Preface

On behalf of the ICES 2001 Conference Committee, it is our pleasure to present to you the proceedings of the fourth International Conference on Evolvable Systems: From Biology to Hardware, ICES 2001, held in Tokyo, Japan, on 3-5 October 2001, addressing the latest developments and discussing challenges facing the field of evolvable systems.

The idea of evolving machines, whose origins can be traced back to the cybernetics movement of the 1940s and the 1950s, has recently re-emerged in the form of the nascent field of bio-inspired systems and evolvable hardware. Following the workshop, Towards Evolvable Hardware, which took place in Lausanne, Switzerland, in October 1995, the First International Conference on Evolvable Systems: *From Biology to Hardware* (ICES96), was held at the Electrotechnical Laboratory (MITI), Tsukuba, Japan, in October 1996. The second and the third International Conferences on Evolvable Systems: *From Biology to Hardware* (ICES98 and ICES 2000) were respectively held in Lausanne in September 1998, and in Edinburgh in April 2000.

Following the success of these past events, ICES 2001 was dedicated to the promotion and advancement of all aspects of evolvable systems, including hardware, software, algorithms, and applications. By bringing together researchers who use biologically inspired concepts to implement real systems in artificial intelligence, artificial life, robotics, VLSI design, and related domains, ICES 2001 reunited this burgeoning community.

High quality papers were selected and presented at the conference. These contributions cover a wide variety of aspects pertaining to evolvable systems and applications: evolutionary design of electronic circuits, embryonic electronics, biological-based systems, evolutionary robotics, evolutionary optimization, evolutionary learning, and the various applications of evolvable hardware.

We wish to thank all the authors for submitting their work, as well as the Program Committee members and reviewers for their enthusiasm, time, and expertise. Finally, we would like to thank the sponsors, who helped in one way or another to achieve our goals for the conference. These sponsors are Real World Computing Partnership, the Japanese Society for Artificial Intelligence, SIG on AI Challenges, Logic Systems Laboratory (EPFL), and the National Institute of Advanced Industrial Science and Technology (AIST).

August 2001

Yong Liu
Kiyoshi Tanaka
Masaya Iwata
Tetsuya Higuchi
Moritoshi Yasunaga

Organization

ICES 2001 Conference Committee

General chair: Tetsuya Higuchi, National Institute of Advanced Industrial
    Science and Technology (AIST), Japan
Program co-chair: Daniel Mange, Swiss Federal Institute of Technology,
    Switzerland
Program co-chair: Moritoshi Yasunaga, University of Tsukuba , Japan
Program co-chair: Yong Liu, University of Aizu, Japan
Publicity chair: Kiyoshi Tanaka, Shinshu University, Japan
Finance chair: Hiroshi Okuno, Kyoto University, Japan
Local chair: Masaya Iwata, National Institute of Advanced Industrial Science
    and Technology (AIST), Japan
Conference secretary: Ayako Suzuki, National Institute of Advanced Industrial
    Science and Technology (AIST), Japan

ICES 2001 Program Committee

Peter Dittrich, University of Dortmund, Germany
Rolf Drechsler, Albert-Ludwigs-University, Germany
Tim Goredon, University College London, U.K.
Pauline Haddow, Norwegian University of Science and Technology (NTNU),
    Norway
Alister Hamilton, Edinburgh University, U.K.
Masaya Iwata, National Institute of Advanced Industrial Science and
    Technology (AIST), Japan
Isamu Kajitani, National Institute of Advanced Industrial Science and
    Technology (AIST), Japan
Tatiana Kalganova, Brunel University, U.K.
Lishan Kang, Wuhan University, P. R. China
Michael Korkin, Genobyte, Inc., U.S.A.
Pierre Marchal, Centre Suisse d'Electronique et de Microtechnique, Switzerland
Karlheinz Meier, University of Heidelberg, Germany
David Montana, BBN Technologies Robert Popp, U.S.A.
Masahiro Murakawa, National Institute of Advanced Industrial Science and
    Technology (AIST), Japan
Andres Perez-Uribe, University of Fribourg, Switzerland
Hidenori Sakanashi, National Institute of Advanced Industrial Science and
    Technology (AIST), Japan
Eduardo Sanchez, Swiss Federal Institute of Technology, Switzerland
Moshe Sipper, Swiss Federal Institute of Technology, Switzerland
Kiyoshi Tanaka, Shinshu University, Japan
Gianluca Tempesti, Swiss Federal Institute of Technology, Switzerland

Adrian Thompson, University of Sussex, U.K.
Jim Torresen, University of Oslo, Norway
Andy Tyrrell, University of York, U.K.
Milan Vasilko, Bournemouth University, U.K.
Xin Yao, University of Birmingham, U.K.