Adapting Project Management Principles and Tools for Research and Development

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Abstract

Project Management principles and tools are often well understood by engineers in corporate engineering departments, but are frequently unused or unwanted by many in Research and Development. The problem is often a cultural perception that Project Management is too rigid and not flexible enough to be applied to situations where inventions and innovations are taking place. This paper presents ideas for adaptation of project management principles and tools to the culture and needs of research and development projects.

Introduction

In today's competitive business world, the use of project management principles and tools has proven to be extremely valuable. The use of project management is increasingly being used in more and more business areas where it has traditionally been little applied.

Oddly enough, one of the application areas where project management is needed most is also an area that often resists its use: Research and Development (R&D). There is a challenging need for adaptation of project management to R&D. The adaptation is necessary so that R&D people will (1) be willing to use project management and (2) see the value of using project management. To adapt project management principles and tools to R&D projects, some of the biggest challenges are caused by the differences in R&D culture from those of other organizations, like an engineering department or a construction company. The cultures can be very different.

A Research and Development Cultural Challenge

Many R&D people fear having to use formal project management. They feel uncomfortable with too much structure. The often don't want to be held to detailed plans that seem inappropriate for research projects. They struggle with being asked to "Schedule an invention." And, they don't see the value of using project management techniques when there are so many uncertainties in their projects.

The fear of too much structure is mostly a cultural issue. The use of Project Management techniques is often associated with large engineering and construction projects where (1) detailed plans are normal and essential, (2) milestones and deadlines have very specific dates, and (3) there is a high degree of control and oversight.

For example, an engineering department culture can often be highly structured and might be likened to a military culture: one that is rigid and where followers salute to the exacting commands and demands from their leaders; those leaders doing most of the decision making and expecting specific deadlines to be met and budgets to be kept. But R&D people often don't feel comfortable in this type of culture.

Instead, the R&D Department culture might be more likened to that of the Beach Boys where there are (1) a desire for little structure, (2) a need to experiment without a lot of oversight, and (3) an interest in exploring interesting and perhaps valuable side trails. Can project management fit into this flexible-type culture?

The answer is a big "Yes." But to be successfully used, the principles and tools of project management must be adapted to the R&D culture. First, it is important to remember that project management is really about working with people, including R&D people, to accomplish important objectives. "It is the people—not the procedures and techniques—that are critical to accomplishing the project objective. Procedures and techniques are merely tools to help people do their jobs" (Gido and Clements, 1999). Second, in R&D we need to allow flexibility in the tools—these tools need to be used to help us, not to beat us up. Third, in R&D we need to encourage better project objective definition, even if the objective might need to be modified later. Fourth, in R&D we need to encourage better planning and replanning with the understanding that things will likely need to change, but that planning will still help everyone to work more effectively and efficiently.

Dealing with Some Specific R&D Project Management Challenges

Based on the author's own experience, three of the most common R&D project management challenges are (1) the difficulty in clearly identifying project objectives, (2) inadequate planning, leading to overly optimistic estimates of time and resource needs, and (3) the difficulty in dealing with unknowns. Let's look more closely at each of these and how project management principles and tools can be adapted to help.

Defining Project Objectives. When defining project objectives we want to paint as clear a picture as is reasonably possible (Larsen, 2002), so that everyone working on the project sees and understands the same objective—otherwise we could easily have X number of people working on X number of projects, instead of the same project.

The following suggestions can help in the difficult task of defining R&D project objectives:

(1) Make sure you are solving the right problem—don't jump to conclusions! Ask lots of questions. It is not uncommon in R&D for us to start solving a problem, perhaps given us by a business team or perhaps conceived by ourselves or other people, and then after considerable time, effort and cost, to find that we have been solving the wrong problem. Getting started right can make a big difference and will help maintain credibility.

(2) Look at alternative objectives—your first impressions might not be the best. Even though we have identified the correct problem, how we define the objectives can affect how effective we are at solving that problem.

(3) Talk with people familiar with the research topic and get their input on how to clarify the project objectives and the project value—understand the project justification for funding, both for now and in the future.

