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Heidegger in the Hands-on Science and Technology Center: Philosophical Reflections on Learning in Informal Settings

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Introduction and Purpose

Unusual for the philosophy of education, this paper takes Martin Heidegger's essay of 1954 *The Question Concerning Technology* as its starting point and applies it to a practical problem which is: *Can interactive science and technology centers reveal the essence of technology to the lay visitor.* At the outset this sounds like an unusually over-specific application of Heidegger's ideas to a single special case. But the notion that the interactive science and technology center (ISTC) does provide a valid and instructive vehicle for the discussion of Heidegger's ideas, particularly in their application to education, will be maintained throughout this article. There is also a sense in which Heidegger's essay has more relevance now in the present ecologically aware age than it did when it was written in the 1950s.

In order to set this paper into context, a slight departure has been made from the path of philosophical analysis in order to identify what is meant by an ISTC and by the exhibits found therein. It is worth saying that considerable investment has been made around the world in these centers in both developed and developing nations and yet no detailed philosophical analysis has been made into their claims until relatively recently (Walton, 1998). The significance is that ISTCs bridge the many, often conflicting, domains which have been characterized as *edutainment* (Friedman, 1996, p. 16) and which make up the sector of activity where formal, informal, and non-formal education is found within the context of the leisure industry. So, despite its somewhat unusual theoretical perspective and apparently esoteric subject matter, this is essentially a paper dealing with the application of philosophical analysis to a practical situation. It also seems relevant as the breadth of the technology education community becomes broader. The recently released standards for the development of curriculum in the U. S. (International Technology Education Association, 2000) is an example of the expansion of the responsibility for technology education beyond the traditional walls.

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Interactive Science and Technology Centers

Recent years have shown a rise in the number of interactive science and technology centers (ISTCs) around the world. Persson (1996) said, "there are now several hundred centers in the US, 33 in the UK, 31 in Scandinavia, 12 in Spain, 10 in the Netherlands and six in France" (Persson, 1996, p. 55). These hands-on centers are distinguished from traditional museums in that they are concerned with "the transmission of scientific ideas and concepts rather than the contemplation of scientific objects" (McManus, 1992, following Friedman, 1989). Rennie and McClafferty (1996, p. 57) maintain that the generic term "*science center"* is often used to describe such centers in a way that does not differentiate between those centers that focus on science and those that focus on technology. Indeed, this view that "technology" is often subsumed by "science" bears witness to a more widely held view of technology as applied science (Gardner, 1994). Rennie and McClafferty adopted the pragmatic position that it is impractical to distinguish between science and technology "because typically, centres contain exhibits which concern both science and technology and the research carried out within them usually fails to consider such differences." According to McManus (1992), the environment of the ISTC is markedly different from that of other museums in that they contain "a decontextualized scattering of interactive exhibits." As is generally the case with museums and galleries, ISTCs attract a diverse range of visitors: teachers and children on organized school visits; families; children and adults singly or in groups. The ISTC is a place where visitors may indeed come with the express purpose of learning science and technology but it is also likely that a visitor may visit an ISTC simply as a leisure activity in which learning takes place as an incidental or unintended outcome (Lucas, 1983).

As informal environments in which science and technology can be learned, ISTCs present problems for the philosopher of education. The first of these problem relates to the description of what is going on in such centers with regard to learning. A brief examination of the literature reveals an alarming degree of muddled thinking. The terms *formal learning* and *informal learning* have been used to characterize the conditions in which learning takes place. Informal learning is characterized by factors such as its voluntary nature, its lack of structure, and its open-endedness while formal learning is characterized by its compulsory nature, its structure, and the preference for intended learning outcomes (Lucas, 1983; Wellington, 1990; Griffin, 1994). Such a characterization is, however, misleading in that it suggests that the mental processes involved in learning are in some way different in ISTCs than they would be in other museums or centers.

