

## How is Culture and Cultural Development Possible?

Matthias RAUTERBERG

Department of Industrial Design  
Eindhoven University of Technology – TU/e  
[g.w.m.rauterberg@tue.nl](mailto:g.w.m.rauterberg@tue.nl)

**Abstract**—In the context of the second law of thermodynamics it is difficult to explain any kind of process contributing to enhance order. Culture can be seen as such an ordering process, but then we have to explain how this is possible. In this paper I introduce an attempt to overcome and combine these contrary views. Based on the theoretical concept of Swenson’s autocatakinesis I explore the possibilities of developing cultural technology beneficial to society.

**Keywords**—autocatakinesis, autopoiesis, cultural computing, culture, evolution, second law of thermodynamic

### I. INTRODUCTION

In the upcoming research arena of cultural computing [1] it is assumed that culture can be influenced on a short and medium term range by interacting with cultural content provided via computing technology. But how can we understand what culture is and how it develops? A very fundamental question is how is culture as an ordering principle actually possible? In the light of physics and in particular of the 2nd law of thermodynamics, the development of order (e.g. through culture) seems not possible. On the other side since thousands of years we can observe the increase in ordered complexity from tribes till modern societies.

### II. THE MECHANISTIC WORLDVIEW

Based on Newtonian mechanical world view modern science has been built on—at least in the West. This has giving rise to a biased view of mind and suggesting that members of a society are continuously working to destroy order, which can only be maintained by an external ‘teacher’ (i.e. a divine concept). The Cartesian worldview has strongly emphasized the absolute separation of mind (*res cogitans*) and matter (*res extensa*). First was the separation of mind and body, so that Cartesianism is grounded in a set of binary dichotomies in separating the individual from her/his environment. [Un]fortunately this leads to the conviction that knowledge refers to a self-sufficient immaterial substance that can be investigated independently from the individual, the environment, and the context in which it is situated. Rooted in Cartesian dualism/Newtonian mechanics, traditional learning approaches claimed on objectivism and constructivism at their basis with incommensurability between ‘knower’ and ‘known’. Barab et al. [2] “make the argument for an alternative set of assumptions predicated on a relational ontology and grounded in recent develop-

ments in the understanding of *self-organizing systems*.” Meaning and knowing are “actualized through the dynamic between learner (self) and environment (non-self), and that which is neither the learner nor the environment” [2].

To overcome this mechanistically view several attempts were undertaken. *Autopoiesis* is one of the most prominent ones: A combination of ‘auto’, meaning ‘self’, and ‘poiesis’ meaning ‘creation’ or ‘production’; *autopoiesis* literally means ‘self-creation’ and an autopoietic system is characterized by a fundamental dialectic among *structure*, *mechanism* and *function*. *Autopoiesis* was introduced by Maturana and Varela [3]. Thompson [4] provides a condensed definition: “For a system to be autopoietic, (i) the system must have a semi-permeable boundary; (ii) the boundary must be produced by a network of reactions that takes place within the boundary; and (iii) the network of reactions must include reactions that regenerate the components of the system” (p. 101). However, the autopoietic theory is for Swenson [5] “miraculously decoupled from the physical world by its progenitors [...] (and thus) grounded on a solipsistic foundation that flies in the face of both common sense and scientific knowledge”. Now we should have a closer look into this fundamental critique.

### III. CULTURE ACCORDING TO PHYSICS

Anthropology and ecological science address the relations between living components and their environments. The research of human ecology addresses the particular case of social creatures like humans. However according to Swenson [6], there is an opposing trend built into the foundations of modern science, which separates living components and particularly humans from their environments. This trend relies on dualisms traceable from Descartes with its grounding in Boltzmann’s thermodynamics, unfortunately precludes a truly ecological science. A deeper understanding of thermodynamic law and the principles of *autocatakinetic* (‘self-organizing’) systems provides the nomological fundament for dissolving Cartesian incommensurability; this can put evolution and development really back in its universal context, and will show the reciprocal relation between living components and their environments. This new view provides a principled foundation for ecological science in general, human and media ecology in particular.

In making a clear distinction between the living and the nonliving, Swenson [5] argues that the living hook their

autocatakinetics onto macroscopic observables (higher-order invariants) in kinematic fields. The transformation of the Earth's atmosphere [from oxygen-less to oxygen-rich], as well as the social-cultural systems, that have systematically arisen, are seen as empirical evidence of the world's departure from thermodynamic equilibrium, or progressive ordering of complexity [6]. This trend is clearly against the widespread understanding of the 2nd law of thermodynamics, which predicts that the world should be becoming continuously and increasingly disordered: striving towards a maximum of 'entropy'. Therefore evolutionists believe that biological and cultural evolution defy or negate physical evolution—a belief, in effect, of two incommensurable 'rivers', the *river of physics* which flows down to disorder, and the *river of culture*, psychology, and biology which flows up towards order [6]. How can we overcome this incommensurability? As a possible answer Swenson proposed the theory of *autocatakinetic systems*. An autocatakinetic system is defined as "one that maintains its 'self' as an entity constituted by, and empirically traceable to, a set of nonlinear (circularly causal) relations through the dissipation or breakdown of field (environmental) potentials (or resources) in the continuous coordinated motion of its components (from auto-'self' + cata-'down' + kinetic, 'of the motion of material bodies and the forces and energy associated therewith,' from *kinein*, 'to cause to move')" [7].

