Automation, Collaboration, & E-Services

Volume 4

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The Automation, Collaboration, & E-Services series (ACES) publishes new developments and advances in the fields of Automation, collaboration and e-services; rapidly and informally but with a high quality. It captures the scientific and engineering theories and techniques addressing challenges of the megatrends of automation, and collaboration. These trends, defining the scope of the ACES Series, are evident with wireless communication, Internetworking, multi-agent systems, sensor networks, and social robotics – all enabled by collaborative e-Services. Within the scope of the series are monographs, lecture notes, selected contributions from specialized conferences and workshops.

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Computer-Supported Collaborative Decision-Making

Springer

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Foreword

Decisions, we all have to make them. They influence our world. We endeavor to make good decisions, since we know they always bear consequences. Poor decisions often lead to negative results; sometimes, even good decisions may not guarantee positive results. So we try to learn how to improve our decisions to increase gains and reduce risks.

Evidently, humans were trying the same for a very long time. For instance, from the bible we can learn that:

- "Listen to advice and accept instruction, and in the end you will be wise"—*Proverbs, 19:20* ($\sim$950 BC)
- Two heads are better than one, originating from "Therefore two are better than one, for they may enjoy better profit of their labor"—*Ecclesiastes, 4:9* ($\sim$940 BC)

There are a number of obvious advantages when multiple participants collaborate in deliberating and reaching a decision. One may think: "Of course, they can all be happy if things go well; they can blame each other if things go wrong". But while sharing responsibility can be an advantage, there are significant other merits. Multiple humans can debate and integrate diverse experiences, opinions, and views, and negotiate over risks, alternative plans, and even conflicting positions. Sensors and robots can similarly integrate and fuse multiple types of readings, locations, perspectives, and computational intelligence. They—groups of people, robots, and sensors—can negotiate, back each other up, help each other to overcome delays or shortage of knowledge, tools, and energy, and finally make timely and "best" decisions. Such "best" decisions imply benevolent group participants, able to consider all available information and logic, balance and settle their respective needs, priorities, constraints, risks, and objectives. That seems truly smart.

Knowing all of that, throughout history people have indeed used the instruments of meetings, committees, teams, government bodies, and other groupings to follow the wisdom of multiple brains in their effort to make better decisions. What is new?

To answer this question, Academician F.G. Filip and his coauthors, Profs. C.-B. Zamfirescu and C. Ciurea, combine their accomplished expertise in the theory and

practice of decision systems in a creative way. They begin by explaining the relation and mutual roles of collaboration and decision-making. With the advent of computers, communication, and cyber, they describe how and why DSS, decision support systems, could evolve and progress. With the advent of computer-supported collaboration and cyber-collaborative systems, they evaluate various collaborative methods and the role of collaboration engineering.

What is new and inspiring, as presented in this book for students, developers, practitioners and researchers, is that multiple decision-makers can now collaborate with each other and beyond. They (we) can reach significantly wiser decisions in even more complex situations, by collaborating more effectively and with higher levels of collaborative intelligence. These new capabilities are visionary, yet already embedded and enabled by essential cyber technologies: From data, mobile, web and social networking technologies, to advanced cyber-collaborative support systems and useful applications.

The authors are contributing to the ACES book series, and through it to enriching the science and knowledge of computer- and cyber-supported collaboration for better decisions: For better society, better well-being, and better understanding.

September 2016

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Preface

This is a book about how management and control decisions are made by persons who collaborate and possibly use the support of an information system.

In the book, we adopt the following definitions:

The *decision* is the result of human conscious activities aiming at choosing a course of action for attaining a certain objective (or a set of objectives). It normally implies allocating the necessary resources and it is the result of processing information and knowledge that is performed by a person (or a group of persons), who is empowered to make the choice and is accountable for the quality of the solution adopted to solve a particular problem or situation.

The act of *collaboration* implies that several entities who work together and share responsibilities to jointly plan, implement and evaluate a program of activities to achieve the common goal to jointly generate values.

A collaborative group is made up of several members, who are assigned or decide by themselves to jointly attain a set of common goals by carrying out a set of activities and using a number of procedures and techniques.

A *decision support system* (DSS) is an anthropocentric and evolving information system, which is meant to implement the functions of a human support team that would otherwise be necessary to help the decision-maker to overcome his/her limits and constraints that he/she may encounter when trying to solve complex and complicated decision problems that count.

The Context of Writing the Book

In 2007, the second edition of the "Decision Support System" by F.G. Filip was published in Romanian by the Technical Publishers, Bucharest. It contained a presentation of a DSS concepts illustrated by *Dispatcher*®, a practical system meant to support the production planning and control decision-making in the milieu of continuous process industries. In the final section of the book, the author made a

promise to come back together with several of his colleagues with new books about particular classes of DSS, including *group decision support systems* (GDS).

C.B. Zamfirescu received his Ph.D. in 2005 from the Technical University "Politehnica" of Bucharest with a thesis entitled "Anthropocentric Group Decision Support Systems". The document contained several original results, such as agent-based social simulation for group decisions, swarming models of computation to automate the facilitation of group decisions, goal-oriented dialog system with inconsistent knowledge bases and so on. A part of these results, together with newer ones, is contained in the book we are proposing to our readers.

In 2011, Cristian Ciurea received his Ph.D. from the Academy of Economic Studies of Bucharest with a thesis entitled "Collaborative Systems Metrics". Several ideas, such as applications in economy of collaborative systems, quality characteristics of collaborative systems, collaborative virtual organizations, collaborative production processes, were contained in the thesis and a part of them is included in the present book.