In the absence of physiological evidence to the contrary, all that can be said is that the learning which takes place in ISTCs is the same as learning which takes place anywhere else. What is different, of course, is the *situation* or *conditions* under which such learning occurs. The ISTC is an environment for learning that is different from the classroom in that the visitor is presented with a range of objects with which he or she must interact. Frank Oppenheimer founded one of the first such centers, the Exploratorium in San Francisco. He

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had the vision of a museum of science and technology in which exhibits would be organized around areas based upon the five senses and also "on propriosensitive controls which form the basis of balance, locomotion and manipulation" (Oppenheimer, 1968, p. 218). He continued:

> … although it seems essential that the museum be structured according to some underlying plan such as the one suggested above, it is also important that the people who use the museum not be forced to follow some preconceived pattern. In the proposed organization some people might be interested in following the domain of perception from one area to another. Some might remain rooted in just one area such as in the physics of sound or in food technology, whereas others may want to wander around the halls at random. (Oppenheimer, 1968, p. 218)

This approach reveals a tacit epistemology for such centers that knowledge can be acquired by the visitor by direct experience with scientific phenomena and technological artifacts. The ISTC aims to place the visitor in a position in which it is possible to discover, through sensory acts, new knowledge and understanding of the world. The acquisition of knowledge may be mediated by guides or explanations, but this is not always the case. Similarly, labeling may be used as an *advance organizer*, placing the activity into a conceptual framework. The situation for learning which is found in the ISTC has been distinguished from other such situations (Walton, 1998) in the following terms :

- the learner sets explicit personal goals for learning—*the learner decides what he or she would like to visit and investigate;*
- the learner participates strongly in the learning process—*learning usually takes place as a result of the visitor making a direct physical interaction with the exhibit;*
- unintended outcomes may result—*the learning which actually takes place may provoke surprise or may be unexpected from the learner's point of view.*

By comparison with the ISTC, the technology classroom is more likely to be a place where the goals for learning are defined by the teacher rather than the learner; where participation is often directed by interaction with the teacher and where fewer unintended outcomes are likely to result. However, one must not lose sight of the fact that the distinguishing feature of the technology classroom —which, from a British perspective at least, is viewed as *design* and technology —lies in the way it becomes a place where the hands-on experience of the student is principally directed towards the design and manufacture of an artifact. Thus, the experience is directed towards an act of *creation* rather than of explanation.

The artifice of the ISTC lies in organizing exhibits in such a way as to promote a feeling of individual discovery in the mind of the learner—the so called *Aha!* experience. This experience was interpreted by Vygotsky as the point where "the development curve may rise sharply and begin to run ahead of the instructional process" (Vygotsky, 1987, p. 207). This sudden transition is seen by Vygotsky as a point at which development and instruction coincide to

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transform any subsequent learning. By contrast, Csikszentmihalyi has identified situations in which the solving of presented problems in unlikely or artificial situations can provoke feelings of frustration and listlessness. He stated:

> I had this experience even in the Exploratorium in San Francisco, certainly one of the best museums of this sort. Most of the problems were already structured, presented, and all I had to do was follow the lead given by the card on the display, and most of it was not much fun. (Csikszentmihalyi, 1987, p. 85)

The second problem which ISTCs pose for the philosopher of education resides in the subject matter of the ISTC. These centers aim to inform the public about the ideas of science and technology. They are, as has already been stated, concept-led rather than object-led museums where the visitor's interaction with physical artifacts is central to their function. The role of the technological artifacts present within an ISTC is to act as a stimulus to thought. The visitor, after hands-on interaction with the exhibits, is expected to think differently about the world than before. This poses the question: Does the object have any significance in its own right or is its significance merely instrumental in that it becomes the means by which the visitor acquires new knowledge or understanding? This places the objects within an ISTC into a different category when compared with objects found in other museums. Artifacts such as scythes, steam engines, and horse-drawn ploughs found in a museum of agriculture form a record of that technology and also bear testimony to the cultural and historical forces which were at play at a particular time and in a particular place. These artifacts have been given a pedagogical function in bearing witness to a particular aspect of socio-technological culture. They are objects which once were used to change the world but which now bear silent witness to the changes which men and women have wrought. By contrast with such techno-cultural artifacts, many exhibits found in ISTCs are designed with the sole purpose of demonstrating or explaining scientific or technological principles. They are not used to change the world but to change the visitor's view of the world. They exist only within the culture and context of the ISTC.

