R&D Project Management – Is it Agile?

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ABSTRACT

Agile methodologies and Management of Research and Development (R&D) both focus on successful project execution considering requirements which may be both dynamic and incompletely understood. There are, however, differences between the circumstances of agile and R&D projects. This uses the twelve foundational agile principles from the perspective of R&D as a framework in which to compare agile vs. R&D projects, highlighting similarities, differences, and places for cross-pollination between the two approaches.

INTRODUCTION

“Agile” software development and project management methodologies stem from a goal of creating an efficient, dynamic process which enables teams to “create and respond to change in order to succeed in an uncertain and turbulent environment.” (Agile Alliance, 2018) Given that uncertainty is a hallmark of research, it would seem that agile practices would work well for managing research and development (R&D) efforts. This paper compares the twelve “Principles Behind the Agile Manifesto” (Agile Alliance, 2017) with the R&D project management.

CATEGORIES OF R&D

Any discussion of research and development must take into account the wide range of activities encompassed by the term, with pure theoretical and experimental research at one boundary and product development at the other. The Organisation for Economic Co-operation and Development (OECD) and the U.S. government-wide Office of Management and Budget (OMB) each define three sub-categories of R&D, including Basic Research (the earliest stage, consisting of “experimental or theoretical work undertaken primarily to acquire new knowledge”), Applied Research (which retains the goal of acquiring new knowledge, but is “directed primarily towards a specific, practical aim or objective”), and Experimental Development (which draws upon knowledge gained from research to improve or produce new products or processes) (OECD, 2015)(US OMB, 2016). The U.S. Department of
Defense offers a finer-grained categorization with five sub-categories of R&D, as shown in Table 1. (US DoD, 2016)

Table 1: U.S. Department of Defense R&D Categories

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<th>Category</th>
<th>Description</th>
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<tr>
<td>Basic Research</td>
<td>Systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts.</td>
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<tr>
<td>Applied Research</td>
<td>Translates basic research into solutions. Systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.</td>
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<tr>
<td>Advanced Technology Development</td>
<td>Focused on development and integration of hardware for field experiments and tests with a goal of providing proof of technological feasibility and assessment of operability and producibility.</td>
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<tr>
<td>Demonstration/Validation</td>
<td>Includes all efforts necessary to evaluate integrated technologies in a realistic operating environment to assess performance and cost impact of the technology.</td>
</tr>
<tr>
<td>Engineering and Manufacturing Development</td>
<td>Translates integrated technologies into product designs through engineering and manufacturing development.</td>
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Figure 1, adapted from (Wingate, 2015), represents characteristics across the R&D continuum. Basic Research may have an intangible product such as increasing knowledge or testing a hypothesis. As such, the project contains a great many unknowns and the project plan is expected to undergo considerable change in ways which cannot be completely forecast \textit{a priori}. Each step through the R&D continuum builds on the knowledge gained in previous steps, leading to reductions in uncertainty and more concretely definition of the desired outcome. Put another way, research creates technological possibilities, while development applies a stable set of technological possibilities to the requirements of an application context (Iansiti, 1997). The characteristics of the phases of R&D drive differences in project management approaches across the continuum. Since Agile principles were established in the context of software development projects, this paper will look more towards the development end of the R&D spectrum. In terms of the DoD taxonomy, this means the phases referred to as “Applied Research” and “Advanced Technology Development”. (US DoD, 2011)
AGILE PROJECT MANAGEMENT

Agile project management encompasses as set of processes to manage work performed in a manner consistent with agile principles, that is, breaking the total work into small chunks of work of short duration (often called “sprints”). Agile methods are predicated on delivering value to the business sooner rather than later and on the idea that requirements change over time. Thus, each sprint begins with an update to the understanding of requirements and priorities and each sprint produces a product of value to the business.

Agile project management is based on agile development methods. Agile was codified in 2001 in the form of The Agile Manifesto (Beck, et. al. 2001), which is built upon twelve principles. While the manifesto is worded in terms of software development, the principles have been generalized to speak more generally in terms of “product” rather than “software”. It is also easy to find reformulations of the principles from a project management rather than software development perspective. For this paper, the original formulation of the principles is used, with an understanding that the principles should be interpreted more broadly than just software development.

AGILE PRINCIPLES VS. R&D

Agile and R&D both assume that the project cannot be fully specified upfront. Both assume that as the project executes, the team and stakeholders will gain a better understanding of the problem and solution approaches, leading to changes to the outcome as well as the path to get there. The two approaches part ways in that Agile is focused on completion – at any given time there is a known path to the current understanding of the final product, while in R&D both the feasibility of the final product and the work to get there may be uncertain. The remainder of this section contrasts the Agile Principles one by one with R&D approaches, highlighting the similarities and differences between the two.

