# Editorial. The Constructivist Challenge

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***Purpose:*** This is an attempt to define constructivism in a pluralistic way. It categorizes constructivist work within a three-dimensional space rather than along one dimension only. ***Practical implications:*** The interdisciplinary definition makes it possible to perceive the rather heterogenous constructivist community as a coherent and largely consistent scientific effort to provide answers to demanding complex problems. Furthermore it gives authors of Constructivist Foundation the opportunity to locate their own position within the community. ***Conclusions:*** I offer a catalogue of ten points that outline the constructivist program. Each of these aspects invites authors to extensively reflect on it and to approach it from their disciplinary background to do work in any of the types of investigations the journal covers. ***Key words:*** constructivist approaches, interdisciplinarity, dogmatism.

What is constructivism? Consider the following example. Suppose that we take a piece of chalk and write on a blackboard "A = A." Now we point at it and ask, "What is this?" We may get one of the following answers. (a) White lines on a black background; (b) An arrangement of molecules of chalk; (c) Three signs; (d) The law of identity. Regardless whether you are an art critic, a chemist, a philosopher, or a mathematician, it is obvious that the answer will depend on your educational background. At first sight we may find this example amusing and harmless. We all know that personal preferences bias the way we perceive the world. But what about the following example, originally attributed to Danish nobel prize winner Niels Bohr and retold by Humberto Maturana? A teacher "who asks a student to measure the height of a tower with the use of an altimeter, may flunk the student if he uses the length of the altimeter to triangulate the tower and obtains the height of the tower through geometry and not through physics. The teacher may say that the student does not know physics" (Maturana 1978, p. 42). What this episode suggests is twofold. Firstly, by focusing on one particular approach only we will quickly get caught in ignorance and denial of other approaches that might turn out much more fruitful. Of course, such is the human psyche: functionally fixed (Duncker 1935/1945). Once we have found a viable solution (such as reading the display of an altimeter) we tend to stubbornly apply the pattern of our solution to all other problems as well. In other words, our thinking is canalized (cf. the "If it ain't broken don't fix it" syndrome, Riegler 1998, 2001b), caught in the momentary situational context as determined by the way we have learned to deal with things. But secondly, the analogy also warns us of authoritarian attempts to think there is only true solution to a whatever we identify as a problem. Their appeal to "reality" as the ultimate arbiter of (scientific) disputes gives rise to the belief that there exists a mind-independent reality which defines what is true and what is not. However, as Mitterer (1992) pointed out, isn't claiming authority by referring to an external truth the attempt to make one's own point of view unassailable? The two analogies above should make it clear that science and philosophy gain from variety and the possibility of choosing from other options.

Such variety and freedom of choice has always been a major aspect a constructivist philosophies and sciences. Heinz von Foerster's (1973/2003, p. 227) "ethical imperative": "Act always so as to increase the number of choices" does not only anthropo-morphize W. Ross Ashby's (1956) *Law of Requisite Variety* which states that the variety of actions available to a control system must be at least as large as the variety of actions in the system to be controlled (so by having more choice you stay in control). Foerster's imperative is also a reminder to the fact that most problems in science are undecidable in principle. These are problems of "organized complexity" (Weaver 1948), characterized by a "sizeable number of factors which are interrelated into an organic whole" (p. 539). Any attempt to capture their behavior in neat formalisms in order to make reliable predications is rendered impossible. It is the responsibility of the scientist to decide these problems: "Only those questions which are in principle undecidable *we* can decide" (Foerster 1991/2003). The solution to such "big problems" in science simply cannot be delegated to nature as the monolithic "objective arbiter." Therefore pluralistic perspectives are of utmost importance when scientifically approaching phenomena of organized complexity.