Heidegger and Technology

In his lecture of 1953, *The Question Concerning Technology*, Heidegger addressed what has become a central concern in the twentieth century: What is humankind's relationship to technology? Heidegger's approach was to attempt to reveal the essence of technology. In doing so he maintained that, "technology is not equivalent to the essence of technology" (Heidegger, 1954:1978, p. 311). Indeed, Heidegger maintained that the essence of technology is bound up with revealing the totality of being; in the "laying bare" of phenomena. According to Frede, Heidegger proceeds on two levels;

> He distinguishes between (a) the "ontic" level of the factual (for human existence Heidegger introduces the special term "existenti*ell*") that is open to observation, the level of field studies for the phenomenologist, and (b) the

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> "ontological" level, the phenomenological description of the deep structures that underlie and explain the ontic (for the structure of human existence Heidegger introduced the term "existenti*ale*"). (Frede, 1993, p. 55)

This means that, in Heidegger's terms, "technology" is more than the artifacts and activities that form the ontic. It can be spoken of in terms of the *mode of truth* that is the framework of possibilities which forms the essential nature of technology which is to be revealed and which gives technology its ontological sense. Superficially, this ontology of technology seems to bear some similarity with the platonic notion of the *ideal form* yet, as Guignon (1993, p. 4) pointed out, a significant distinction can be drawn between Heidegger's "substance ontology" and the traditional notion of the "metaphysics of presence." According to Guignon, Heidegger's approach challenges the idea that "reality must be thought of in terms of the idea of substance at all" (1993, p. 4). In this way it is possible for Heidegger (1993, p. 327) to claim that the essence of technology existed prior to the industrial and scientific revolutions of the seventeenth and eighteenth centuries.

This notion of the "ontological priority of technology" has gained the support of philosophers of technology such as Ihde (1979) who see in this position a counterbalance to the popular view that technology is merely applied science (Gardner, 1994). The Heideggerian view sees technology therefore as a means of understanding being. Heidegger coined the term "clearing" to represent the enlightenment through which the individual gains a transcendental understanding of being. He chose to use the word "clearing" rather than "truth" because he saw, in revealing the essence of technology, the potential for danger: the danger that we may mistake the standing-reserve of technology for the essence of technology. In other words, we may mistake the artifact for the purpose for which it was conceived. This point was illustrated by Latour as he discussed how a technological project moves from idea to artifact:

> By definition, a technological project is a fiction, since at the outset it does not exist, and there is no way it can exist yet because it is in the project phase. (Latour, 1996, p. 23)

It is important, therefore, in seeking the essence of technology, not to conceal but to reveal what is real. Heidegger's position can be summarized thus:

- His aim was to reveal the true nature of technology.
- The success of technology lies in the structures and artifacts it produces.
- The danger that lies at the heart of technology is that the visible structures and artifacts of technology act as surface details that obscure its true nature and so prevent its revelation.
- As human beings we are limited in the access we have to this revelation. We cannot see beyond our understanding of surface detail. In fact our very actions as technological beings create more obfuscatory detail.
- As human beings with the power of thought we are able to reflect upon this limitation to our understanding. Through this awareness we are linked ultimately with the true nature of technology.

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Heidegger and the ISTC

At the outset, therefore, Heidegger presented a picture of technology as instrumental, as a means to an end (1993, p. 313). But, in saying this, Heidegger took pains to point out that that this does not reveal the true nature of technology, it does not reveal its essence. This raises the question, to what end are interactive exhibits built? Alongside a range of possible ends such as to entertain the visitor, to stimulate and amuse, to generate income, etc., lies the central reason which is to reveal something of the nature of scientific and technological ideas. Interactive exhibits have a reflexive quality in that they exist to exemplify and elucidate generalized principles. They exist to reveal something of the nature of science and technology. If this is indeed the case then it would seem that ISTCs act as a special case of technological artifacts which are not used to change the world but rather are used to change our perception of how the world works.

