31st May 2006 | Draft

Enactivating a Cognitive Fusion Reactor

Imaginal Transformation of Energy Resourcing (ITER-8)

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Document has four separate annexes; conclusion and references are in this document
[See also website of ITER-8: Cognitive Fusion Reactor]

Summary

Virtually unprecedented research resources are about to be committed to the construction of an experimental nuclear fusion reactor by an intergovernmental coalition of countries -- with significant funding via the European Union. It constitutes a major research and technological challenge designed to benefit from national experiments over the past 30 years. It is hoped to be a key step in the resolution of the foreseeable energy challenges of the planet.

The initiative described here is complementary to this project and quite distinct, although it is designed to benefit symbiotically from the creative challenges and breakthroughs in research on controlled nuclear fusion. It is focused on the challenge of engendering psychocultural energy, notably as a response to the increasing popular apathy with regard to major social projects such as the European Union. The initiative is seen as vital to sustaining the creativity, excitement, collective purpose and fun without which unlimited supplies of conventional energy are effectively meaningless to any higher quality of life. The initiative involves the enactivation of a "cognitive

fusion reactor" through which individual and collective energy can be engendered. It is a coherent act of will, creativity and imagination designed to serve as an attractor for those who can engage in its processes or benefit therefrom. It builds on the integrative approaches developed over 30 years through the experimental online databases of the *Encyclopedia of World Problems and Human Potential* -- most recently with extensive funding from the European Union.

The following outline first clarifies the challenges of controlled nuclear fusion in contrast with those of controlled cognitive fusion. Their complementarity is then highlighted notably with respect to the toroidal dynamics considered as essential to the stability of both their respective processes -- especially to the degree that they mirror each other. The challenges of nuclear fusion are reviewed as a template of requisite variety by which the challenges of cognitive fusion can be modelled. The unconventional nature of the cognitive fusion initiative is then clarified as a higher dimensional construct -- considered as fundamental to psychosocial processes of the 21st century. The nature of the conformal, coactive "non-relationship" to other projects, institutions and people is then briefly noted.

Background

The ITER-8 initiative described here is inspired by the allocation of resources to the design and experimental development of ITER. Conceived at an international summit in 1985, it was originally named the *International Thermonuclear Experimental Reactor* (also known as the *International Thermonuclear Energy Reactor*) -- as a way of harnessing nuclear fusion as a peaceful power source. It has since taken the form of a Joint Undertaking under the Euratom Treaty (the Treaty establishing the European Atomic Energy Community) and has been given the name ITER International Fusion Energy Organisation (IIFEO). The experimental tokamak fusion reactor is to be constructed at Cadarache (France) with the ITER headquarters located in Barcelona (Spain). Participating countries include: China, India, Japan, Russia, South Korea, the USA-- and the counties of the European Union,

ITER: The ITER initiative is significant in that it represents one of the world's major research hopes for new sources of energy at a time when the probability of energy shortage is becoming increasingly evident. As a potentially safe, environmentally friendly and economically competitive energy source fusion has the potential to provide practically inexhaustible energy with greatly reduced levels of radioactive waste compared with fission. It is also significant because of the fundamental nature of the research required to render it viable. Such factors have justified the allocation of unprecedented research funds (only exceeded by the funding of the International Space Station). It is thereby hoped to ensure "business as usual" for the foreseeable future. The construction cost between 2006 and 2013 is expected to be up to $12 billion (10-billion-euro). If ITER is successful, a demonstration fusion power plant would be built in the mid-2030s, with the prospect of the first commercial fusion plant being created mid-century to assess economic feasibility.

ITER-8: In the spirit of complementarity basic to fundamental physics, the ITER-8 initiative outlined here is framed as a complementary approach to ITER. It seeks to benefit from every cognitive and design advance made in the construction and operation of ITER as the best of what humanity is capable in the sustainable generation and management of energy. These are understood for ITER-8 as cognitive patterns that may be of relevance as design metaphors in its elaboration of a cognitive fusion reactor and in the sustainable management of the psychosocial energies that would be thereby engendered.