The present first issue of "Constructivist Foundations" is the attempt to provide this plurality. It creates an interdisciplinary forum for authors and readers, philosophers and engineers, academics and practitioners, to approach the most challenging scientific problems from the constructivist perspective. This perspective, however, is not a monolithic building, nor is it the philosopher's stone. Rather, it "is a way of thinking, not a collection of facts," as Ernst von Glasersfeld (1985/1992) once said about cybernetics which is one of the major roots for several contemporary constructivist schools. For many it sounds unthinkable to refrain from searching for *the* correct answer, for *the* correct solution to a given problem. Unfortunately, unambiguous solutions work for simple systems and simply problems only. We are used to the situation in Newtonian physics that deals with a small number of entities subject to a few forces only. And we are used to thinking that such situations can be extrapolated to massively large inhomogeneous systems. However, as it has turned out over the last decades these systems of organized complexity such as human cognition, quantum physics, life, economy, global weather, and many more, evade our attempts to generate simple and clear-cut answers. These systems call for interdisciplinary approaches, for open inquiries that enable investigators to escape the confinements of a specific discipline and to become aware of aspects that are necessary to *satisfyingly* solve the problem.

By now it should have become obvious that there is no simple answer to the initial

question "What is constructivism?" There are many constructivist "schools" as constructivist concepts have been developed in various scientific disciplines. In order to provide an impression of how diverse constructivist "schools" can be I shall sketch a few of the constructivisms relevant for the journal.

## The plurality of constructivism

When some 30 years ago by Ernst von Glasersfeld started publishing on a concept he called "radical constructivism" (Glasersfeld 1995; cf. also his recollection article in this edition) he pioneered the *philosophical-epistemological approach*. He maintains that knowledge is not passively received but actively built up by the cognizing subject (first principle of radical constructivism). Furthermore the function of cognition is adaptive; it serves the organization of the experiential world, not the discovery of ontological reality (second principle). He calls his version "radical" because he claims that constructivism has to be applied to all levels of description. "Those who ... do not explicitly give up the notion that our conceptual constructions can or should in some way represent an independent, 'objective' reality, are still caught up in the traditional theory of knowledge" (Glasersfeld 1991).

Glasersfeld refers to the skeptic tradition in philosophy, especially to Sextus Empiricus, Berkeley (*Esse est percipi*, i.e., to be is to be perceived), Vico (*Verum ipsum factum*, i.e., the truth is the same as the made), and to Hans Vaihinger's (1911/1952) *as-if philosophy*. For Glasersfeld, skepticism points the way to the insight that whatever world view we construct we do not have any means of validating it. He also quotes Jean Piaget from whom he took over the idea that the child constructs his or her world by means of assimilation and accommodation.

Another philosophically oriented perspective is Herbert Müller's (2000; cf. also his article in this edition) *epistemic structuring (of experience)* approach. It assumes mental structures to be tools for mastering unstructured experience. The principle of zero-derivation claims that reality structures are not derived from any given pre-structured entities inside or outside the subject thus obviating the need for belief in mind-independent reality.

The *cybernetic approach* has a different history. Originally hired as editor of the proceedings of the Macy-conferences on cybernetics (cf. Pias 2003) the subject of which was "circular-causal and feedback mechanisms in biological and social systems," it soon struck Heinz von Foerster that a "cybernetics of observing systems" is far more interesting than a "cybernetics of observed systems." His so defined *second-ordered cybernetics* became the guiding paradigm of the Biological Computing Lab (BCL) he was running for many years.

Starting from the insight that nervous signals are merely electrochemical, Heinz von Foerster formulated the *Principle of Undifferentiated Encoding*: "The response of a nerve cell does *not* encode the physical nature of the agents that caused its response. Encoded is only 'how much' at this point on my body, but not 'what'" (Foerster 1973/2003, p. 215). The principle can be found in Maturana and Varela's assertion that the cognitive apparatus is an "organizationally closed system" (see biological approaches below).

It can be claimed that the *psychological-cognitive approach* started with developmental psychologist Jean Piaget whose scientific conviction can be summarized in his statement "L'intelligence organise le monde en s'organisant elle-même" (Piaget 1937/1954, p. 311). In his theory of cognitive development (e.g., he argued that in the beginning, a newborn knows little about how to cope with the perceptive impressions around her. Faces might be funny or threatening colorful spots and voices unknown sounds. In fact, she doesn't even know that these are colors and sounds. Only by *assimilation* and *accommodation* the child constructs a collection of rules (schemata) during her ontogeny. Schemata serve as a point of reference when it comes to assimilating new experiences. If impressions are too alien to be aligned to an older, already assimilated experience, they are either not perceived at all or give rise to the accommodation of those existing schemata, which are appropriately adjusted in order to include the new "exotic" experience. With each of these assimilating or accommodating steps the child constructs another piece of reality. Piaget's theory has been interpreted in a constructivist way especially by Glasersfeld.