(4) Get lots of feedback on various drafts of your objectives as you develop them—make them as clear, specific, and measurable as possible, even if you will likely need to change them later.

(5) Make your objectives SMART (Dobson, 1993). This acronym can help you remember important criteria by which to determine if you have good objectives. The definitions involved with the acronym are as follows:

S:	Specific	Focused, clear, not abstract
M:	Measurable	Verifiable, quantified if possible, so that "You can tell when you have reached the objective
A:	Agreed-upon	All key players agree and are committed, preferably in writin**g**
R:	Realistic	Challenging; but not impossible to achieve, nor perceived that way; within the project constraints; not too rigid
T:	Time-Oriented	Clear completion time frame

Planning. Planning R&D projects is often either vastly inadequate or almost avoided altogether because of the large amount of uncertainty in these projects—how do you plan an invention? Yet, uncertainty is really more reason to plan, not a good excuse to avoid it. By planning, you manage uncertainty. By *not* planning, uncertainty manages you.

When planning R&D projects it is especially important to realize that a project plan is simply a tool to help you, to serve you—The plan is your servant, not your master! If you need to change the plan, do it. You created it, you are the master. Make it work for you and help you. The plan itself is not nearly so important as the process of planning, by which you carefully consider all of the various aspects and challenges of the project and how to meet them. *Not planning* is irresponsible; *planning* and *replanning* are how you stay in control of the project. Smith has said that project *replanning* equals project *control* (Smith, 1993).

When planning R&D projects, plan the near-term part of the project in detail; then, roughly plan the rest of the project, even if the best you can do is a very rough plan listing major milestones. As the project moves along, add the details to future plans as soon as possible. Thus, the level of detail planned is like a wave moving forward in time as the project progresses, the depth of planning continually getting deeper.

Planning for Unknowns. There are two major types of unknowns: *Known unknowns*, and u*nknown unknowns*. Known unknowns are the things we know we don't know.

For example, I might know that I don't know if a new technology will be useful for an untested application. Or, I might know that I don't know whether it will rain or snow on the day I planned to do an outdoor experiment to be conducted in the future.

Unknown unknowns are the things we don't know we don't know—events which we have no reasonable way of being expected to predict. An example of an unknown unknown might be…well, we don't know. But unknown unknowns happen all the time. We might be working on a project with a very fine project manager who suddenly has a heart attack and is out of commission for several months. We likely had no way of reasonably being able to foresee such an event—it was an unknown unknown.

How do we deal with known unknowns and unknown unknowns? Let's look at known unknowns first.

For predicting known unknowns we need to think ahead; we need to ask "What could go wrong?" Much of the success or failure of R&D projects can be determined by thinking ahead about what could go wrong, and then using a structured approach to addressing the most important issues. To help you foresee what might happen and what to do, try doing a “Fatal Flaw Analysis.”

Fatal Flaw Analysis, as devised by the author, consists of two steps: First, hold a brainstorming session with key project personnel, and perhaps several other creative people not associated with the project, to answer the following type of questions: “What could possibly go wrong with this project?” or “What might happen that could have a bad effect on this project?” During this brainstorming step, list all suggestions without making any judgment about their merit, validity, applicability, worth, etc. Right now you are just brainstorming flaws, not judging them; you will evaluate the brainstormed ideas in the second step.

Second, once you have written down all the brainstormed ideas or flaws, and again with a qualified group of people, evaluate and prioritize the ideas by deciding into which box in Figure 1 to place each idea, based on (1) the likeliness of the flaw occurring and (2) its effect on the project.

← Likeliness of Occurrence →

←Effect on Project→

	Very Probable	Moderately Probable	Very Unlikely
High negative impact	1 “A” Priority	2 “B” Priority	3
Moderately affects project	4 “B” Priority	5 “C” Priority	6
Very low impact	7	8	9

Figure 1. Fatal Flaw Analysis

The flaw ideas listed in box 1 have “A” or top priority. These flaws are very probable and have a high negative impact on the project. Therefore, you must carefully address ways to either prevent these flaws from occurring or find a way to prevent the damage when these flaws occur. The flaw ideas in boxes 2 and 4 have “B” or next priority and also must be addressed, being superseded in importance only by the “A” priority. Finally, the “C” or third priority items, which are found in box 5, need to be dealt with as project resources permit and should not be ignored. The flaws listed in boxes 3, 6, 7, 8, and 9 are either so unlikely or of so little impact that project resources probably do not justify dealing with them.

