The Past, Present and Future of Cybernetics and Systems Research

Carlos Gershenson

Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas & Centro de Ciencias de la Complejidad, Universidad Nacional Autónoma de México

Péter Csermely

Semmelweis University, Department of Medical Chemistry, Budapest, Hungary

Péter Érdi

Center for Complex Systems Studies, Kalamazoo College, Kalamazoo, MI, USA. Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, Budapest, Hungary

Helena Knyazeva

National Research University Higher School of Economics, Moscow, Russia

Alexander Laszlo

Syntony Quest, Sebastopol, CA, USA

Abstract: Cybernetics and Systems Research (CSR) were developed in the mid-twentieth century, offering the possibility of describing and comparing different phenomena using the same language. The concepts, which originated in CSR have spread to practically all disciplines, many now used within the scientific study of complex systems. CSR has the potential to contribute to the solution of relevant problems, but the path towards this goal is not straightforward.

This paper summarizes the ideas presented by the authors during a round table in 2012 on the past, present and future of CSR.

1 Introduction

The ideas contained in this paper were presented at a round table with the same title on April 2012, during the European Meeting on Cybernetics and Systems Research at the University of Vienna, Austria. The guided reflection on the challenges and opportunities of cybernetics and systems research (CSR) included initial interventions by panelists Peter Erdi, Helena Knyazeva, Stefan Thurner, Peter Csermely, and Alexander Laszlo. Afterwards, the floor was opened to interventions from the general public and further interventions by panelists.

Science strives for understanding our world. This is also the aim of CSR (Heylighen & Joslyn, 2001). One of the main differences between traditional science and CSR is that the former focuses more on the structure, while the latter focuses more on processes and dynamics. In this way, the same description can be used to describe different phenomena. In other words, CSR searches for *isomorphisms* across disciplines.

2 The Past

The scientific study of systems began with Ludwig von Bertalanffy's General Systems Theory perhaps as early as the 1920's, but became popular after the 1940's (von Bertalanffy, 1968). By describing the general properties of phenomena independently of their substrate, the same language can be used to describe phenomena from different domains, allowing the search of commonalities, for example between logic circuits and neural networks or between human language and DNA transcription. Moreover, systems research allowed the development of synthetic methods (Steels, 1993) to complement analytic ones. In an analytic method, a model is abstracted from observations. Then the model is used to make predictions, which are contrasted (verified) with further observations. In a synthetic method, a model is also abstracted from observations. However, this model is used to *build* a system which to be verified should reproduce the observations. Synthetic methods not only provide a further approach for understanding phenomena. They also enable to *engineer* systems, which exhibit properties of the studied system.

Cybernetics, as defined by Wiener (Wiener, 1948), is concerned with the scientific study of control and communication in animals and machines. The term comes from the Greek *kibernetes*, which means steersman. This analogy illustrates one of the main concerns of cybernetics: how can systems be guided in their dynamic environment? (Gershenson, 2007; Prokopenko, 2009; Ay et al., 2012).

The roots of cybernetics can be traced to ancient times. There are examples of artifacts which used the principles later formalized by cybernetics that were built in ancient China, India, and Greece. Thales of Miletus already proposed a holistic worldview, which is also present in oriental philosophies. The ideas exposed in Plato's Republic aimed at proposing how a city state could govern itself. It was in a similar context that Ampère wrote about *cybernétique* in 1834, concerned with the study of government and bureaucracies. The concept of feedback had been used in several contexts by the XIXth century: Watt used it for steam engines, Wallace for evolution, Maxwell for physics, and von Uexküll for ethology. In the XXth century, developments in electricity, electronics, control, physics, logic, medicine, physiology, neuroscience, and evolutionary theory, among others, generated the necessity of new organization principles to solve particular problems in each area. However, following general systems theory, many of these problems were very similar once their

particular substrate was neglected. In the 1920's, the Russian scholar Alexander A. Bogdanov proposed fascinating ideas, which are close to GST in his opus "Tectology". The term "tectology" coined by him comes from Greek and literally signifies "science of organization". In his opinion, tectology is aimed to reveal some universal principles of organizational forms, whether forms of life, human behavior and health, languages or economics (Knyazeva, 2011).