Psychologist Ulric Neisser (1975) developed a theory of *schemata controlled information pickup*. A cognitive schema "accepts information as it becomes available at sensory surfaces and is changed by that information. It directs movements and exploratory activities that make more information available, by which it is further modified" (p. 55).

For Kevin O'Regan and Alva Noë (2001) seeing is knowing sensorimotor dependencies, and the brain is a device to extract algebraic structures between perception and action. The authors refer to the work of Donald MacKay (1969) on "sensorimotor contingencies" and continued the work of Paul Bach-y-Rita (1972) who pioneered with work on sensory substitution. In particular, Bach-y-Rita showed how a blind person could gain some notion of sight by converting visual camera images into tactile information, and interpreted this as expression of brain plasticity.

The *theory of autopoietic systems* formulated by biologists Humberto R. Maturana and Francisco J. Varela can be referred to as *the biological-neurobiological approach.* Autopoietic systems are a sub-class of self-organizing systems which, if they exist in the physical domain, are the class of living systems. For them, the nervous system is a closed network of interacting neurons where any change in the state of relative activity of a collection of neurons leads to a change in the state of relative activity of other or the same collection of neurons. This is referred to as the "organizational closure" of the nervous system. It can be argued that organizational closure represents the starting point for the formal interpretation of radical constructivism (Riegler 2001a).

The work of neurophysiologist Rudolfo R. Llinás (2001) provides empirical backing. He too formulated a *closed-system hypothesis*: "[The brain] is capable of doing what it does without any sensory input whatsoever" (p. 94). According to his dreaming machine-argument, we "are basically dreaming machines that construct virtual models."

Neurophysiologist Gerhard Roth (Haynes et al. 1998) maintains that the limbic system, the unconsciously working part of the brain responsible for evaluations, is the ultimate instance of volitional cognition. In their view, consciousness is just a pseudo-ruling ego. It is not the ego who constructs; it is constructed,

or as Wolfgang Prinz (1997, p. 155) put it, "We do not do what we want, but we want what we do." In other words, this raises the question who (or what) is responsible for the constructions that form our cognition (Riegler 2003).

Later on, Varela together with Evan Thompson and Elenor Rosch developed another constructivist variant known as *enactivism* or *enactive cognitive science* based on key concepts such as autopoiesis, structural determinism and structural coupling. In the enactivist paradigm, experience is rooted within the organizational autonomy of the acting system and is considered fundamental for social and cultural phenomena. As the authors put it, it attempts to account for "how action can be perceptually guided in a perceiver-dependent world" (Varela, Thomspon & Rosch 1991, p. 173; cf. also the McGee's survey in this edition).

One could assume that the most "objective" of all disciplines, physics, does not contribute to the constructivist spectrum. Interestingly, however, arguing from the background of physics, Olaf Diettrich (2001) developed a *constructivist evolutionary epistemology* (or *cognitive operator theory*). He claims perceived patterns and regularities are just invariants of inborn cognitive (sensory) operators. Therefore, laws of nature are human-specific. A different set of cognitive operators yields a different cognitive phenotype. Creatures equipped with such alternative phenotypes would be impossible to communicate with. Diettrich's approach also claims a homology between mechanisms generating mathematical terms and those generating observational ones, explaining thus why mathematics is such an effective tool to describe the world.

In his quantum-physical world view, Gerhard Grössing (2001) maintains that perceived non-classical structure of space and time in relativistic cases are human-specific artifact based on neurophysiological processes.

Paul Watzlawick's well-known Palo-Alto group (Watzlawick, Weakland, & Fisch 1974) for family therapy uses constructivism to make patients solve their interpersonal problems. Their approach can be called *psychiatrist-therapeutic*. The basic therapeutic intervention is to disrupt patterns of symptomatic interaction by "reframing" a habitual situation, i.e., to "place conceptual and/or emotional setting or viewpoint in another frame which fits the 'facts' of the same concrete situation equally well or even better and thereby changes its entire meaning" (p. 95). This encourages the patients to find alternative constructions of their worldview. In other words, it helps to escape canalizations I referred to in the beginning.

