that can strengthen the end user experience:

1. Pre-development activities
2. Focus of design strategy
3. Iterative design activities

5.1.1 Omission 1: Pre-development Activities – "Setting a Weak Foundation"

The SCRUM process does not take into account any pre-development activities like user research, persona identification, ideation, brainstorming, storyboard creation, and contextual inquiry to determine *design requirements* such as user benefits, user requirements, and usability goals. The previously mentioned design activities require a significant of time investment and it is a critical path to creating "usable" and enjoyable user experiences. In reviewing literature from the main advocates of SCRUM, the SCRUM process appears to have omitted many, if not all, of the aforementioned pre-development activities entirely. Furthermore, the SCRUM process does not take into account the time and importance of such activities. As a result, it is perceivable that a product could be building on an invalidated foundation; thus, failing to deliver optimal user experiences to the intended user.

5.1.2 Omission 2: Focus of Design Strategy – "Missing the Big Picture"

The consequences of not undertaking pre-development activities to determine design requirements can be dire. Even when business goals or product strategies are well defined, the final design is only meaningful if the intended user perceives value. The absence of design requirements may result in a final product that lacks focus or "miss the big picture" in its entirety since there is not a *design strategy* to adhere to. The final product could be an abundance of small and "shippable" working increments that does not work harmoniously with one another to form meaningful user experiences. Furthermore, it is almost impossible to meet usability goals and validate design solutions without clearly knowing what the big picture is. Below is an adaptation of Preece, Roger, and Sharp's usability goals [13]:

- Does the effectiveness of its design meet business and user requirements and if so, how?
- Does the efficiency of its design meet business and user requirements and if so how?

- Does the utility of its design meet business and user requirements and if so how?

- Does the learnability of its design meet business and user requirements and if so how?

- Does the memorability of its design meet business and user requirements and if so how?

5.1.3 Omission 3: Iterative Design Activities – "Building on a Weak Foundation"

The fundamental problem with the SCRUM process is that it is unconducive to long-term planning and discourages longstanding strategic design thinking. In the absence of utilizing the SCRUM process with sufficient design requirements, it is plausible that subsequent conjecture design solutions are built on a less than desirable foundation. The SCRUM process, in principle, allows the SCRUM team to maneuver relatively quickly and respond to changes in business, product, and user objective. However, the scale of these changes are inherently restricted to the flexibility of the foundation that it is built on. Consider the following scenario:

> Software Company A is developing a product that allows users to perform task Z. Without adequately defined design requirements, Company A decides to utilize Technology AA as it meets business requirements and product strategies for the reasons that Technology AA is the most powerful, readily accessible, and cost effective. After five to six successful sprints, a member of the development team brought forth a few assumed target users to test the feasibility of Company A's "shippable" increments. Company A's test results indicate that the "shippable" increments are "unusable" by the assumed target users. In other words, target users were not able to perform task Z as desired.

There are many questionable decisions from a technical perspective. How can a technology be evaluated without knowing exactly who the intended users are albeit the accessibility and cost effectiveness of the technology? What if the chosen technology does not provide the desired outcome that users expect due to the technology's inherent complexity? From a design perspective, how can positive user experiences be created without knowing exactly what the design requirements are (user benefits, user requirements, usability goals)? Without design requirements, what if intended users are not looking to perform task Z but an alternative task Y? Most importantly, what if the intended users are completely different to the actual users? Despite the validity of the above questions, there is no method of effectively determining why the test users in the above scenario are not able to perform Task Z at this early stage of the development cycle. What is probable is that the development team may be encouraged or have no choice but to continue developing the product with the assumption the test product is unfinished or premature, which therefore answers why user testing yielded undesirable outcomes. As a result, the development team may continue to build on a "weak" or invalidated foundation only to realize that decisions that were made early in the SCRUM process were unjustified.

Additionally, assuming that design requirements have been determined and the development team has been successfully progressing, the backlog grooming and sprint review meetings does not provide sufficient time to permit sensible design decisions to be made if unexpected variables were to arise or existing variables were to change drastically. According to Schwaber and Sutherland, grooming is prescribed to take less than 10% capacity of the development team and is considered only a "part-time" activity [16]. And as mentioned earlier, user story grooming is built on the team's interpretations of how "shippable" working increment would function. Since the increments are concurrently developed to grooming activities, the team would not know definitively how

increments would function until a sprint review. Given the linearity of a prioritized backlog, a considerable number of user stories would only be completed close to the end of a sprint, which greatly limits the amount of time designers have to react. It is also questionable that a single sprint review meeting would allow sensible design decisions to take place that would make "shippable" working increments more "usable" without properly evolving the design in an iterative manner. Evidently, the main problem is that there is an insufficient amount of time for designers to conduct adequate iterative design activities to undertake necessary modifications to reiterate the design; thus, the original design that is based on the underlying vision is not given the opportunity to evolve.