Several useful concepts which were studied, developed or formalized within cybernetics are now commonly used in science and even common language: information (Shannon, 1948), open and closed systems, variety (Ashby, 1956), homeostasis (Bernard, 1859; Cannon, 1932; Ashby, 1947a; Ashby, 1960), self-organization (Ashby, 1947b; Ashby, 1962), autopoiesis (Varela et al., 1974; Maturana & Varela, 1980; Luhmann, 1986), synergetics (Haken, 1988), dissipative structures (Nicolis & Prigogine, 1977), organizations (Beer, 1966), game theory (von Neumann & Morgenstern, 1944), cellular automata (von Neumann, 1966), isomorphisms (Macrae, 1951), experimental epistemology (McCulloch, 1965), and computational psychiatry (Montague et al., 2012).

3 The Present

The concepts developed within cybernetics have spread memetically to all sciences, humanities, and beyond. Everybody speaks of systems, although not necessarily citing von Bertalanffy. Many cybernetic concepts are used but not being named as cybernetics. They have been absorbed by our present worldview.

A case of this can be seen with the scientific study of complexity (Bar-Yam, 1997; Mitchell, 2009). It takes an approach similar to cybernetics and systems research (Érdi, 2008, p. 35–45), but in many cases it does not refer to its roots in CSR.

Complexity comes from the Latin *plexus* which means interwoven. This implies that components are interdependent. Thus, the key in complex systems research is that there is a strong focus on *interactions* (Gershenson, 2013). Interactions in complex systems co-determine the future of systems, and thus limit predictability and the experimental testing of equations. It is not enough to know initial and boundary conditions, as interactions generate novel information and complex systems are not isolated: there are relevant changes from the outside and from the inside of the system.

Complexity scales with number of elements, with number of interactions, with complexity of elements and with complexity of interactions (Gershenson, 2007). For instance, the interaction between two people can be more complex than interactions between several people in a crowd. One of the challenges of complexity is to find proper trade offs, for example to reveal the optimal size of groups for a specific purpose.

We are able to study complex systems because of computers and statistics. Only now we are able to build models which can take into account dozens or millions of variables and interactions. Considering large multidimensional spaces, it has become clear that simple rules can lead to complex dynamics (Wolfram, 2002).

The contributions that complexity has made in line with CSR include network theory (Csermely, 2006; Newman, 2010; Motter & Albert, 2012), statistical mechanics (Stanley, 1987), agent based modeling (Bonabeau, 2002), and evolutionary dynamics (Nowak, 2006).

There have been applications to most fields, including systems biology (Kauffman, 1993; Kitano, 2002), computer science (Berners-Lee et al., 1992; Brin & Page, 1998), eco-

nomics (Arthur, 2011), social systems (Epstein & Axtell, 1996), ecology (Ulanowicz, 1997), and chemistry (Lehn, 1990).

The availability of "big data" (Lynch, 2008) is enabling us to contrast different models, so many of them can be rejected. Many biological and social theories were impossible to test because of lack of data. Now we are having not only the data, but the methods to analyze it. This is not about making "soft" sciences harder, but about making them empirical.

The pervasiveness of complex systems and the resulting technology is changing society. For example, mobile devices leave digital trails, which can be exploited for different purposes (Blondel et al., 2013), including the verification of social theories. However, privacy concerns are yet to be resolved (de Montjoye et al., 2013). We want progress, but at what cost?

4 The Future

The future is ripe with challenges. The XXIst century has been and will be a century of crisis, fast changes, urban and economic problems, limits of growth, instability, overpopulation, climate change, and several other challenges. Globalization is leading systems to become more and more interdependent. There are many problems that must be solved. To what extent CSR will contribute to the solution of these problems? To what extent CSR would be acknowledged, given the fact that it has already permeated into mainstream science? In practice, it does not matter. It is clear, however, that cybernetic and systemic concepts are necessary to solve future challenges (Helbing et al., 2012; Helbing, 2013).

For understanding phenomena, we have to refine our descriptions in order to relate different scales (levels of abstraction). From an evolutionary perspective, we also need to develop a better understanding of transitions (Turchin, 1977; Smith & Szathmáry, 1995; Scheffer et al., 2009), e.g. what makes the non-living to become living (from chemistry to biology), what makes the living creatures become conscious (from living systems to human consciousness), and what is the nature of the human spirit (as the highest level of consciousness). These are three main emergences in the big history of the universe.