Psychologist George Kelly (1955) developed a challenging subjectivist theory, *Personal Construct Psychology*, that focuses on the concept of anticipation. His "man as scientist" metaphor expresses the idea that "a person's processes are psychologically channelized by the way in which he anticipates events" (p. 46) Human beings aim at a better control of their world by predicting events and constructing their reality. These constructions are constantly subject to validation and subsequent modification if necessary.

The list of constructivist approaches could be even further extended. For example, there is *the literature-media science approach* championed by Siegfried J. Schmidt (1987), Gebhard Rusch (1987) et al. in the 1980s in Germany. Part of the credit also goes to Wolfram K. Köck who made excellent German translations of authors such as Maturana, Glasersfeld, and Foerster, which triggered the great impact of radical constructivism on the humanities in German-speaking countries. Further researchers in this area are Nancy Spivey (1997) and Stefan Weber (2005) who argues in favor of a non-dualistic media theory as proposed by Mitterer (1992, 2001). Building primarily on Maturana and Varela's autopoietic theory, Niklas Luhmann (1984/1995) developed a *system theoretical* version, which has found many followers especially in Germany. Ernst von Glasersfeld and Leslie Steffe (Steffe & Gale 1995) contributed a great deal to implementing radical constructivism in *educational sciences*. Former BCL member Gordon Pask (1975) developed a *constructivist theory of communication* as applied to education and extended by Bernard Scott (e.g., Scott 2001).

In reaction to mathematical Platonism, *mathematical constructivists* such as L. E. J. Brouwer, Arend Heyting (1975), and Jean Paul Van Bendegem claim that mathematical objects exist only if a method can construct them. As a consequence they oppose, for example, the notion of infinity, either by denying the actual infinite or by denying both the actual and the potential infinite (Van Bendegem 1999).

With *Erlangen Constructivism* Paul Lorenzen and Wilhelm Kamlah (Kamlah & Lorenzen 1967/1984, Lorenzen 1987) attempted a circular-free foundation of sciences and scientific languages. Its basis is twofold: a prescientific vocabulary and standardized action schemata to generate objects. Later, Erlangen Constructivism was transformed into *Methodological Culturalism* by Peter Janich (1996). He claims a relativism on the fact that all justifications are based on pre-active and prediscursive consensuses, which are marked by an already achieved cultural level. ("Alle Begründungen und Rechtfertigungen finden zulässige Anfänge in präaktiven und prädiskursiven Konsensen, die durch eine schon erreichte Kulturhöhe ausgezeichnet sind.")

As proponents of the *computational approach* Steven Quartz (Quartz & Sejnowski 1997) and Gert Westermann (2000) could be listed as well as Gary Drescher (1991) who cast Piaget into algorithms.

Last but not least *Constructionism* (Harel & Papert 1991) as an educational philosophy should be mentioned. It emphasizes that in order to learn about abstract concepts it is necessary to create and experiment with artifacts. In this perspective, understanding and experience are closely related in the sense that learning is considered a process of active knowledge construction rather than passive knowledge absorption.

## Does constructivism matter?

Will constructivism change science? Carnap discussed the effect of epistemology in his well-known thought experiment of two geographers – a realist and an idealist – who travel to Africa to investigate claims about an unusual mountain. Carnap's conclusion is that the "two geographers will come to the same result not only about the existence of the mountain, but also about its other characteristics, namely position, shape, height, etc. In all empirical questions there is unanimity… [The epistemological] divergence between the two scientists does not occur in the empirical domain, for there is complete unanimity so far as the empirical facts are concerned." (Carnap 1928/1967, p. 334). Similarly, Hel-

mut Schwegler (2001) argues that all science including physics is basically a language game in the sense of Wittgenstein, i.e., scientists communicate via language and work via these communications. But in order to play this language game correctly one doesn't need to adopt the constructivist world view. So, after all, does a constructivist foundation matter? As Glasersfeld said, knowledge is always the result of a constructive activity rather than the accumulation of propositional data (such as position and heights of mountains). In other words, constructivism shifts the focus of attention from the propositional "knowing that" to the pragmatic "knowing how." In a certain sense, scientists rather resemble shoemakers who have to work with their given material. In the "realist mode" shoemakers stick to the principles of shoemaking which are believed to be true. Constructivist shoemakers, however, will more flexibly adopt alternative approaches as for them the commitment to a hypothetical truth is no longer an essential criterion (Dewey Dykstra, personal communication). If this analogy is correct, then one of the advantages of a constructivist-biased science certainly has more potential to come up with new solutions.

