PREFACE

This book is devoted to a discussion of analogies and differences of complex production systems – natural, as in biological cells, or man-made, as in economic systems or industrial production. Hierarchical models of industrial supply chains are characterized by systems of differential equations closely related to traffic flow models. Interesting questions asked in this context go much beyond the static network analysis. Since most production systems are highly stochastic and event-driven, they are rarely, if ever, at equilibrium. Hence the reaction of a given supply network to specific events as well as its transient response to parameter changes and control actions has to be understood through simulation as well as through fundamental models. Additionally, these dynamic responses are constrained by economics, leading to the evolution of systems with higher productivity and profitability. On the other hand, recent research has put forward a view of a biological cell as a factory where products of one machine are used by other machines for manufacturing of their own products or for regulation of their functions. In some cases, a cell may operate in a synchronous mode, so that the operation cycles of individual machines are temporally correlated and the intermediate parts are released exactly when they are needed for further production by other machines. A special property of biological production networks is that, to a large extent, their activity is self-organized and persists despite the presence of strong thermal fluctuations. Progress in micro- and nanotechnology may soon bring about a possibility to produce nanorobots and to design self-reproducing artificial cells, leading to a revolution in industrial manufacturing. However, the principles of purposeful operation of large ensembles of nanodevices and populations of artificial cells should first be investigated. Obviously, they again should bear strong similarities to biological organization. The common themes of industrial and biological production include evolution and optimization, synchronization and self-organization, robust operation despite high stochasticity, and hierarchical dynamics.

The book presents selected lectures given at the international workshop "Networks of Interacting Machines: Industrial Production Systems and Biological Cells" (Berlin, December 2003), organized with the financial support of the Klaus Tschira Foundation. Its authors are a group of scientists and industrialists from Europe, Japan and USA. Together, we hope to provide an overview of modern perspectives on principles of production organization.We are grateful to the Tschira Foundation for providing financial support and thank Dr. Oliver Rudzick for his assistance in the preparation of manuscripts.

Dieter Armbruster
Arizona State University
Tempe, AZ, USA

Kunihiko Kaneko
University of Tokyo
Tokyo, Japan

Alexander S. Mikhailov
Fritz-Haber-Institut der Max-Planck-Gesellschaft
Berlin, Germany