In contrast to the needs for the kinds of energy available from nuclear fusion (or nuclear fission and other familiar energy sources), the following initiative relates to the fundamental need of society and individuals for another form of energy. This may be variously described as the "energy" associated with imagination, creativity, hope, fun and a sense of coherent, collective purpose -- even "the political will to change" (cf *Reframing Sustainable Sources of Energy for the Future: the vital role of psychosocial variants*, 2005) . This "energy" is to be contrasted with the psychosocial apathy and despair which is increasingly widespread and undermines the coherence of any other initiatives -- whether or not they benefit from the "unlimited" energy that ITER may help to provide.

What follows is the outline design of the "**cognitive fusion reactor**" named here as "ITER-8". This acronym stands for: Imaginal Transformation of Energy Resourcing -- Alternation Technology Enactivation. The figure 8 is appended as a reminder of:

- the configuration of precepts traditionally advocated to engender psychosocial energy sustainably (and in contrast with that used by ITER in defining the requisite temperature for nuclear fusion, namely 10^8 degrees centigrade)
- the counter-intuitive "twistedness" required for fusion (as exemplified in the case of nuclear fusion by the figure-of-eight shape into which plasma must be twisted -- whether physically in a stellarator or magnetically in a tokamak)

As the name implies, ITER-8 specifically engages with the challenges of:

- **Imagination**, and the need to elicit and sustain it, as is recognized by many
- **Transformation**, as the need for psychosocial and paradigmatic transformation in response to conditions recognized as increasingly problematic
- **Energy**, as the psychosocial energy that sustains the desire and will to live and innovate in response to turbulent social conditions and shortage
- **Resourcing**, in recognition of the need for sources of energy that are currently inadequately acknowledged
- **Alternation**, as the fundamental pragmatic need for switching between alternatives as appropriate rather than promoting particular alternatives as unquestionably preferable
- **Technology**, as the need for the development of a new range of disciplines, know-how and "*techne*" to ensure sustainability
- **Enactivation**, as the radical independence of its initiation from conventional institutional project logic and its supporting financial mechanisms

ITER-8 is a coherent act of will, creativity and imagination designed to serve as an attractor for those who can engage in its processes. It is expected that some of its processes will be supportive of the creativity required in the experimental development of the ITER fusion reactor at Cadarache (France).

It cannot be emphasized too strongly that ITER is considered an extremely ambitious experiment which may indeed give rise to energy at the levels hoped -- and without engendering disastrously unmanageable problems, whether envisaged or unforeseen. As an experiment it is an initiative in the face of what might prove impossible -- justified by a sense of potential. Similarly, ITER-8 is an initiative in response to what may be impossible but may indeed have enormous potential.

Experimental challenge of fusion for ITER

The technical issues presented here regarding controlled nuclear fusion may be initially omitted in preference to the subsequent discussion of controlled cognitive fusion or even of the comparison between the two forms of fusion.

Three energy sources are potentially capable of reducing the world's fossil fuel dependence: nuclear fission, nuclear fusion and solar energy:

- Nuclear fission: a neutron strikes the nucleus of a heavy element, such as uranium -- splitting to form lighter elements and releasing heat energy, and leaving problematic amounts of radioactive waste.
- Nuclear fusion: nuclei of light elements, such as hydrogen are fused to make heavier elements. Fusion releases about four times more energy for a given mass of fuel than does fission. To make fusion happen, the atoms of hydrogen must be heated to very high temperatures (100 million degrees) so they are ionized (forming plasma) and have sufficiently high energy to fuse, and then held together i.e. confined long enough for fusion occur.
- Solar: currently this is considered the least viable in terms of the amounts of energy required.

The Joint European Torus (JET) is currently the world's largest nuclear fusion research facility and has clarified many of the challenges of fusion reactors [see other experimental sites].

The acronym ITER previously referred to International Thermonuclear Experimental Reactor or International Tokamak Experimental Reactor. The ITER Legal Entity (ILE) is now officially known as the ITER International Fusion Energy Organisation (IIFEO) which holds the license for construction of ITER. IIFEO will subsequently be responsible for the safe operation of ITER. IIFEO will be established soon after the signature/ratification of the Joint Implementation Agreement between the ITER Parties, probably late in 2006. Before then, the ITER project will continue with its International Team supported by host organizations (Max Planck IPP, JAERI, and CEA at Garching, Naka, and Cadarache respectively), and with Participant Teams provided by each negotiation participant. [more]. ITER is scheduled to power up in 2016 and will be the penultimate step towards commercial fusion power -- possibly from 2050 at the earliest.