## The common denominator

Let us pick up again the initial question, "What is constructivism?" As argued above, giving a one-dimensional answer does not only contradict constructivist principles, it is above all counterproductive for scientific and philosophical endeavors. It would be difficult if not impossible to lump together the many independent disciplinary roots and proponents of constructivism. However, it is possible and desirable to distill their common denominator. From what has been said so far in this editorial but without going into further details (and thereby violating the idea of a denominator being wide enough to cover various paradigms) I present the "constructivist program." It encompasses the following ten aspects.

1. Constructivist approaches question the Cartesian separation between objective world and subjective experience. As argued by Josef Mitterer (2001), such dualistic approaches, being the prevailing scientific orientation, are based on the distinction between description and object, and their argumentation is directed towards the object of thought. His thesis says: The dualistic method of searching for truth is but an argumentative technique that can turn any arbitrary opinion either true or false. Therefore the goal of dualistic philosophies, i.e., philosophies based on the subject–object dichotomy, is to convince a public audience (readers, listeners, discussion partners) of the truth. An example to surmount the separation is the concept of "co-enaction" (Varela, Thompson & Rosch 1991, p. 150) according to which "...knower and known, mind and world, stand in relation to each other through mutual specification or dependent coorigination."

2. As a consequence of point 1, constructivist approaches demand the inclusion of the observer in scientific explanations. Foerster (quoted from Glasersfeld 1995) summarizes the crucial point in a single statement, "Objectivity is the delusion that observations could be made without an observer." Maturana (1978, p. 3) made it a dictum: "Everything said is said by an observer to another observer that could be him- or herself."

3. Representationalism is rejected. Questioning Wittgenstein's correspondence theory of representation ("in order to tell whether a picture is true or false we must compare it with reality") induced Glasersfeld to formulate the radical constructivist paradigm. In the constructivist perspective knowledge is the result of an active construction process rather than of a more or less passive representational mapping from the environment of an objective world onto subjective cognitive structures. Therefore, knowledge is a system-related cognitive process rather than a representation (Peschl & Riegler 1999).

4. According to constructivist approaches, it is futile to claim that knowledge approaches reality. Instead, reality is brought forth by the subject. As Glasersfeld (1991, p.16) put it, "those who merely speak of the construction of knowledge, but do not explicitly give up the notion that our conceptual constructions can or should in some way represent an independent, 'objective' reality, are still caught up in the traditional theory of knowledge."

5. Constructivist approaches entertain an agnostic relationship with reality, which is considered beyond our cognitive horizon. Any reference to it should be refrained from. This position is not necessarily limited to skeptical philosophies. Positivist Rudolf Carnap expressed the necessity of this aspect in his 1935 book saying that "we reject the thesis of the Reality of the physical world; but we do not reject it as false, but as having no sense, and its Idealistic anti-thesis is subject to exactly the same rejection. We neither assert nor deny these theses, we reject the whole question."

6. Therefore, the focus of research moves from the world that consists of *matter* to the world that consists of *what matters*. Since the cognitive apparatus brings forth the world out of experiences, our understanding of what we are used to refer to as "reality" does not root in the discovery of absolute mind-independent structures but rather in the operations by which we assemble our experiential world" (Glasersfeld 1984). Or in the words of Foerster, instead of being concerned with "observed systems" the focus of attention shifts to "observing systems."