There is also the need to build a closer relationship between natural sciences and the humanities. Ethics, esthetics, and other branches of philosophy, especially when they apply naturalistic approaches, are already successfully using notions of systems thinking. But if we consider the modern cognitive science, philosophy of mind, and epistemology, it's rather strange why they do not deal with human spirit—*menschlicher Geist* (Knyazeva, 2009). Why is the concept of human spirit lacking in the modern research? If we do not study it from a scientific point of view, other people will treat it from mysterious, esoteric, religious, and similar non-scientific perspectives.

A common language and a common vision are required. CSR has the potential of offering this to both sciences and humanities. Global problems require a combination of phenomenology and theory, of reductionism and holism. But to achieve this, a common language is needed (Knyazeva & Kurdymov, 2008).

A shift in education is also necessary. It is still unclear how the education of the future will be, but it is clear that current education is failing. CSR has the opportunity to contribute to this effort.

5 Discussion

We are recovering from extremes of reductionism in science. For example, biology is recovering from the reductionist use of the results of molecular biology (Csermely, 2006). Extreme reductionism focuses on a single isolated protein, adds another and studies the interaction. This is nonsense because in real cells there are hundreds of other proteins interacting with both proteins and affecting their interactions. The extreme of focusing on isolated components of complex systems should be avoided. But also the other extreme should be avoided: the extreme of focusing on systems and forgetting about the data. In other words, our descriptions will be insufficient if we focus at a single scale, e.g. element or system. Focusing on multiple scales will give us a broader understanding of phenomena (Bar-Yam, 2004). This leads to three methodological comments:

1. We should be humble. The understanding of systems has limits. Let us focus on a protein in the brain, which interacts with other proteins. Imagine the brain is of a youth on a first date, excited, so also proteins are excited. The protein in the middle of the turmoil doesn't have a clue why, nor that it is in a brain, nor that the owner of the brain is on a first date, which is the cause of its current situation. If we think we are like a proteins, we start to understand how humble we should be when understanding systems at higher levels.

2. We have to be very cautious. There is a difference between finding solutions to problems and finding problems to solutions. Some models have been disproved with experimental data, but sometimes we stick to our models and we try to find the segment of the world, which can be finally described by that model. As an example of these fallacies, Adam Smith's invisible hand metaphor for market behavior may be cited, which became a basis of a large number of models in economy even in years when the complexity of market dynamics has already been well established.

3. We have to be open-minded. For example, mathematicians, physicists and biologists can have different understanding of phase transitions. But they are just using the same word for different descriptions. All of them are right and we should be aware of it. The same phenomenon can be described from a variety of contexts (Gershenson, 2002), which is exemplified well by the Indian parable of the six blind men and the elephant. It will be more productive to be inclusive and consider different perspectives rather than being exclusive and reject all but one.

From an evolutionary perspective, in science the best ideas are those that change society and endure. Metaphors can be used for providing novel descriptions. But in order to change systems we have to understand them. We need to ask good questions, and then to listen very carefully what nature replies. This is how all of science should be done.

6 Conclusions

CSR have strongly influenced all scientific disciplines. As an example, the term "system" is used commonly in daily language. One of the breakthroughs of CSR involves the attempt to find commonalities across disciplines. Even when this was achieved to a certain degree, there is still a lack of a common language to communicate successfully, especially between the natural and social sciences.

Currently, the scientific study of complex systems has several commonalities with CSR. It could be argued that complexity has inherited many of the aims of CSR, and they

can be distinguished roughly by complexity being dominated more by natural sciences and CSR more by social sciences, although there is a strong overlap. One of the aspects that has propagated complexity has been its ability to contrast its theories and dispose those that do not match observations. This is a challenge for CSR, where theories should also be contrasted with real data. Nevertheless, this is becoming feasible due to the increased accessibility to several sources of information and methods for analysing this data.

It is suggested that CSR researchers should be humble (since our knowledge and cognitive abilities are limited), cautious (not to believe blindly in our models), and open-minded (towards other disciplines and approaches). As our future unfolds, CSR has the opportunity to solve relevant problems of our globalized society (Laszlo & Laszlo, 2003). This makes CSR an ambitious endeavor. However, in order to find our limits we have to go beyond them.