In building an exhibit to exemplify a scientific or technological principle, the exhibit designer is making real an intellectual construct or abstract idea. This act of *reification* would suggest that, contrary to the usual existentialist interpretation, *essence precedes existence*. But to say so directly would be mistaken since it would regard the exhibit as coming into being without an agent. Heidegger's notion of the ontic-ontological priority of *Dasein* (Heidegger, 1927, 1978, p. 57) implies that human beings exist as agents within a world of technological potentiality. Viewed in this way, the builder takes the "standing reserve" of wood and metal, ordering it to create an object that demonstrates some aspect of science and technology. In Heidegger's terms it is the designer who is able to challenge nature to reveal something of the essence of technology. There is a distinction between an interactive exhibit and some other technological artifact such as a lathe or a transistor radio. The interactive exhibit is designed and built with the end of encouraging reflection by the visitor upon the essence of technology while other artifacts are designed for ends extrinsic to themselves: the lathe to enable other artifacts to be made and the radio as a means of communication.

In this way the interactive science and technology center can be viewed as a useful example of the Heideggerian scheme in action. The exhibits found within such centers represent a special case or category of technological artifact which is designed and built with the specific aim of encouraging reflection upon its own essence. Of course, in most cases this is only true to a limited extent. An exhibit which demonstrates chaotic motion reveals only a limited set of ideas relating to the nature of the world and in so doing it shows only one way in which technology can be used to frame this idea. But it does show that the idea can be framed. Heidegger uses the term *gestell* to describe this act of framing, or what he called "enframing."

> Enframing means the way of revealing that holds sway in the essence of modern technology and that is itself nothing technological. On the other hand, all those things that are so familiar to us and are standard parts of assembly, such as rods, pistons, and chassis belong to the technological. The assembly itself, however, together with the aforementioned stock parts, fall within the

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> sphere of technological activity. Such activity always merely responds to the challenge of enframing, but it never comprises enframing itself or brings it about. (Heidegger, 1978b, p. 325)

But, is it possible for the ISTC to seek to be a means for probing more deeply into the essence of technology or of addressing the fundamental issues which relate to mankind's responsibility for technology and its impact upon the World?

Heidegger, Aesthetics and Ecology

The development of interactive exhibitions has tended to proceed along the lines of individual exhibits which are sometimes grouped thematically but which individually isolate a particular scientific or technological idea or concept and exemplify it for the visitor. This approach is primarily reductionist in that it treats the physical world as a system that can be dissected and whose nature can be apprehended by considering its constituent parts. There are, however, interactive exhibitions that have been designed to promote a holistic view of the world and to encourage a critical reflection on the part of the visitor about mankind's relationship with the world. Two such examples are the *Labyrint* exhibition developed in the Slovak Republic, and the *Earth Gallery* at the *Earthcentre* in the United Kingdom. *Labyrint* is comprised of a series of interactive installations, many of which are made up from the detritus of technology—rusty metal, broken equipment, etc.—in juxtaposition with living organisms. The visitor interacts with the exhibits through movement, sound, and light. The exhibition was set up with an expressed aim, as stated in the guide:

> The exhibition is intended as a dialogue between the rational and the emotional. Natural Phenomena and technical discoveries are presented by means of very impressive sculptures as working three-dimensional exhibits produced mainly from waste metal. The visitor can play and make [their] own experiments. …The exhibits touch basic universal concepts such as chaos, order and prediction; dynamic balance and equilibrium; microscopic and macroscopic world; mutual relations and values. (Teplanova, 1996)

In a similar vein the *Earth Gallery* evokes the spirit of the Earth and its natural environment through moving abstract forms. Glass monoliths suggest the changing seasons with rusted metal bringing to mind change and decay. Both exhibitions depart from the mainstream of interactive collections in that they use art installations to encourage the visitor to reflect upon the nature of the natural world and of mankind's interaction with it. The use of art in the interactive setting is significant from the perspective of Heidegger's work. Heidegger looks back to the *Nicomachean Ethics* of Aristotle (Book 6) in identifying the common features of art and technology in which both are seen as revealing truth.

