

Preface

*We think we have scientific knowledge when we know the cause.
(Aristotle, Posterior Analytics Book II, Part II)*

About 12 years ago, when I was a graduate student, many people were concerned about my Ph.D. topic – investigating the effect of the complexity of proceduralized tasks on the performance of human operators working in nuclear power plants. Although they agreed with the fact that procedures (especially emergency operating procedures) play a crucial role in securing the safety of nuclear power plants, it was amazing that most of them pointed out a very similar issue: “I cannot understand why operating personnel see any difficulty (or complexity) in conducting procedures, because all that they have to do is to follow a simple IF-THEN-ELSE rule as written.” Actually, this issue is closely related to one of the main questions I was recently asked, such as “Don’t you think your work is too academic to apply to actual procedures?” or “I guess we don’t need to consider the complexity of procedures, because we can develop a good procedure using many practical procedure writers’ guidelines. Then what is the real contribution of your work?”

I absolutely agree with the latter comment. Yes, we can develop a good procedure with the support of many practical and excellent guidelines. However, I would like to emphasize one more thing – existing guidelines seem to mainly focus on limited facets that cover some of the aspects needed to make a good procedure. For example, traditionally, most procedure writers’ guidelines have recommended the use of easy sentence structures, clear writing styles, and consistent vocabularies that would be essential for specifying what should be done by operating personnel. I think these recommendations stemmed from the belief that all anticipated situations can be controlled by performing chronological actions as prescribed in a written procedure. Unfortunately, it is evident that we cannot develop a procedure that covers every situation. In addition, since procedure writers are highly experienced and possess a lot of domain-specific knowledge, they have frequently developed procedures not for less experienced people but for themselves. As a result, less experienced people have to solve their problems using a procedure that is too ambiguous or difficult to actually follow in a real-life. For this reason, from the point of view of an engineer, I started my research in order to search for a viable solution that is able to overcome this limitation.

Personally, I believe that one of the important virtues of a good engineer is the ability to provide a practical solution, such as a creative design or an outstanding idea, which actually works and has a sound technical foundation. From this standpoint, I summarized the results of my research with the associated technical solutions, which have been studied for several years, in this book. The goal of my research is to develop a systematic framework, not only by which the complexity of proceduralized tasks can be properly quantified but also from which effective countermeasures or remedial actions to reduce it can be naturally deduced. To this end, I have tried to combine a series of multidisciplinary works that seem to be closely related to the quantification of task complexities. For example, I introduced the evaluation paradigm of software complexity to provide a technical basis for quantifying the complexity of proceduralized tasks, and I adopted a classical but still valuable theory from cognitive engineering, which deals with the decision making process of human operators. In addition, I took advantage of traditional procedure writers' guidelines as well as principles in order to incorporate useful insights about the development of procedures. This implies that the readers of this book should possess basic knowledge about software engineering and cognitive engineering. In addition, since detailed examples about the quantification of proceduralized tasks are given based on a series of tasks to be performed by operating personnel working in nuclear power plants, it would be better for the readers to be familiar with nuclear engineering as well as the procedures of nuclear power plants.

This book starts with an introduction providing a motivation that ties together the three technical parts of this book: a fundamental concept (Part I), the development of a systematic framework to quantify the complexity of proceduralized tasks (Part II), and several promising applications pertaining to the developed framework (Part III). Although this book was written to be read in a linear fashion, readers may read it in many different ways. For example, those who just want to know an overview on the importance of procedures (e.g., why we need to use procedures or why we have to consider the complexity of proceduralized tasks) can read the two chapters included in Part I. If readers want to learn about a practical contribution to the evaluation of task complexities, they can read Part III, which deals with how the developed framework can be used to resolve several pending issues about the performance of human operators. In contrast, if readers would like to focus on the technical details of quantifying the complexity of proceduralized tasks, they can read the six chapters that make up Part II.

When I started to write this book, I was very nervous because many people told me that writing is a very solitary work. However, in the course of writing the book, I realized that writing was definitely not an isolated work but a kind of social endeavor through which I could enrich the contents of my book with the vast knowledge as well as diverse experiences of other people. In this regard, I deeply appreciate the encouragement of Dr. Jaejoo Ha and Dr. Joon-Eun Yang at KAERI who continually emphasized why I must write this book. In addition, the technical comments of Dr. Wondea Jung at KAERI were insightful for evolving a theoretical background on quantifying the complexity of proceduralized tasks. Dr. Dong-Han Ham of Middlesex University also provided excellent comments that were

very helpful in improving the theoretical foundation of the book.

However, I would be remiss if I did not mention the sincere support of the operating personnel and training instructors working at the reference nuclear power plants. Without their help, this book would likely have turned out to be full of long-winded and hypothetical explanations lacking any useful insight. Through this book, I would like to express my heartfelt appreciation to all of them.

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