Because you have gone through this structured approach to determine what might go wrong in the project, you have in effect identified many of the known unknowns and how to address them. As part of the analysis you have also considered the risk or probability that the events will occur. Because we have identified the approximate likelihood or risk of the events happening, the resulting additional budget and additional duration of the project could be categorized respectively as “Risk Fund” and “Risk Time” when estimating project costs and duration. The Risk Fund would be added to the original estimate of the project cost. The Risk Time would be added to the original estimate of the project duration.

There is a different kind of known unknown: Sometimes, during planning, there are paths in the work that lead to a task or tasks for which we do not currently know what the actual outcome will be. For example, a certain task might be to react chemical A with chemical B in hope to get chemical C; but we don’t know for sure if we will get chemical C or something else, like chemicals D or E, in large amounts. So we might decide that we cannot plan beyond that reaction step and we will just have to wait and see what happens. This approach of delayed planning, until we know the outcome of uncertain tasks, is not recommended—it leaves us too unprepared.

For activities in your plan that have uncertain outcomes, try the following approach to avoid a crisis. First, decide what the three most-probable outcomes are (Gershenson, 1993). Talking with experts can help in this step. Second, assume that all three of the most-probable outcomes will happen and plan accordingly. This is shown in a Network Diagram (also called a PERT chart) in Figure 2.

By planning as if each of the three most-probable outcomes occurs, you now have a more realistic idea of the project risks with respect to cost, time, and viability. You have a better basis for deciding what actions might be needed to make the project a success. You have a much better foundation and understanding of what might happen and how to communicate this to senior management so that you minimize surprises—it is good to remember that managers don’t usually like surprises, and this will help you to prevent those surprises.

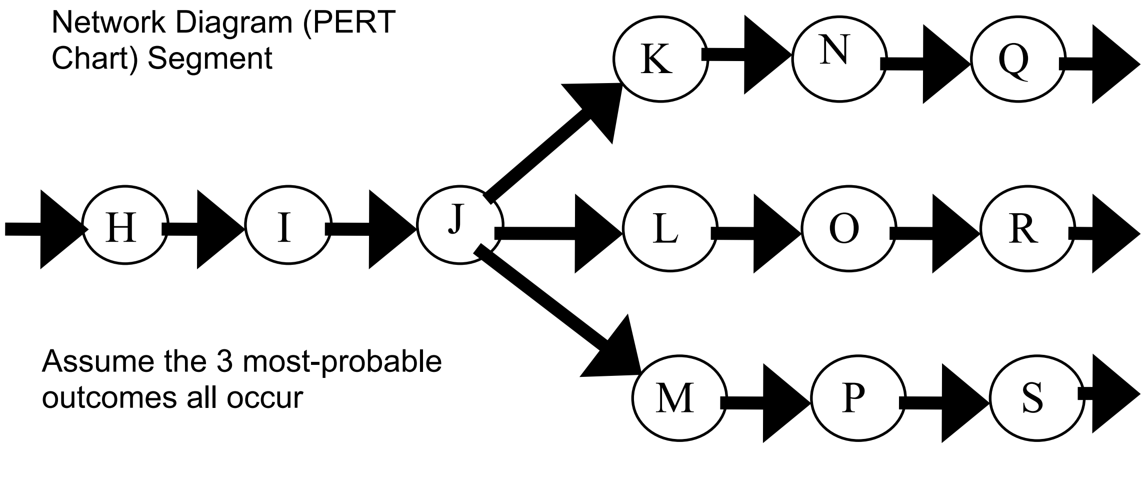

Figure 2. Planning When a Task (J) Has An Uncertain Outcome

Planning for Unknown Unknowns. For unknown unknowns it is common to add a contingency to the project cost estimate which is a function of corporate policy combined with the uncertain nature of the project. Contingencies for very uncertain R&D projects can be as much as 30% or more of the total R&D project cost. A time contingency should also be added to the project duration estimate for unknown unknowns. Performance contingencies are also needed. The magnitudes of these time and performance contingencies are dependent on the specific project. In practice these contingencies are often based mainly on good judgment and experience, though there are various approaches to calculating them.