7. Constructivist approaches focus on self-referential and organizationally closed systems. Such systems strive for control over their inputs rather than their outputs. Cognitive system (mind) is operationally closed. It interacts necessarily only with its own states (Maturana & Varela 1979). The nervous system is "a closed network of interacting neurons such that any change in the state of relative activity of a collection of neurons leads to a change in the state of relative activity of other or the same collection of neurons" (Winograd & Flores 1986, p. 42). This is a consequence of the neurophysiological principle of undifferentiated encoding: "The response of a nerve cell does not encode the physical nature of the agents that caused its response." (Foerster 1973/2003, p. 293). Humberto Maturana (1978) suggests that we can compare the situation of the mind with a pilot using instruments to fly the plane. All he does is "manipulate the instruments of the plane according to a certain path of change in their readings" (p. 42). In other words, the pilot doesn't even need to look "outside." The enactive cognitive science paradigm expresses clearly: "...autonomous systems stand in sharp contrast to systems whose coupling with the environment is specified through input/output relations. ...the meaning of this or that interaction for a living system is not prescribed from outside but is the result of the organization and history of the system itself." (Varela, Thompson & Rosch 1991, p. 157)

8. With regard to scientific explanations, constructivist approaches favor a process-oriented approach rather than a substance-based perspective. For example, following Maturana living systems are defined by processes whereby they constitute and maintain their own organization. Their structure refers to the "actual relations which hold between the components which integrate a concrete machine in a given space" (Maturana & Varela 1979) while their organization defines the "dynamics of interactions and transformations" a system may undergo. Material aspects are therefore secondary.

9. Constructivist approaches emphasize the "individual as personal scientist" approach as their starting point is the cognitive capacity of the experiencing subject. Sociality is defined as accommodating within the framework of social interaction. While social interaction is not considered a new quality in contrast to interacting with non-living entities, its complexity is acknowledged. However, society is not a priori given, not the "social precedes the personal" (Gergen 1997). Rather, "society" must be conceptually analyzed. Constructivism is also rather pragmatic about "common knowledge" such as texts. They "contain neither meaning nor knowledge – they are a scaffolding on which readers can build their interpretation" (Glasersfeld 1992, p. 175).

10. Finally, constructivism asks for an open and more flexible approach to science in order to generate the plasticity that is needed to cope with the scientific frontier. Also today's knowledge-based society must be assessed through its ability and willingness to continuously revise knowledge. Krohn (1997) refers to it as the society of self-experimentation. Luhmann (1994) defines knowledge as schemata that are regarded as true but ready to be changed. Constructivism must be considered as a way to forgo the dogmatism that prevents science from becoming more fruitful and productive than today.

This list is deliberately painted with a big brush. Rather than limit future developments right from the onset, the list wants to give the necessary latitude to future authors in Constructivist Foundations to further extend the constructivist program. This is the constructivist challenge, and the journal will be one of its main champions.

## NAVIGATING THE PLURALITY

Given the plurality of constructivist approaches it seems heretical to order them in one dimension only. Hence Constructivist Foundations will navigate the constructivist space in three dimensions.

**Dimension 1: Discipline**
Along this dimension we find the following disciplines.
- biological-physiological
- cognitive-psychological
- educational
- engineering-computer scientific
- historical
- philosophical-epistemological
- physical

**Dimension 2: School**
Since many scientists and philosophers have developed their respective version of constructivism without necessarily paying much attention to historical or contemporary parallels a number of labels for constructivist research have emerged. Therefore authors may align their submission to Constructivist Foundation to any from the following (incomplete) list of "schools" (or paradigms).
- constructivist evolutionary epistemology
- cybersemiotics
- enactive cognitive science (cf. McGee's survey in this number)
- epistemic structuring of experience (cf. Müller's conceptual paper)
- radical constructivism (cf. Glasersfeld's recollection article)
- second order cybernetics (cf. Aerts's interview with Foerster)
- theory of autopoietic systems

**Dimension 3: Types of inquiry**
As different disciplines prefer different types of inquiry, submissions to Constructivist Foundations investigations too may focus on different ways of how to use their insights. Contributions will be classified according the following dimension.

Opinions are written from the personal perspective of constructivist researchers and philosophers (and are therefore subject to editorial editing only).

Surveys provide an extensive overview with the goal to bracket single insights and results to provide a global picture.

Conceptual papers develop philosophical-argumentative support.

Empirical studies focus on psychological, biological, physical etc. evidence.