References

Arthur, W. B. (2011). The second economy. McKinsey Quarterly. URL https://www.mckinseyquarterly.com/Strategy/Growth/The_second_economy_2853.

Ashby, W. R. (1947a). The nervous system as physical machine: With special reference to the origin of adaptive behavior. Mind 56 (221) (January): 44–59. URL http://tinyurl.com/aqcmdy.

Ashby, W. R. (1947b). Principles of the self-organizing dynamic system. Journal of General Psychology 37: 125–128.

Ashby, W. R. (1956). An Introduction to Cybernetics. Chapman & Hall, London. URL http://pcp.vub.ac.be/ASHBBOOK.html.

Ashby, W. R. (1960). Design for a brain: The origin of adaptive behaviour, 2nd ed. Chapman & Hall, London. URL http://dx.doi.org/10.1037/11592-000.

Ashby, W. R. (1962). Principles of the self-organizing system. In Principles of Self-Organization, H. V. Foerster and G. W. Zopf, Jr., (Eds.). Pergamon, Oxford, pp. 255–278.

Ay, N., Der, R., and Prokopenko, M. (2012). Guided self-organization: perception– action loops of embodied systems. Theory in Biosciences 131 (3): 125–127. URL http://dx.doi.org/10.1007/s12064-011-0140-1.

Bar-Yam, Y. (1997). Dynamics of Complex Systems. Studies in Nonlinearity. Westview Press, Boulder, CO, USA. URL http://www.necsi.org/publications/dcs/.

Bar-Yam, Y. (2004). Multiscale variety in complex systems. Complexity 9 (4): 37–45. URL http://necsi.org/projects/yaneer/multiscalevariety.pdf.

Beer, S. (1966). Decision and Control: The Meaning of Operational Research and Management Cybernetics. John Wiley and Sons, New York.

Bernard, C. (1859). Leçons sur les propriétés physiologiques et les alterations pathologiques des liquides de l'organisme. Paris.

Berners-Lee, T., Cailliau, R., Groff, J.-F., and Pollermann, B. (1992). World-wide web: The information universe. Internet Research 2 (1): 52–58. URL http://dx.doi.org/10.1108/eb047254.

Blondel, V., de Cordes, N., Decuyper, A., Deville, P., Raguenez, J., and Smoreda, Z., Eds. (2013). Mobile Phone Data for Development: Analysis of mobile phone datasets for the development of Ivory Coast. Selected contributions to the D4D challenge sponsored by Orange. URL http://perso.uclouvain.be/vincent.blondel/netmob/2013/D4D-book.pdf.

Bonabeau, E. (2002). Agent-based modeling: Methods and techniques for simulating human systems. Proceedings of the National Academy of Sciences of the United States of America 99 (Suppl 3): 7280–7287. URL http://dx.doi.org/10.1073/pnas.082080899.

Brin, S. and Page, L. (1998). The anatomy of a large-scale hypertextual web search engine. In Proceedings of the seventh international conference on World Wide Web. pp. 107– 117. URL http://infolab.stanford.edu/~backrub/google.html.

Cannon, W. (1932). The wisdom of the body. WW Norton & Co, New York.

Csermely, P. (2006). Weak Links: Stabilizers of Complex Systems from Proteins to Social Networks. Springer.

de Montjoye, Y.-A., Hidalgo, C. A., Verleysen, M., and Blondel, V. D. (2013). Unique in the crowd: The privacy bounds of human mobility. Scientific Reports 3. URL http://dx.doi.org/10.1038/srep01376.

Epstein, J. M. and Axtell, R. L. (1996). Growing Artificial Societies: Social Sci- ence from the Bottom Up. Brookings Institution Press MIT Press. URL http://www.brookings.org/press/books/artifsoc.htm .

Érdi, P. (2008). Complexity Explained. Springer. URL http://link.springer.com/content/pdf/10.1007%2F978-3-540-35778-0.pdf.

Gershenson, C. (2002). Contextuality: A philosophical paradigm, with applications to philosophy of cognitive science. POCS Essay, COGS, University of Sussex. URL http://cogprints.org/2621/.