Swenson's theory of autocatakinetic systems provides a principled basis for putting living things (e.g. humans) back in the world. To do so we have to recognize living things and their environments as single irreducible unified systems. This holistic view provides "the basis for contextualizing the deep and difficult questions concerning the place of humans, as both productions and producers of an active and dynamic process of terrestrial evolution, which as a consequence of the present globalization of culture is changing the face of the planet at a rate which seems to be without precedent over geological time" [6]. Now we can ask the question how this cultural development emerges.

An autocatakinetic system must increase the rate of entropy production of the system plus environment at a sufficient rate to satisfy the balance equation of the 2nd law, then ordered flow, according to the balance equation, must be more efficient at dissipating potentials than disorder flow. **If ordered flow produces entropy faster than disordered flow, and if the world acts to minimize potentials at the fastest rate given the constraints, then the world can be expected to produce order whenever it gets the chance** [8].

#### IV. SOCIETY AND CULTURAL COMPUTING

Kurtz [9] argues that non-biological evolution is better explained in terms of the evolution of social organization. He also rejects the materialist bias that dominates the explanations for why and how evolution takes place. Instead he argues that 'human agents' play a larger role in evolution than has been acknowledged so far. So we have to get in touch with the deeply in our mind embedded cultural di-

mensions. Barab et al. [2] argue that a self-organizing system 'wants' to or strive opportunistically "to order themselves once the intention has been properly initialized." With this perspective, 'teaching' instruction involves establishing the appropriate 'field conditions' or connecting the learning human into a systemic set of relations through participation in an intentional service as attractor. This type of learning cannot be handed to the learning human as such but develops itself through dynamic activity and active participation as part of 'a system as a whole'.

Fundamentally important is the assertion not only that a learning human practices, creates and establishes meaningful relations "that arise due to their functional significance as part of a dynamic system are fundamentally different from teacher- or textbook-owned descriptions of practices and meanings, but that they are in this way far richer, more meaningful, and more functional. Context and participation, to put it directly, not only matter but in a deep and fundamental way are everything" [2].

In biological theories a clear distinction is made between the 'operation' question and the 'origin' question. The new evolutionists are also emphasizing this distinction between functional ecology and evolution. A more adequate understanding of complex systems structures, complex systems processes, temporal process, systemic history, and rapid change is available if we would recognizing in a holistic manner functional ecology and evolution as distinct, but inseparably related. We need to return to the evolutionary viewpoint once so influential in the past, and use it to complement ecological analyses for our new designs in cultural computing [10].

#### V. REFERENCES

1. Rauterberg, M., *From personal to cultural computing: How to assess a cultural experience*, in *uDayIV--Information nutzbar machen*, G. Kempter and P.v. Hellberg, Editors. 2006, Pabst Science Publisher: Lengerich. p. 13-21.
2. Barab, S.A., et al., *Principles of self-organization: Learning as participation in autocatakinetic systems*. *Journal of the Learning Sciences*, 1999. **8**(3-4): p. 349-390.
3. Maturana, H. and F. Varela, *Autopoiesis and cognition: The realization of the living*. 1980, Boston: Reidel.
4. Thompson, E., *Mind in life: Biology, phenomenology, and the sciences of mind*. 2007, Cambridge MA: Belknap/Harvard Univ. Press.
5. Swenson, R., *Galileo, Babel, and autopoiesis (It's turtles all the way down)*. *International Journal of General Systems*, 1992. **21**(2): p. 267-269.
6. Swenson, R., *Autocatakinetics, evolution, and the law of maximum entropy production*. *Advances in Human Ecology*, 1997. **6**: p. 1-47.
7. Swenson, R., End-directed physics and evolutionary ordering: Obviating the problem of the population of one, in *The Cybernetics of Complex Systems: Self Organization, Evolution, and Social Change*, F. Geyer, Editor. 1991, Intersystems Publications: Salinas, p. 41-60.
8. Swenson, R., *Spontaneous order, autocatakinetic closure, and the development of Space-Time*. *Annals of the New York Academy of Sciences*, 2000. **901**(1): p. 311-319.
9. Kurtz, D.V., *The evolution of social organization*. *Social Evolution & History*, 2011. **10**(2): p. 3-48.
10. Bartneck, C., et al., *Applying virtual and augmented reality in cultural computing*. *International Journal of Virtual Reality*, 2008. **7**(2): p. 11-18.