Synthetic studies try to turn conceptual or empirical insights of constructivist theories into models, simulation, or hardware devices.

## The articles in this edition

The present first edition provides a sample of the sort of articles that will be published in upcoming editions of Constructivist Foundations. It starts with a recollection of Ernst von Glasersfeld who summarizes the (personal) history of the radical constructivist paradigm. Newcomers to constructivism may find the text particularly appealing. Glasersfeld writes in a rather lucid and comprehensible way (being multilingual he has developed a profound command of pragmatic language use) and his personal account makes it easy to get a grip on his concepts even if one is meeting them for the first time.

The second opinion article is a voice from the past, an interview with Heinz von Foerster that he gave ten years ago at the large and stimulating conference "Einstein meets Magritte: An interdisciplinary reflection on science, human action and society," which fea-

tured nineteen famous plenary speakers such as Ilya Prigogine, Brian Arthur, Francisco Varela, Chrisopher Langton, Julian Jaynes, William Calvin, Bas van Fraassen, to name but a few. The interview has never been published before and is also available as audio file for download from the journal's web page. Like Glasersfeld's article it serves as a historical document for readers who want to get the whole picture. Therefore, endnotes were added that explain the relevance of people mentioned by Foerster. He survived this interview by seven years and died on 2 October 2002 in California (cf. memorial volume in Riegler 2005).

The third contribution is the first part of an extensive overview of the enactive cognitive science (ECS) approach, mainly pioneered by Francisco Varela (1946–2001). Kevin McGee is brilliant at pulling many aspects together into a coherent survey of the historical and conceptual background of ECS. By outlining research themes he proves that ECS is a fruitful research framework for the future. The second part of McGee's survey will appear in the next edition of Constructivist Foundations.

Another type of paper published in the journal are conceptual-philosophical articles that provide the foundation for further theoretical reflections and practical empirical or synthetic work. Herbert Müller's conceptual framework of "epistemic structuring of experience" is introduced and discussed in the fourth paper. It opposes traditional metaphysical ontology and focuses on the inversion of thinking by thoroughly applying constructivism at all levels. As a result the author claims that many "hard" problems in philosophy such as the mind–body problem may find easy solutions. The article not only introduces a new constructivist variation, it has also been shaped in a novel way. Originally written as a target article for the world-wide-web-based discussion forum "Karl Jaspers Forum" at http://www.kjf.ca, it received such a large number of comments (which in turn spurred many responses by the author) that the author wrote a revised version that includes the criticism and support from the comments. In other words, the paper has undergone "public reviewing" which served as a sufficient criterion for publication in Constructivist Foundations. Also in future, the editors of the journal intend to exploit this mode as an alternative to the standard double-blind peer reviewing used for other papers in the journal.

The last paper in this edition is an empirical study of constructivist education that has become a well-known education paradigm in the US. Its author Dewey Dykstra dismisses a number of allegations against constructivist education and presents a new constructivist alternative to the "elitist-realist paradigm."

The selection of papers for this edition reflects the flexibility of constructivist strategies. It is evident that a broad variety of topics and types of paper is difficult to find in most other journals. Variety and diversity, however, do not mean shallowness as the reviewed papers show; they are distinct in their deep discussion. It is the conviction of the editors that carefully crafted conceptual, empirical and synthetic articles as well as comprehensive surveys yielding a global perspective and personal opinions of senior scientists will contribute to turning constructivist approaches into a valuable ingredient of the scientific endeavor as they provide new perspective, insights, and inspiration in areas where conventional epistemologies have proven increasingly insufficient research strategies.

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Alexander Riegler obtained a Ph.D. in artificial intelligence and cognitive science in 1995 from the Vienna University of Technology with a dissertation on constructivist artificial life. His research interests include cognitive science, philosophy of science, and research in biological and cognitive complexity. He worked at the department of Theoretical Biology (University of Vienna), and at the department of Computer Science (University of Zurich). Since 1998 he has been a research fellow at the Center Leo Apostel for Interdisciplinary Research (Free University of Brussels). He co-organized the interdisciplinary conferences "New Trends in Cognitive Science", in 1997 on knowledge representation and in 2001 on virtual reality.

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