Gershenson, C. (2007). Design and Control of Self-organizing Systems. CopIt Arxives, Mexico. URL http://tinyurl.com/DCSOS2007.

Gershenson, C. (2013). The implications of interactions for science and philosophy. Foundations of Science Early View. URL http://arxiv.org/abs/1105.2827.

Haken, H. (1988). Information and Self-organization: A Macroscopic Approach to Complex Systems. Springer-Verlag, Berlin.

Helbing, D. (2013). Globally networked risks and how to respond. Nature 497 (7447) (05): 51–59. URL http://dx.doi.org/10.1038/nature12047.

Helbing, D., Bishop, S., Conte, R., Lukowicz, P., and McCarthy, J. B. (2012). FuturICT: Participatory computing to understand and manage our complex world in a more sustainable and resilient way. 214 (1): 11–39. URL http://dx.doi.org/10.1140/epjst/e2012-01686-y.

Heylighen, F. and Joslyn, C. (2001). Cybernetics and second order cybernetics. In Encyclopedia of Physical Science and Technology, 3rd ed., R. A. Meyers, (Ed.). Vol. 4. Academic Press, New York, 155–170.

Kauffman, S. A. (1993). The Origins of Order. Oxford University Press, Oxford, UK. Kitano, H. (2002). Systems biology: A brief overview. Science 295 (5560): 1662–1664. URL http://dx.doi.org/10.1126/science.1069492.

Knyazeva, H. (2009). Nonlinear cobweb of cognition. Foundations of Science 14 (3):

167–179.

Knyazeva, H. (2011). The russian cosmism and the modern theory of complexity: The comparative analysis. Analecta Husserliana 107: 229–235.

Knyazeva, H. and Kurdymov, S. P. (2008). Synergetics: New universalism or natural philosophy of the age of post-nonclassical science. Dialogue and Universalism 11-12: 39–61.

Laszlo, A. and Laszlo, E. (2003). The systems sciences in service of humanity. In Encyclopedia of Life Support Systems (EOLSS), F. Parra-Luna, (Ed.). EOLSS Publishers, Oxford, UK.

Lehn, J.-M. (1990). Perspectives in supramolecular chemistry—from molecular recognition towards molecular information processing and self-organization. Angewandte Chemie In- ternational Edition in English 29 (11): 1304–1319. URL http://dx.doi.org/10.1002/anie.199013041.

Luhmann, N. (1986). The autopoiesis of social systems. In Sociocybernetic Paradoxes. Observation, Control and Evolution of Self-steering Systems, F. Geyer and J. van der Zouwen, (Eds.). Sage, London, 172–192.

Lynch, C. (2008). Big data: How do your data grow? Nature 455 (7209) (09): 28–29. URL http://dx.doi.org/10.1038/455028a.

Macrae, D. G. (1951). Cybernetics and social science. The British Journal of Sociol- ogy 2 (2) (06): 135–149. URL http://www.jstor.org/stable/587385.

Maturana, H. and Varela, F. (1980). Autopoiesis and Cognition: The realization of living. Reidel Publishing Company, Dordrecht.

McCulloch, W. S. (1965). Embodiments of mind. MIT press, Cambridge.

Mitchell, M. (2009). Complexity: A Guided Tour. Oxford University Press, Oxford, UK.

Montague, P. R., Dolan, R. J., Friston, K. J., and Dayan, P. (2012). Computational psychiatry. Trends in Cognitive Sciences 16 (1): 72 – 80. Special Issue: Cognition in Neuropsychiatric Disorders. URL http://dx.doi.org/10.1016/j.tics.2011.11.018.

Motter, A. E. and Albert, R. (2012). Networks in motion. Physics Today 65 (4): 43–48. URL http://link.aip.org/link/?PTO/65/43/1.

Newman, M. (2010). Networks: An Introduction. Oxford University Press, Oxford, UK. Nicolis, G. and Prigogine, I. (1977). Self-Organization in Non-Equilibrium Systems:

From Dissipative Structures to Order Through Fluctuations. Wiley, Chichester.

Nowak, M. A. (2006). Evolutionary dynamics: exploring the equations of life. Harvard University Press.

Prokopenko, M. (2009). Guided self-organization. HFSP Journal 3 (5): 287–289. URL http://dx.doi.org/10.2976/1.3233933.

