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## Adaptive Project Management

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Originally developed by ecologists, adaptive management has become a powerful framework for project management. It is a structured and systematic process to continually improve decisions and practices by learning from the outcomes of previous decisions. Adaptive management includes a number of organizational principles, such as iterative development and avoidance of irreversible decisions. Adaptive management relies on metrics and quantitative methods such as Monte Carlo simulations to integrate actual project performance to the management of projects.

### What is Adaptive Management?

Will polar bears die because of global warming? Most likely not, as they, like all other living creatures, are capable of adaptation. Of course, if global warming is extreme, no adaptations the polar bears make will help them find suitable habitats. Nevertheless, the ability to adapt is a distinctive feature of all life.

Adaptive management is a structured and systematic process for continually improving decisions, management policies, and practices by learning from the outcomes of decisions previously taken.

In the 1970s, a group of ecologists that included C.S. Holling and Carl J. Walters researched how life forms adapt to their environment. This would provide answers to such questions as how to predict fish stocks that are dependent on many uncertain factors related to human activities? To meet this challenge, the scientists introduced the idea of adaptive management or adaptive resource management. Essentially, adaptive management is '*learning by doing*'. It is a structured and systematic

process for the continual improvement of decisions, management policies, and practices, by learning from the outcomes of previous decisions. Since then, adaptive management has become a key approach in the field of environmental engineering. Examples of the implementation of adaptive management for large-scale natural resource management include projects in the Everglades and Grand Canyon National park. The Department of

Defense has been exploring adaptive management concepts for environmental cleanup at Navy facilities. The National Oceanic and Atmospheric Administration has utilized adaptive management for coastal habitat restoration activities.

Many engineers from different fields use a number of basic principles of adaptive management without actually understanding the work done by Holling and Walters. In 2001, a group of prominent software gurus met in the Snowbird resort in Utah to discuss effective software development processes. During the course of this meeting, they wrote the “Manifesto for Agile Software Development”. This document offers a number of basic principles, which are similar to those of adaptive management:

- Regular adaptation to changing circumstances, including changing requirements
- Constant collaboration in project teams and with clients
- Iterative development processes

At the same time, authors of the Agile Manifest suggested a new idea: effective adaptive management is possible only in creative business environments with self-organizing teams and trusted and motivated individuals.

Ideas related to agile project management have spread rapidly beyond software development. Many teams and organizations are applying the agile approach to complex projects. One of the ‘relatives’ of agile project management is *flexible product development*. Flexible product development offers the ability to make changes in the product, even late in the development cycle.

Agile project management and other similar methods focus mostly on the organizational aspects of adaptation process. Two principles are the most important:

- Iterative decision-making or making choices based on learning from the outcomes of previous decisions.
- Strategic flexibility or avoidance of irreversible decisions

Adaptive management processes originally developed by the ecologists were much broader. In addition to organizational principles, they include quantitative analysis methods, which will improve decisions by analyzing actual project performance, particularly:

- Multi-model analysis and hypothesis testing
- Actual performance measurement
- Quantitative project cost and schedule risk analysis

The essence of adaptive project management: *projects are managed based on learning from actual project performance and these learnings are obtained and analyzed using quantitative methods.*

## **Barriers to the Acceptance of Adaptive Management**

There is only one living species in the world that often actively resists adaptation – humans. In particular, project managers frequently do not realize that adaptive methods will most likely bring better project results than traditional project management processes, where the project plan is finalized before initiation.

Many organizations embrace adaptive management methods and techniques. Many software development companies and teams actively use some principles of the agile approach. Nevertheless, traditional project management processes still dominate the field of project management.

Why are project managers are so reluctant to embrace adaptive management? The answer lies in human psychology. There are a number of psychological biases that prevent people from accepting adaptive principles.

### **Tendency to Be Consistent**

Politicians often accuse each other of being inconsistent, which in this case is meant to be interpreted as a character flaw, “Three years ago you supported the war, now you are against it. Will you admit to being wrong then, or are you wrong now?” In reality, inconsistency may be not so bad, if it is an acknowledgement of changing circumstances or new information. For example, if a politician did not initially accept the role of humans in global warming, but changed his mind after reading new scientific evidence, most people would agree this decision. The world is always changing, new or additional information is revealed and decision-makers must adapt to the new information. Perhaps the best politician would be somebody who adapts to changing circumstances rather than sticking to outdated strategies or policies

When people are accused of being inconsistent, they tend to become very uncomfortable. Police interrogators or lawyers often use this idea. They try to put people in the position in which they make inconsistent statements, which makes the subject uncomfortable and provides a psychological advantage to the interrogators.

The tendency to appear consistent is very common in project management. When there is new information about the project and it is critical that decisions are made quickly to deal the developing situation, the tendency to consistency is often an obstacle to making these crucial decisions. If a device does not work, sometimes it does not make sense to fix it. Building a new device could be a better solution. Project managers have to be willing admit to errors and adapt to new circumstances.

In addition, even if individual project managers are capable of making U-turns, the corporate culture may not support it. Senior management often frowns upon managers who stray from project plans.