The last decades saw an impetuous advance in the information and communication technologies and in associated concepts. The new versions of the Internet protocol, social networks, mobile and cloud computing, and business intelligence and analytics have had a serious impact, not only on the information system design, but also on the way the business has been conducted and decisions have been made. Collaborative activities carried out by various entities, such as enterprises, people, machines, computers and so on, are ever more numerous and visible. Two very recent books (Nof et al. 2015; Nunamaker et al. 2015) present the new achievements in collaborative systems under the influence of and enabled by the new information and communication technologies (I&CT) and are a good example to follow. The new series *Automation, Collaboration & E-Services* (ACES) of Springer, which is meant "to capture" the scientific and engineering theories and technologies addressing challenges of the megatrends of automation and collaboration, was viewed by the authors as a valuable means to make available an up-to-date view of computer-supported collaborative decision-making to various readers. The invitation sent by Prof. S.Y. Nof, the ACES series editor, came in time and stimulated the authors to propose the current book.

The Book Goal

The book is intended to present a balanced view of the computer-supported collaborative decision-making domain to include both well-established concepts and a selection of new results in the domains of methods and key technologies. It is meant to answer several questions, such as: (a) "How are evolving the business models towards the ever more collaborative schemes?"; (b) "What is the role of the decision-maker in the new business and technological context?" (c) "What are the basic characteristic attributes and trends in the domain of decision-supporting information systems?"; (d) "Which are the basic methods to aggregate the

individual preferences of the people who collaborate in decision-making activities?"; (e) "How far can automation go?"; (f) "What is the impact of modern information and communication technologies on the design and usage of decision-supporting information systems meant for groups of people?".

The book is intended to be a reference text for researchers, analysts and system developers in the field of information systems, which are meant to be used in supporting management and control decision-making. The managers interested in getting competitive advance on the market using modern methods and technologies can also benefit from studying the material. The book is also recommended as a textbook for graduated students in automatic control, computer science, informatics, industrial engineering, management, and business administration.

Material Organization

The book is composed of five chapters as follows:

Chapter 1, entitled "Collaboration and Decision-making in Context", is meant to set the stage for the following chapters by describing the business context and introducing the terminology to be used throughout the text. We review the main concepts concerning management and control schemes, the mission and allocated functions of the human agent in the loop, and basic aspects of multi-attribute/multi-participant decision-making.

Chapter 2, entitled "Decision Support Systems", reviews basic concepts of the decision support systems domain. Several topics are addressed in sequence, such as decisions and decision-makers, mainly particular subclasses of the general DSS class, DSS construction, so that the reader could get a view of DSS "physiology" (functions and usage), "anatomy" (composition), and "ontogeny" (design and construction). A particular attention is paid to group/multi-participant DSS and intelligent DSS.

Chapter 3, entitled "Collaborative Activities and Methods", is meant to review the most important methods used in collaborative human activities with a particular emphasis on group decision-making. To set the stage for method presentations, the chapter starts by explaining several concepts, such as e-collaboration, collaborative groups, crowd participation, and reviews the development history of computer-supported collaboration. The chapter continues by reviewing the most frequently used voting rules defined in social choice theory and their extensions employed in knowledge-driven DSS. The engineering issues of deploying computer-supported collaborative activities in real working environments are presented in the final section of the chapter.

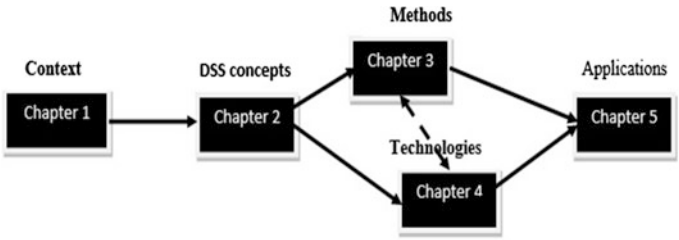
Chapter 4, entitled "Essential Enabling Technologies", contains a review of the major key technologies which have significantly influenced the design and usage of information systems. Business intelligence and analytics, Web technology, social networks, mobile and cloud computing are described in "parallel" sections with similar organization. Their impact on computer-aided decision-making is highlighted. Biometric

systems and serious digital games and their possible usage to ensure the authorized access and facilitate users' training are presented in the final sections of the chapter.

Chapter 5, entitled "Application Cases", contains three sections addressing: (a) the usage of biology inspired models to simulate the facilitator activity, (b) an application of big data in labor market analysis, and (c) an integrated and evolving information platform used in various collaborative decision-making cases.

Each chapter contains at the end a section with *Notes and comments* that highlights the main ideas presented and guides the reader through the most important references, if she/he wants to go deeper in the field. In each chapter, the authors have presented a selection of relevant standards.

The book is organized in accordance with a quasi-sequential-parallel scheme which reflects the recommended order of chapter studying (see figure below).



Throughout the material, there are several "pointers" to sections where the concepts and ideas just introduced are addressed in more details. Consequently, the reader can design his/her study order in accordance with his interests and curiosity.

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References

Nof SY, Ceroni J, Jeong W, Moghaddam M (2015) Revolutionizing Collaboration through e-Work, e-Business, and e-Service, vol 2. Springer.

Nunamaker JF Jr, Briggs RO, Romano NCR Jr (2015) Collaboration Systems: Concept, Value, and Use. Routledge.

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