Fusion: There is a wide variety of information explaining the fusion process (cf Fusion Power Associates; Internet Plasma Physics Education Experience - IPPEX). Theoretically this is a simple physical process: the binding of the nuclei of two similar atoms, whether it occurs in stars or in a fusion reactor:

- **Stars**: The fusion reaction occurs in stars, like the Sun, and is the source of their power. In the centre of the sun, fusion takes place at a temperature of 15 million degrees and a pressure of 100,000 atmospheres. Energy is released through a chain of reactions that begins with the fusion of two protons into a deuteron (a deuterium nucleus containing one proton and one neutron). The deuteron then combines with another proton to produce a nucleus of helium-3, which, in turn, fuses with another helium-3 nucleus to form a nucleus of helium-4 (an alpha particle). This process takes hundreds of millions of years, ensuring the long-term heating permitting life on the planets. Such protonic fusion cannot therefore be used as a viable source of terrestrial fusion energy.

- **Fusion reactors**: Since stellar conditions are not reproducible on Earth, fusion reactors use lesser pressures and greater temperatures (in the region of 100 million degrees centigrade, namely 10^8 degrees) to achieve a more rapid result. In a fusion reactor energy is produced in a similar manner when light atoms in a plasma are fused together to form heavier ones. The atoms used are deuterium (one proton and one neutron) and tritium (one proton and two neutrons). Both are isotopes of hydrogen and very abundant in nature. The result of forcing them together is to split them into a neutron and a helium-4 nucleus (with two neutrons and two protons) -- otherwise known as an alpha particle -- plus another particle that does not carry much energy. Because this reaction involves only the rearrangement of protons and neutrons, rather than the transformation of a proton into a neutron, it proceeds much more rapidly than protonic fusion. The mass of the two incoming nuclei is greater than the mass of the product. This loss of mass is converted into energy (as predicted by Einstein's formula, $E=mc^2$), less than in protonic fusion. But, provided the deuterium and tritium nuclei can be made to collide with one another indefinitely at energies of between 10 and 100 keV, the reactions proceed at a useful rate for power production.

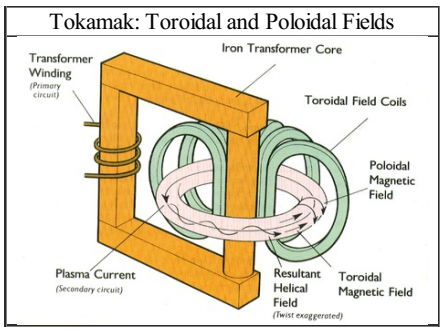
Self-heating: For power production, the challenge is to produce a 'burning plasma' where enough ions are confined at sufficient density and temperature such that the heat from the alpha particles can maintain the plasma without significant auxiliary heating power. The burning plasma is a nearly fully-ionized gas in which the fusion power captured by the plasma keeps the plasma hot. A burning plasma is dominated by this self-heating. This condition has not yet however been achieved in a laboratory for any useful period of time.

The plasma -- the ionized gas of deuterium and tritium nuclei -- will be heated by an external source to a temperature of at least 100 million degrees centigrade. At this temperature, the deuterium and tritium nuclei begin to fuse, forming helium nuclei and neutrons. These magnetically-confined helium nuclei will then collide with deuterium nuclei in the gas, transferring some of their energy to the deuterium nuclei and heating the gas further -- the burning plasma mode. The plasma becomes self-heating -- as with a star -- and a strong external energy source is no longer necessary.

The dynamics of the self-heating are a fundamentally new and key feature studied in ITER. It would be the first magnetic confinement fusion experiment to produce burning plasma. The reaction would produce ten times the amount of external power injected into it. If successful, ITER would produce 500 megawatts of fusion power for 500 seconds or longer during each "shot" of the fusion experiment,

with a repetition period of roughly 2000 seconds. In contrast, the Tokamak Fusion Test Reactor at the Princeton Plasma Physics Laboratory, one of ITER's predecessors that shut down in 1997, produced a maximum of 11 megawatts for only one-third of a second. The goal of ITER is to obtain an energy gain (Q) of 10, namely to operate in a regime where the plasma heating from alpha-particles has twice the value of auxiliary heating.