### **Sunk Cost Effect**

In 1996, NASA selected Lockheed Martin to design, build, and fly the X-33 Advanced Technology Demonstrator test space vehicle. The X-33 would launch vertically from a specially designed facility and land on a runway at the end of the mission.

In 2001, the X-33 project was cancelled when the project was more than 85 percent complete. What happened? The composite liquid hydrogen fuel tank failed during testing in November 1999. In response, Lockheed Martin proposed to complete the development of the X-33 by replacing its two composite liquid hydrogen tanks with aluminum tanks. However, NASA concluded the benefits of testing the X-33 in flight did not justify the cost: the X-33 would not be able to reach space with aluminum tanks.

NASA's investment in the X-33 program totaled \$912 million. Despite the huge expenditure, NASA cancelled the program. They essentially resisted the sunk cost effect: the tendency to invest more money in a venture in an attempt to recover previous losses. This psychological effect usually prevents project managers from performing adaptive actions. Instead of stopping work on an ineffective project or course of action, they invest more and more into it with the hope of somehow reviving the project.

One well publicized example of the sunk cost effect is the Concorde aircraft. The French and British governments continued to fund this aircraft even when it became apparent that it was no longer economically feasible.

### **Guilt of Indecisiveness**

Organizations expect managers to make decisions, even if managers do not have the information required to make these decisions. Instead of collecting information and analyzing data, which may give the appearance of indecisiveness, project managers make irreversible decisions intuitively, based on their "gut feel." This style provides the appearance of decisiveness and leadership, regardless of the quality of the decisions.

In reality, it is important to analyze when and what additional information is required, how much this additional information will cost, and how waiting for additional information would affect the project's bottom line. In other words, it is important to use adaptive management.

### **How does Adaptive Management work?**

Traditional project management processes include the phases of project planning, execution, monitoring and control and evaluation. If, as a result of an evaluation, it was found that something did not go well, this learning may be used in future projects.

Adaptive management processes can be active and passive (Figure 1). The main objective of *passive adaptive management* is to incorporate the process of learning into existing management approaches. The learnings obtained from each iteration of the project can be used on the next iterations. In this manner, risk and uncertainties associated with each iteration can be significantly reduced.

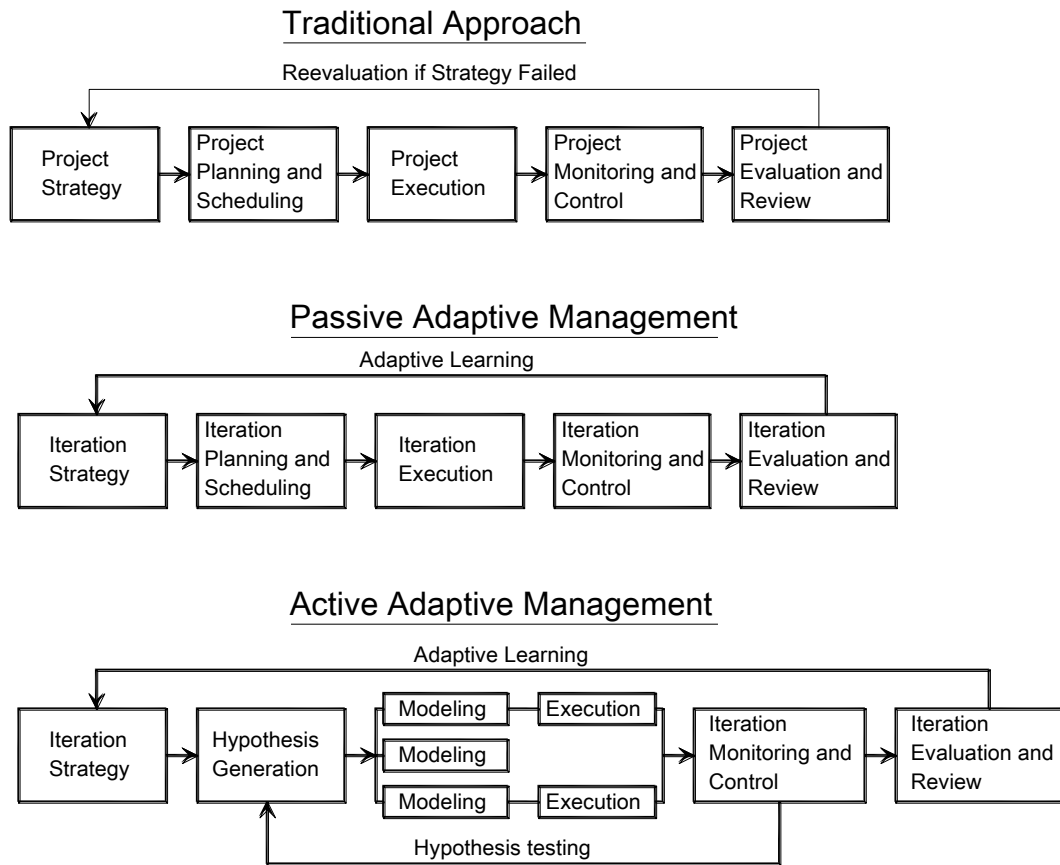


Figure 1. Traditional project management process versus active and passive adaptive management processes.