Finally, wisdom dictates that plans be made for unknown unknowns. The approach here is very different from the plans for the rest of the project. The type of planning for unknown unknowns is basically similar to what organizations do to plan for a crisis. You don't know what the crisis will be, but you plan procedures and actions that you will take if a crisis occurs in your project. For example, is this project important enough that when a project crisis occurs you will bring everyone on the project team together and work on it until it is resolved; or will you stop the project until senior management has a chance to review the situation; or will you quickly schedule a meeting to get expert opinion and then go on with the project after completely replanning the project, etc.

Some of the Benefits of R&D Project Management

By better setting of R&D objectives and by better planning of R&D projects, even in spite of all the uncertainty, the effectiveness and the efficiency of R&D resources can be improved. Better R&D project management will help people to

- Get the big picture
- Better understand the difficult tasks ahead and when they will happen
- Put first things first by prioritizing important tasks above less-important tasks
- Minimize efforts on unfruitful sidetracks
- Stay focused on the objectives
- Make better estimates of time and resource needs
- Improve communication with key project personnel (Larsen, 2003)
- See the need to look at alternative approaches or technology
- Make better decisions when dealing with tradeoffs between time, performance, and resource constraints on the project

Two final notes regarding the attainment of benefits from R&D project management: (1) "It is…difficult to predict financial returns for an R&D project" (Shtub, et al., 1994), but this should not negate the importance of continued innovation to successful technological leadership. And (2) "Executives must be careful about how much control they exercise over R&D project managers. Too much control can drastically reduce bootleg research, and, in the long run, the company may suffer." (Kerzner, 2001)

Summary

In summary, the adaptation of project management principles and tools to R&D is needed and should take R&D culture needs into account. Flexibility is needed in applying project management to R&D. The main areas needing special adaptation attention are in the areas of setting project objectives, planning and replanning, and dealing with unknowns. By making the needed adaptations, businesses will benefit from the real potential available in applying project management principles and tools to R&D.

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About the Author

Eldon R. Larsen is a Professor of Engineering at the Marshall University Graduate College where he leads the Engineering Management emphasis for the Master of Science in Engineering degree. He chairs the Marshall University Graduate Council. Dr. Larsen has taught Project Management courses since 1994 in industrial and university settings. He also teaches Operations Management and Management of Technical Human Resources and Organizations. Before joining the Marshall University Graduate College full time in 1999, Dr. Larsen was an adjunct professor. Dr. Larsen received BS and MS degrees in Chemical

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Dr. Larsen worked 16 ½ years for Union Carbide Corporation (UCC). At UCC he led a major effort to develop and implement Project Management for Research and Development. As a result of his efforts, he received an individual "Chairman's Award," the highest award an individual could receive at UCC. Dr. Larsen co-authored a UCC training manual entitled, "Project Management for Research and Development." He served approximately two years on UCC's Project Work Process Phase Integrators Team, which oversaw Union Carbide's Engineering Department capital project work process.

Dr. Larsen is active in several professional organizations. He is currently the national Second Vice-Chair of the Management Division of the American Institute of Chemical Engineers (AIChE), and is a past Director of that division. He has served as Vice Chair, Chair, and Past Chair, and is currently Member-At-Large of the Charleston Section of the AIChE, and is a senior member of the national AIChE. He is an At-Large Director of the West Virginia/Ohio Valley Chapter of the Project Management Institute (PMI), and is a national member of the PMI. He is a member of the American Society for Engineering Management (ASEM) and a member of the American Society for Engineering Education (ASEE).