Scheffer, M., Bascompte, J., Brock, W. A., Brovkin, V., Carpenter, S. R., Dakos, V., Held, H., van Nes, E. H., Rietkerk, M., and Sugihara, G. (2009). Early-warning signals for critical transitions. Nature 461 (7260) (09): 53–59. URL http://dx.doi.org/10.1038/nature08227.

Shannon, C. E. (1948). A mathematical theory of communication. Bell System Technical Journal 27: 379–423 and 623–656. URL http://tinyurl.com/6qrcc.

Smith, J. M. and Szathmáry, E. (1995). The major transitions in evolution. Oxford University Press.

Stanley, H. E. (1987). Introduction to phase transitions and critical phenomena. Oxford University Press.

Steels, L. (1993). Building agents out of autonomous behavior systems. In The Artificial Life Route to Artificial Intelligence: Building Embodied Situated Agents, L. Steels and R. A. Brooks, (Eds.). Lawrence Erlbaum.

Turchin, V. (1977). The Phenomenon of Science. A Cybernetic Approach to Human Evolution. Columbia University Press, New York. URL http://pcp.vub.ac.be/POSBOOK.html.

Ulanowicz, R. (1997). Ecology, the Ascending Perspective. Columbia University Press, New York.

Varela, F. J., Maturana, H. R., and Uribe., R. (1974). Autopoiesis: The organization of living systems, its characterization and a model. BioSystems 5: 187–196.

von Bertalanffy, L. (1968). General System Theory: Foundations, Development, Applications. George Braziller, New York.

von Neumann, J. (1966). The Theory of Self-Reproducing Automata. University of Illinois Press, Champaign. Edited by A. W. Burks.

von Neumann, J. and Morgenstern, O. (1944). Theory of Games and Economic Behavior. Princeton University Press.

Wiener, N. (1948). Cybernetics; or, Control and Communication in the Animal and the Machine. Wiley and Sons, New York.

Wolfram, S. (2002). A New Kind of Science. Wolfram Media, Champaign, IL, USA. URL http://www.wolframscience.com/thebook.html.

About the Authors

Carlos Gershenson

Carlos Gershenson is the head of the computer science department of the Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas of the Universidad Nacional Autónoma de México since January 2012, and a full time researcher since 2008. He is also an associated researcher to the Centro de Ciencias de la Complejidad of the same university.

Péter Csermely

Peter Csermely is a professor of network science at the Semmelweis University, Budapest, Hungary. Published more than 250 books and papers with a total citation over 7000. A member of the Hungarian Academy of Sciences and Academia Europaea. Developed several talent support networks, serves as the president of the European Council of High Ability and the Hungarian Talent Support Council. Was an Ashoka, Fogarty, Howard Hughes and Rockefeller Fellow and received the Descartes Award of the European Union.

Péter Érdi

Péter Érdi serves as the Henry R. Luce Professor of Complex Systems Studies at Kalamazoo College, and also a research professor at the Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, in Budapest, Hungary. His main fields of interest are computational neuroscience and computational social sciences.

Helena Knyazeva

Helena Knyazeva is Dr. habil. in Philosophy, Head of Department of Evolutionary Epistemology at the Institute of Philosophy of the Russian Academy of Sciences in Moscow. Her fields of research interests are epistemology and philosophy of science, focusing on complex systems studies. She is Member of the German Society for Complex Systems and Nonlinear Dynamics in Germany, of the Association for Complex Thinking in France as well as of the Scientific Council "Multiversidad Mundo Real Edgar

Morin" in Mexico. Many times, she has been an invited Research Scholar in several universities in Germany, France, USA, Czech Republic and Bulgaria. She has published more than 400 works, including 8 books in Russian and about 30 research articles in international professional journals on complex systems and synergetics. She is translator of works of I. Prigogine, H. Haken, W. Ebeling, K. Mainzer, J. Petitot, E. Morin, including E. Morin's main work "Method. The Nature of Nature" (Moscow, 2005; 2nd ed. 2013).

Alexander Laszlo

Alexander Laszlo is co-founder and President of Syntony Quest. He is Vice-President-Elect of the International Society for the Systems Sciences. He currently serves as core faculty for the Organizational Systems Renewal program at Bainbridge Graduate Institute in Seattle, Washington.