**Proceedings**

**2013 International Conference  
on Culture and Computing  
Culture and Computing 2013**

**16-18 September 2013  
Kyoto, Japan**



# **Message from the Chairs**

## **Culture and Computing 2013**

Welcome to 2013 International Conference on Culture and Computing (Culture and Computing 2013).

International communities are facing various problems in different topic areas such as: population demographic shifts, energy use and creation, the environment, and food supply. It is necessary to build a global consensus for resolving problems within these topic areas. Unfortunately, there are difficulties that hinder communication among cultures. It is imperative to develop information and communication technologies that encourage mutual understanding and bridge the difference in cultures.

Several research directions impinge on the relations between culture and computing: archiving cultural heritage via ICT (cf. digital archives), empowering humanities researches via ICT (cf. digital humanities), creating art and expressions via ICT (cf. media art), generating culturally-directed behavior (cf. cultural agent), supporting multi-language, multi-cultural societies via ICT (cf. intercultural collaboration), and understanding new cultures born in the Internet and the Web (cf. net culture).

This year, Culture and Computing is back to Kyoto, the cultural heart of Japan, to provide an opportunity to share research issues and discuss the future of culture and computing. The conference is organized so as to exhibit the integration of state-of-the-art cultural computing technologies and Japanese traditional culture, along with several co-located events.

We have a single session Main Track and two Special Track sessions. The Main Track will present a collection of scientific or engineering research results that include, archiving cultural heritages, information environments for humanity studies, art and design, intercultural communication and collaboration, culturally situated agents and simulations, and analysis of new cultures in the Internet and Web.

The Special Tracks are collections of short papers, and are organized for the purpose of encouraging discussions in hot areas. This year, we have Special Tracks for "Digital Humanities" and "Culture based Media Art & Music." The Digital Humanities captures the trend in research and education in the Humanities that has emerged over the last decade. While researchers have not reached consensus on its definition, digital data available online all over the world as well as the global collaboration through the web will usher in a paradigm shift in Humanities research. Culture based Media Art & Music is anticipated in the new century. It has been said that intelligence, sensitivity, and consciousness are the central and most important parts of humanity. The 21st century can be an era of sensitivity if it adopts the essential basis of Asian culture. The generality, value, and importance of culture should be emphasized to the world.

The conference proceedings include both full papers presented in the Main Track, together with short papers discussed in poster sessions and Special Tracks. We are sure you will find your participation in the conference fruitful and hope that it is enjoyable. We are grateful to the authors, presenters, and delegates for their contributions. We would also like to express our special thanks to our program committee members and all the external reviewers for reviewing all the papers. Finally, we wish to thank the IEEE Computer Society Conference Publishing Services for their support in compiling the proceedings.

**Kozaburo Hachimura, Toru Ishida and Naoko Tosa**  
Culture and Computing 2013 General Co-Chairs

**Donghui Lin and Akira Maeda**  
Culture and Computing 2013 Program Co-Chairs

# IEEE Computer Society Technical & Conference Activities Board

## T&C Board Vice President

Paul R. Croll

*Computer Sciences Corporation*

## IEEE Computer Society Staff

Evan Butterfield, *Director of Products and Services*

Lynne Harris, *CMP, Senior Manager, Conference Support Services*

Alicia Stickley, *Senior Manager, Publishing Operations*

Silvia Ceballos, *Manager, Conference Publishing Services*

Patrick Kellenberger, *Supervisor, Conference Publishing Services*

## IEEE Computer Society Publications

The world-renowned IEEE Computer Society publishes, promotes, and distributes a wide variety of authoritative computer science and engineering texts. These books are available from most retail outlets. Visit the CS Store at <http://www.computer.org/portal/site/store/index.jsp> for a list of products.

### IEEE Computer Society *Conference Publishing Services (CPS)*

The IEEE Computer Society produces conference publications for more than 300 acclaimed international conferences each year in a variety of formats, including books, CD-ROMs, USB Drives, and on-line publications. For information about the IEEE Computer Society's *Conference Publishing Services (CPS)*, please e-mail: [cps@computer.org](mailto:cps@computer.org) or telephone +1-714-821-8380. Fax +1-714-761-1784. Additional information about *Conference Publishing Services (CPS)* can be accessed from our web site at: <http://www.computer.org/cps>

*Revised: 18 January 2012*



**CPS Online** is our innovative online collaborative conference publishing system designed to speed the delivery of price quotations and provide conferences with real-time access to all of a project's publication materials during production, including the final papers. The **CPS Online** workspace gives a conference the opportunity to upload files through any Web browser, check status and scheduling on their project, make changes to the Table of Contents and Front Matter, approve editorial changes and proofs, and communicate with their CPS editor through discussion forums, chat tools, commenting tools and e-mail.

The following is the URL link to the **CPS Online** Publishing Inquiry Form:

<http://www.computer.org/portal/web/cscps/quote>