5.2 Integration of Pre-development & Iterative Design Activities

In brief, the study has identified issues preventing pre-development and iterative design activities in the SCRUM process. Figure 3 illustrates a proposed SCRUM'D model to integrate these design activities in an effective manner.
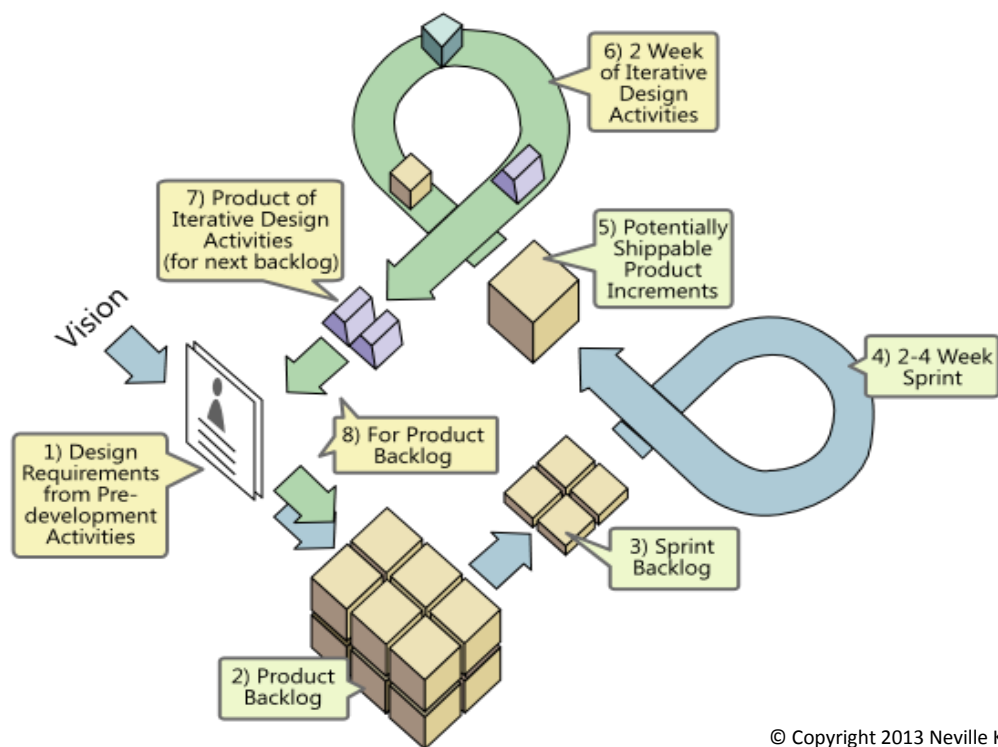
Figure 3 Proposed SCRUM'D Model: Pre-development & iterative design activities in the SCRUM process

1. Begin with a vision that is qualified by pre-development activities where the SCRUM team can work from user stories that are rooted by well-defined design requirements.
2. Backlog of purposeful user stories that are validated by pre-development activities. User stories can be easily groomed since design requirements are clear.
3. Sprint backlog outlines a formalized plan for the upcoming sprint of two weeks (to four).
4. A two week sprint for the development team to complete user stories from the sprint backlog.
5. Potentially "shippable" working increments are available for interaction.

6. A two week duration of iterative design activities for designers to interact with a full set of "shippable" working increments. Refinements and new design details are captured as user stories in the backlog. If two projects were occurring concurrently, the development team can utilize this time to complete a two week sprint for the second project. This would allow multiple projects to be undertaken in parallel.

7. New user stories are created in hope to help the next set of "shippable" working increments evolve.

8. New and existing user stories are prioritized against each other for upcoming sprint.

The proposed SCRUM'D model will be tested at Corel Corporation for upcoming projects. The goal is to continually evolve the SCRUM process to take advantage of pre-development and iterative design activities that result in projects with optimal user experiences.

6. Conclusion

Pre-development and iterative design activities are vital to the success of a product that delivers positive user experiences. The SCRUM process, as described by the main advocates, has demonstrated to be robust for software development environments in the past decades where positive user experiences were not a major consideration for the end product. However, the SCRUM process needs to evolve and thoughtfully consider the inclusion of pre-development and iterative design activities as an integral part of the process. In the second part of this multi-part study, the proposed SCRUM'D model will be utilized and the results will be analyzed, documented, and shared for the benefit of SCRUM practitioners.

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