The goal of *active adaptive management* is to determine the best management strategy *through experimentation*. The process starts with hypothesis generation, which involves the selection of multiple alternatives for the strategy. The next step is to create models for each of the selected alternatives. In practical terms, these models are usually project schedules with a set of risks and uncertainties for the particular iteration. All alternative models should be evaluated using quantitative analysis such as Monte Carlo simulations. The outcomes of these analyses are duration, cost, chance of meeting deadlines and other parameters that may help in the selection of alternatives for execution.

In most cases, only one alternative model will be selected and executed. However, in cases with significant risks and uncertainties, it may be more efficient to execute a number of alternative models at the same time.

Here is an example of how active adaptive management can be used:

1. Define a project strategy and high-level project plan. Ensure strategic flexibility: leave room to reverse previous decisions if necessary.
2. Divide the project plan into multiple phases or iterations.
3. Define a more detailed plan for the next phase or iteration. Do not create detailed plans for future iterations as they may change due to the outcomes of previous iterations. This plan should include a schedule and list of risks (the risk register). You may choose to create multiple alternative project scenarios (project schedules and risks list) for the same project phase.
4. Perform quantitative cost and schedule risk analysis. Different project scenarios may have a similar cost and duration, but have a different risk profile. Quantitative project risk analysis will help to determine what will happen with project schedule if certain risks occur. By analyzing this 'realistic' project schedule, you can select the optimal scenario to execute in the next iteration.
5. Execute one or a couple of project scenarios and continuously measure actual performance versus original forecasts. Repeat the quantitative risk analysis. If the project is partially completed, you may have better idea of which risks actually occurred, and which ones did not. In addition, you should be able to calculate the chance that a risk will occur using the performance data. Figure 2 is an example of how the results of this analysis may appear.

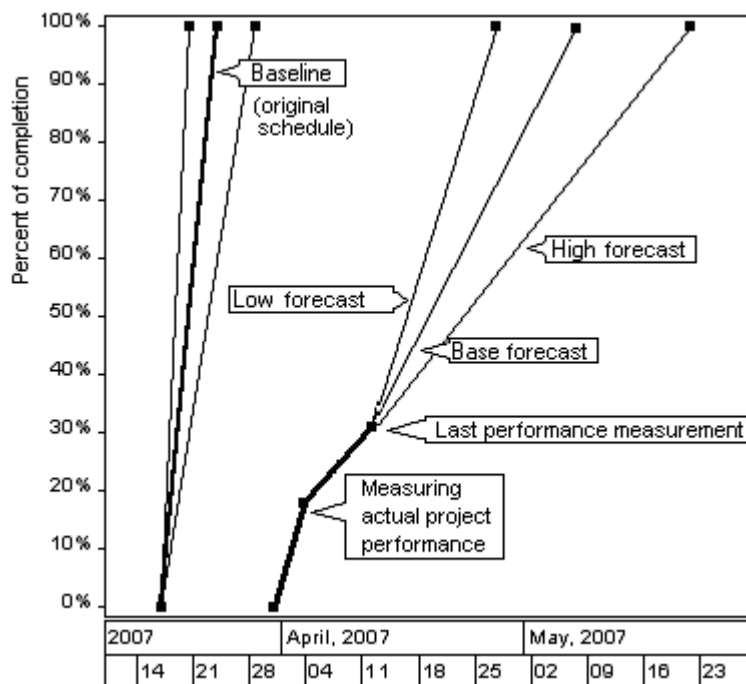


Figure 2. Actual project performance measurement and quantitative risk analysis of partially completed projects

Currently there are a number of advanced project management and risk analysis tools available to perform quantitative analysis. These tools are easy to use knowledge of the complex math used to perform the analysis is not required.

## **Conclusions and Recommendations**

Adaptive management is a structured project management framework. It is not a formalized process that must be strictly followed. This framework can be tailored to different types of space system design and acquisition projects. Principles of adaptive management are strongly endorsed and actively used in many industries, such as information technology and environmental protection.

The first rule of adaptive management is simplicity. If adaptive management does not bring tangible benefits and causes extra organizational burdens, abandon ineffective procedures as soon as possible.

Adaptive management includes the basic principles of agile project management, such as iterative processes and creative business environments. In addition, adaptive management involves the active use of quantitative methods to measure project performance and apply learning to improve decisions.

Below are the practical recommendations related to implementation of adaptive management for both hardware and software projects:

1. Whenever possible, do not define a detailed project plan upfront; instead, use an iterative project management approach.
2. Always identify multiple project alternatives or hypotheses; model these alternatives; and if deemed beneficial, implement a few alternatives at the same time.
3. Use quantitative cost and schedule risk analysis at each phase and iteration of the project.
4. Integrate original assumptions and new learning when planning the next project iterations.
5. Try to minimize the cost of decision reversals; minimize risks by ensuring that the option to change project direction is always available.
6. Ensure that adaptive management is implemented within a creative business environment characterized by a collaborative structure for stakeholder participation and learning.

## **Future Reading**

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