**Principle 1:** “Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.” R&D diverges from this in two regards. First, business value from R&D is often realized through subsequent development rather than through the R&D effort itself. The value of R&D may be intangible knowledge or proof-of-principle prototypes, and so there is less focus on early and incremental of value. In addition, the level of unknowns may be such that the project needs to start with an extended period of experimentation and prototyping. Lesson for Agile development: Understand up front what you do and do not know. Recognize that knowledge has value as well as working code.

**Principle 2:** “Welcome changing requirements, even late in development.” There is agreement between Agile and R&D on this principle, as both recognize that there are significant uncertainties at project outset.
**Principle 3:** “Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.” Advancements in knowledge and capability do not necessarily happen on a regular schedule and so it can be difficult for research to be fit into sprints. Still, some degree of timeboxing can be useful in controlling the investment in non-productive avenues. “R&D personnel are technically trained perfectionists who believe that cost and time are unimportant when it comes to improving the state of the art.” (Kerzner, 1981) Checkpoints, experiments and prototypes can avoid wasting energy in dead ends or pouring additional resources into an area for little improvement, reducing the ultimate return on investment.

**Principle 4:** “**Business people and developers must work together daily throughout the project.**” This is an area of divergence, as research is not always focused on a business need. The application of the knowledge being learned may not initially be clear, there may not be an identified “business person”, and the timescale from research to product may be longer than business’ time horizon. Increased participation from technology transition targets is a good idea as research progresses through the phases shown in Table 1 to help bridge the gap between the researcher, who may not intimately know the business applicability, and the business, which may not initially grasp the value of the new knowledge or capability. (EFCOG, 2010)

**Principle 5:** “**Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.**” There is agreement between Agile and R&D on this principle. Researchers are typically highly motivated individualists and work best with considerable autonomy. (Sapienza, 1995)

**Principle 6:** “**The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.**” There is agreement between Agile and R&D on this principle. While the definition of “face-to-face” has expanded over time to include web-conferencing, R&D thrives on dynamic exchange of ideas among members of a research team – though contemplative solo work time is also an important part of research. (Tidd, 2016)

**Principle 7:** “**Working [product] is the primary measure of progress.**” The level of agreement here depends on where one focuses in the R&D spectrum. In basic research, demonstrable product may not be appropriate or may take the form of executed experiments, though the experiments may not be successful. In applied research and beyond, successful experiments, prototypes, and other product come into play as measures of progress. Still, the non-linear and knowledge-based nature of R&D means that an accretion of working product is not always an appropriate indicator of progress.

**Principle 8:** “**Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.**” Pacing in R&D is less uniform. Innovation cannot necessarily be achieved in time-
boxed sprints. Still, appropriate agile principles can help create a sustainable innovation environment.

**Principle 9:** “Continuous attention to technical excellence and good design enhances agility.” R&D product may take the form of a proof-of-principle or prototype which may be known a priori to be a throw-away or of limited lifespan. Thus, while the underlying research and development should be technically excellent, it may be sufficient for the product to be merely “good enough” to demonstrate the principle.

**Principle 10:** “Simplicity—the art of maximizing the amount of work not done—is essential.” R&D often includes false starts as well as seemingly non-productive contemplative time. Thus, the total work done is almost always more than what would have been required if you had known the outcome at the outset. Minimizing the amount of work done is not always the right approach. However, there can be a temptation to gold-plate work or spend time exploring low value tangents. Researchers may also resist giving up at dead-ends. (Jain and Triantis, 1990) Maximizing the amount of non-productive work not done without impeding discovery is the R&D manager’s challenge.

**Principle 11:** “The best architectures, requirements, and designs emerge from self-organizing teams.” There is agreement between Agile and R&D on this principle. Researchers work well with high autonomy.

**Principle 12:** “At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.” There is agreement between Agile and R&D on this principle. Researchers are creative people and can be great sources of ideas on how to do things better. Potential challenges include controlling the flow of ideas for improvement and mediating among competing ideas. (Badaway, 2010)

**CONCLUSION**

Agile methodologies and R&D agree that productivity is improved when teams are in control rather than constrained by rigid processes or bureaucracy, and that communication and collaboration are essential. However, there is a critical difference: in agile development, while the understanding of the problem may evolve over time, at any instant there is a reasonably complete understanding of how to implement the solution as currently understood. In contrast, at any given moment R&D may have one or more unknown steps on the critical path. As a result, while agile projects can focus on working efficiently towards a solution with value-added interim product, R&D must plan for an exploratory effort, possibly including wasted effort pursuing what turn out to be mis-steps towards a solution. Further, agile projects may be able to receive greater guidance from customers as they are chartered to address a business need, while R&D may not have a customer and the invention may drive the need.
Good areas for cross-pollination between the two include applying the agile concept of sprints to gauge and possibly re-orient research as it processes, and for agile to recognize that the contemplative slack time and exploration typical to R&D can improve final product, even if they do not immediately seem productive.

REFERENCES