Containment: In stars, as natural fusion reactors, it is the non-material gravity field that confines the plasma in a stable and long-lived configuration permitting the reactions to take place. Under the conditions required, a human-scale fusion reactor must also use a non-material container. To make the reactor small enough, it must use a much stronger force than gravity, namely the force of a magnetic field. ITER is to be an experimental magnetic confinement device of the type called a tokamak. This has a toroidal (doughnut-shaped) configuration and a strong, confining magnetic field. The tokamak configuration has been under study by fusion plasma scientists since the 1960s [more] [more]. It has proven to have the best confinement of all the configurations so far envisioned [see alternative confinement concepts: stellarator, reversed-field pinch (RFP), field reversed configuration (FRC), spheromak, levitated dipole]. In the tokamak, poloidal magnetic fields (in the direction of the doughnut's cross-section) are created primarily by a toroidal current inside the plasma itself. This combination of toroidal and poloidal magnetic fields generates an overall nested helical structure which is necessary to keep the plasma stable [image].



Research challenges: Progress to practical fusion energy is currently determined by the evolution of scientific understanding of hot plasmas and by advances in certain critical technologies. Plasmas are gases in which ions and electrons are not attached as atoms or molecules, but rather move freely. Knowledge of toroidal plasma confinement is still far from being complete. The key scientific questions in fusion research concern the remaining uncertainties in the development of fusion as a source of energy. These relate to the understanding, control, and predictability of burning plasma. They include:

- What limits the pressure of high-temperature plasmas?
- What causes the deterioration in confinement that is observed near the density limit in tokamaks -- which could drastically limit the power of a tokamak fusion reactor?
- How do very energetic particles heat and sustain plasmas?
- What are the precise causes of the loss of plasma thermal energy - especially that of electrons?
- How does heat escape from plasmas?
- What is the danger of those instabilities that theory predicts to be triggered by alpha-particles.

These questions are critical because plasma pressure compared to magnetic field pressure (termed *beta*) is what ensures the energy released for fusion power, and so it must be maximized. The energetic particles created by the fusion process must sustain the temperature of a fusion plasma, so the heating process must be understood and controlled. If heat escapes too quickly from a fusion plasma it will cool to too low a temperature, so the understanding of turbulence and heat transport is a critical element of fusion energy science.

The plasma must also be maintained long enough for the reactions to occur. The achievement of sufficiently good confinement of the plasma to permit useful release of energy has turned out to be far more difficult than the first fusion researchers hoped. Many important optimizations have been discovered and developed. One unavoidable way to obtain sufficient confinement is to make the plasma large. The existing large tokamak experiments typically have plasma radii of three meters. Fueled with the most reactive isotopes of hydrogen, those tokamaks demonstrated substantial release of fusion energy. For example, the world's largest tokamak, JET (Joint European Torus), obtained up to 16 megawatts of fusion reactions for just under a second. But, to sustain the plasma in these devices required additional heating that was larger. ITER will develop the technologies required for larger installations, such as large superconducting magnets, diagnostic systems, plasma control tools, and high heat flux materials.

These questions are not only scientific challenges to comprehension -- a "cognitive challenge" for humanity. Their solutions must be integrated successfully in a fusion plasma system. Thus there is an important integrative and innovative element of fusion research. The sustainable, self-consistent solution to these questions lies in a plasma whose heat content is largely sustained by its own fusion reactions, i.e., a 'burning plasma'. The most important technological issues for fusion are then:

- development of techniques to handle high heat fluxes from plasmas
- development of structural materials to withstand high fusion neutron fluxes while incurring low radioactivity
- development of large-scale superconducting magnets to produce the fields needed to contain plasmas

These development needs stem from the high heat and neutron fluxes that emerge from fusion plasmas, and from the need to sustain the magnetic container with a minimum of power, as is made possible by superconducting magnets. [more]

The reactor design in the case of ITER is based on tokamak as confirmed by much research [more | more]. The plasma is heated in a

ring-shaped vessel (or torus) and kept away from the vessel walls by applied magnetic fields. The basic components of the tokamak's magnetic confinement system (see diagram above) are:

- toroidal field: the field produced around the torus. This is maintained by magnetic field coils surrounding the vacuum vessel. The toroidal field provide the primary mechanism of confinement of the plasma particles.
- poloidal field; the field produced around the plasma cross section. It pinches the plasma away from the walls and maintains the plasma's shape and stability. The poloidal field is induced both internally, by the current driven in the plasma (one of the plasma heating mechanisms), and externally, by coils that are positioned around the perimeter of the vessel.