> There was a time when it was not technology alone that bore the name *techne.* Once the revealing that brings forth truth into the splendor of radiant appearance was also called *techne.* …There was a time when the bringing-

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> forth of the true into the beautiful was called *techne*. The *poiesis* of the fine arts was also called *techne*. (Heidegger, 1978b, p. 339)

So, it is not inappropriate—indeed it is probably desirable—that ISTCs should incorporate artistic work into their exhibitions. The use of art objects within a science museum was advocated by Oppenheimer (1990) who saw a complementary approach across the disciplines in the work of artists and scientists. It should be noted that this contrasts strongly with the view put forward in C.P. Snow's *Two Cultures and the Scientific Revolution* that scientists and artists view each other across a cultural divide—a commonplace notion in academic thinking in the United Kingdom. Hein, in describing the artist-in-residence program at the San Francisco Exploratorium, makes the point that distinctions between works of art and of science are not always so sharply drawn.

> The Exploratorium has established a reputation as a science museum. Although that commits it to displaying the findings of science and the techniques and instruments that make them possible, it does not prohibit exposure of uncertainty and doubt. It also does not preclude showing the complementary perceptual discoveries and the intellectual and imaginative creations that artists, using different tools and methods, continue to reveal. (Hein, 1990, p. 170)

In saying this Hein is demonstrating a practical approach which parallels the view, present in Heidegger's work, in which both art and technology are seen as means of bringing forth truth. This interpretation of Heidegger's work has great significance for museums of science and technology for it means that art can be used to make a valid commentary upon the nature of technology. Indeed it is through the art installation form of interactive exhibit that we can actually get much closer to revealing the essence of technology than we do with those exhibits where the technology itself serves only to hide the essence which it is trying to reveal.

The art installation allows us to be critical of technology, to look into the soul of technology and be aware of its potential danger. Yet, many museums only celebrate the achievements of technology, presenting a view of technology as generally progressive, wholesome, and beneficial. Heidegger's view of technology acts as a useful antidote to museums as propagandists for technology in that it warns that technology has dangers as well as benefits. A central aspect of the Heideggerian scheme is that the success of technology blinds us to its dangers because we can only see technology at its surface level as standing reserve:

> The essential unfolding of technology threatens revealing, threatens it with the possibility that all revealing will be consumed in ordering and that everything will present itself only in the unconcealment of standing-reserve. Human activity can never directly counter this danger. Human achievement alone can never banish it. But human reflection can ponder the fact that all saving power

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> must be of a higher essence than what is endangered, though at the same time kindred to it. (Hein, 1990, p. 170)

This danger has been made all too apparent in a number of well documented cases in which the commercial or political pressures which influence the stakeholders in technology–based museum exhibits or galleries can cause the subject matter to be presented in an uncritical way. The *Enola Gay* exhibition held in 1994 at the United States National Air and Space Museum in Washington created considerable controversy (Molella & Stephens, 1996, p. 96). The controversy stemmed from the fact that its subject matter, the airplane that dropped the atomic bomb on Hiroshima, was presented in such a way that it offensive to veterans groups who saw the exhibition as pro-Japanese. The resulting debate "only quieted down when the Smithsonian agreed to present the plane essentially without context" (Hein, 1990). In the United Kingdom a rather more muted discussion has surrounded the *Food for Thought* exhibition at the National Museum of Science and Industry in London. This exhibition, sponsored by the food retailer Sainsbury's, emphasized "the technical rather than the economic, the social, or even the political aspects in the display of food production" (Macdonald & Silverstone, 1992, p. 79). The London Science Museum has avoided becoming involved in the significant debates about food safety current in the United Kingdom by presenting the technology of food production in a partly decontextualized and uncontroversial manner.

