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Reading Response: Rescuing Prometheus

In reading *Rescuing Prometheus* by Tomas Hughes I had a difficult time identifying the overarching theme of the book. I found the individual stories interesting, but could not always identify a clear link between the topics raised by Hughes. However, the material from the book does provide a basis for discussion of some interesting and important questions about system engineering and about uncertainty. The first section of this response outlines the problems in the book that lead to the lack of central theme or connecting story. The second half considers a few interesting topics that emerge from the book.

Book Review

The biggest drawback of the book is that there is no clear indication of what the book is about or what the goal of it is. It seems that Hughes is trying to show that the development and use of system engineering practices allowed complex projects to be completed or significant progress to be made in the development of new technologies. There are some indications that the cases show a diffusion of the use of system engineering from the military to the private sector, as well as a progression in the levels of partnership between the military, industry, and academia. There are also indications that the stories represent an increasing level of complexity in terms of the projects that were undertaken, though this is unclear since complexity and messy complexity are never defined. While all of these topics seem to emerge though the book, there is no indication of what the point of writing about them was. What is the reader supposed to learn?

One way that Hughes could have helped clarify the goals of the book was to show how he picked these specific four cases. It seems to emerge as the book progresses that the cases show a progression of how system engineering and thinking evolved and how it was used. However, without a context for why these projects were chosen, it is unclear if they were the only ones where system engineering was used, the representative ones, ones for which information was available, or simply ones that Hughes was interested in. This lack of acknowledgment and information on the more general evolution of the use of system engineering takes credibility away from the points that Hughes is attempting to make. In addition, it was not clear what that evolution was.

Hughes further fails to define the terms "system engineering" and "complexity"; the discussion in the book centers around these terms and without clear definitions, it difficult to discern the point of the book. In the case of system engineering it is clear that the term or practice has something to do with management, but it is not clear exactly what and to what extent. Hughes also doesn't acknowledge the fact that system engineering changed as it become more known. I would think that what was meant by system engineering during the Sage project was not the same as what was meant for ATLAS and changed further for the other projects. Without the definition of the terms that the book seems to be about, it is very difficult to appreciate or identify the point that Hughes is attempting to make.

In the 4th chapter, the discussion of system engineering starts to change into a discussion about operations research, system dynamics, and the system approach. It is unclear if these are meant to be extension of the original idea of system engineering, tools with which to conduct or supplement system engineering, or a further redefinition of what system engineering is. It would have been better if Hughes provided a better explanation of how these ideas tie together, especially since the original idea of system engineering was one of a managerial technique, and later approaches became more technical and seem to provide tools for solving certain classes of problems.

A definition of complexity and the criteria for determining relative complexities is also necessary in order for the reader to understand if the practice of system engineering helps to tackle projects of high complexity. Hughes further confuses the reader by introducing the term "messy complexity" without providing a definition. How is messy complexity different from complexity and why is the distinction important or useful?

Discussion Points

Rescuing Prometheus provides a basis for discussing several problems related to system engineering including:
- Management of uncertainty,
- Theory versus experimentation,
- Knowledge assessment,
- Method versus people, and
- Dealing with large scale social problems.

It seems that Hughes may have picked the cases in the book to represent an increasing level of complexity. If complexity is defined as the number of interacting technical components, or as the number of interacting organizations and institutions, this might be the case. Does the level of uncertainty also increase with increasing complexity? Was system engineering or system dynamics used as a tool to deal with this increasing uncertainty and complexity?

An issue that is discussed a few times in the book is the question of whether decisions should be guided by theory or by experimentation. The engineers attempting to solve problems and build a functioning system are presented by Hughes as relying more on experimentation and not theory. In many cases this was because there was no theory and the explanations followed the invention, or as Hughes puts it "the why follows the how." However, in discussion of ARPANET there are instances where Hughes specifically points out that that theory would have helped in the development of the technology, but wasn't used. I think the question of theory vs. experimentation is connected to dealing with uncertainty. Is it better to handle uncertainty by developing theory or by trial and error? The answer is probably both, but how do you determine the right mix? It is interesting that in tackling these problems the engineers and managers described in the book are never pictured as explicitly talking about uncertainty. The only conversation relating to uncertainty seems to be about technical solutions that need to be developed.

Uncertainty associated with the large projects that Hughes is describing, as well as with the method of system engineering can be seen in chapter four. Hughes describes the

political arguments over knowledge assessment. The validity of models and whether it is better to understand a system by looking at it as a whole by looking at subsystems were debated.

The book seems to raise the question of whether it was the system engineering method that helped in the undertaking of the large projects that Hughes describes, or if much of the credit should go to the people who were involved in the projects. Through the book Hughes shows that it was the work of a small circle of people who really worked and fought to implement system engineering and made it successful. What part of the success of the method was due to the method itself and what part to the people who were using it and reshaping and redefining it as needed?

This ties in to the discussion of using system engineering to deal with large social problems. Hughes talks about how this attempt failed. I would have liked to see a discussion of whether this was because system engineering was not applicable or because it was applied incorrectly. In the initial attempt to apply systems thinking to social problems there was a large amount of hubris. It seems that those attempting to solve these problems thought that they could do so quickly and effectively. When it turned out that this was not the cases they were also quick to abandon the attempt. Why did they not make more of an effort to determine what parts of system engineering could be applied to social problems. It may not have been possible to solve these problems completely, but this does not mean that progress could not have been made.