Both these cases serve to underline Heidegger's central thesis which is that technology carries with it both danger and salvation. If we remain fixated by technology alone, then we can never progress to understand the essence of technology—it remains forever concealed. Heidegger viewed danger and salvation as being two sides of the same coin. As we progress towards an understanding of the essence of technology, we progress towards an understanding of the means of our own salvation from the danger of technology. It is through artistic revelation in *poiesis* that we can begin to understand how we can be saved from it. Heidegger's essay closes with the words:

> The closer we come to the danger, the more brightly do the ways into the saving power begin to shine and the more questioning we become. For questioning is the piety of thought. (Heidegger, 1978b, p. 341)

This statement is significant because it places the *manner* of our enquiry to the forefront. Questioning is not merely permissible, it is an essential requirement in seeking the truth. Heidegger's view inevitably carries a moral force because he invests the process of questioning with the religious virtue of piety. The view that the manner of enquiry has an ethical basis has been put forward by Degenhardt (1998), who stressed the importance of questioning for teachers:

> But teachers need to be more scrupulous in helping learners see that the encounter with diversity of beliefs is a starting point in the quest for truth, not a reason to abandon it. (Degenhardt, 1998, p. 342)

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Similarly, it is this stress upon questioning which saves Heidegger from the accusation that he is merely propounding a sterile form of essentialism. As with Degenhardt, it is the *manner* of revealing which is important. If truth is to be approached then it needs to be done in a spirit of critical reflection.

Heidegger and Education

Despite being one of the most influential—and controversial—philosophers of the twentieth century, Heidegger is a figure whose work rarely, if ever, is seen to have any bearing upon the philosophy of education. This neglect aside, his writing upon the philosophy of technology does have a significance for those engaged in education. The interactive science and technology center (ISTC) provides a case study in which Heidegger's ideas can be applied. This is an unusual opportunity for philosophical analysis.

Heidegger's attempt to show how the essence of technology is to be approached raises important issues for us all with regard to our understanding of the natural world through science and its transformation through technology. His is one of the first voices to be raised in the twentieth century, not against technology *per se* but against our blindness in appreciating the danger that our love for technology can bring. He is not an intellectual Luddite but rather he is one who sees in the danger of technology the possibility of salvation.

In the specific context of the ISTC, Heidegger's ideas act as an antidote to those who are intent upon presenting an uncritical celebration of the achievements of technology. Of course, this does not mean that we should demonize technology—whether presented in museums, in the classroom, or in the workshop—but rather it means that we must, in Degenhardt's words; engage in "deepening critical reflections" (1998, p. 342). The exhibits found in ISTCs provoke interest in that they represent technological artifacts whose major function is to promote reflection. In these objects we see the processes of challenging, ordering, and revealing reified. Paradoxically these exhibits become the means by which the *visitor* is transformed, the means by which the unfolding of technology is revealed. Poetic or artistic interpretations of technology are significant in that, by cutting through the familiar surface detail which technological artifacts present, these interpretations can help us to approach the essence of technology and, in so doing, make us more aware of our own responsibility in shaping the world. Too few examples of this kind exist. Exhibit designers are as in love with technology as any one else and are just as apt to place the mechanics of an exhibit between the visitor and the essence of technology.

In conclusion, the difficulties associated with Heidegger's writing should not blind us to the fact that he has much to say which is of value particularly as we move into a global society whose culture is increasingly defined by its technology. It is perhaps more relevant now, at the beginning of the 21st century, to take stock of what he had to say at the midpoint of the 20th century.

There are tasks ahead: the first is to make Heidegger's ideas rather more intelligible to the lay mind or at least, by bringing them into the philosophy of education canon, to make them more intelligible to the minds of teachers. This is

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primarily a task for those in engaged in the pre-service and in-service education of teachers. If the philosophy of education is taught at all, then it needs to be seen as shaping the practice of teachers. Heidegger's ideas call us to reflect critically upon the role and purpose of technology in our lives, it should also be seen as a reason for reassessing the way in which science and technology is presented in schools.

The second task is more immediate in that it relates to the increased emphasis being placed upon science and technology in school curricula around the world. It goes without saying that science and technology will continue to have an undoubted instrumental impact on the success of our modern lives. In the United Kingdom the advent of the National Curriculum has meant that attention is now being paid towards encouraging pupils to reflect upon the nature of *science* and yet no clear strategies exist in schools for encouraging reflection upon the nature of *technology*. Technology has an advantage over science in so far as the school curriculum is concerned in that it shares its roots with the creative activity of the artist: *techne* and *poesis*, according to Heidegger, share a common inheritance. Is it possible that through *poiesis*—our artistic and poetic understanding—something of the essence of technology may be revealed?

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