Reservations: A range of reservations and criticisms have been formulated (cf E. Mazzucato, *Why build ITER?* 2003; David Montgomery, *Possible Gaps in ITER's Foundations*, *Physics Today*, February 2006; Raymond Sené, *Iter, techniquement c'est que du bluff! Gazette Nucléaire* 211/212, janvier 2004; Mark Peplow, *Fusion power gets slammed*, March 2006; Warren D. Smith, *Why "The Dream of Unlimited Cheap Fusion Power" is a Load of Horseshit*, Oct 2000):

- the economic viability of fusion energy could be seriously impaired due to:
  - rapid deterioration in plasma confinement at relatively high plasma densities, far beyond what was, and remains, the density limit of tokamaks;
  - raising to acceptable levels the assumed value of the safety factor against the onset of macroscopic instabilities. At the safety factor envisaged, the plasma macroscopic stability (at the plasma pressure needed for producing the desired fusion power) has been called into question. Such instabilities would caused the abrupt termination of the discharge with disastrous consequences for the vacuum vessel and other machine components.
- the current design of ITER (ITER-FEAT) is associated with large costs (~$5 billion for construction and at least the same amount for operation) and an extremely long time schedule (10 years for construction and 20 years for research and decommissioning).
- the construction of ITER will absorb a great fraction of available resources -- both human and financial -- slowing down the investigation of tokamak physics and the development of alternative concepts.
- it could be at least 50 years before a commercially viable reactor is built, if at all.
- one estimate gives a 50:50 chance of success, notably because of the difficulties of the engineering
- the lack of a manageable mathematical framework for calculating the state of the plasma in a confinement device in a way that relates the calculation globally and convincingly to what actually happens in the machine. This becomes apparent when theoretical claims are set alongside the experiments being contemplated. Description sliding freely back and forth between ideal and non-ideal descriptions, are not supportable in fluid mechanics, nor is there reason to expect it to be in plasma physics
- the risk of experimentation based on an essentially secondary role for theory, is not necessarily problematic, but is greater if discussion of the conceptual gap between theory and device building is essentially not taking place
- the unproven claim that an energy gain (Q) of 10 can be reached; ITER is based on a very optimistic extrapolation of existing data, where a small deterioration in plasma confinement would be sufficient to degrade substantially the achieved energy gain.
- the claim that another objective of ITER, namely the development of the engineering of fusion reactors, is totally unjustified since ITER will have little or nothing to contribute to the two major technological problems of a fusion reactor -- the development of materials that can withstand 14 MeV neutrons and the breeding of tritium.
- incomplete knowledge of what to expect in the thermonuclear regime, makes ITER a risky project that could cause irreparable harm to the credibility of nuclear fusion.
- the fusion reactor will in fact constitute a significant radioactive risk possibly equivalent to current fission reactors [more]:
  - the use of tritium, a radioactive isotope of hydrogen with a half-life of 12.26 years, will need to be manufactured and stored in large quantities. 15-20 kg will be necessary for 2-3000 hours of operation (20 kg of tritium represent radioactivity of 200 millions curies). Tritium, like hydrogen, will pass readily through the metals of the installation and constitutes a danger to health, contrary to what is occasionally claimed [more]
  - netrons will have to traverse the combustion chamber if energy is to be recovered. This flux will render the materials radioactive with significant half-lives as with fission reactors. Since elements of the installation will need to be replaced, notably those on the inner surface, these will constitute a significant amount of highly radioactive waste requiring disposal.
- tritium is used to boost nuclear weapons and concerned have been expressed that the expected annual shipments of tritium to the ITER reactor will pose certain nuclear proliferation risks, notably of theft or hijack [more | more]
- dependence on a difficult-to-manage group of bureaucratic institutions from a range of countries and cultures (powerfully caricatured by Leonid E. Zakharov, *Thermodynamics, Science and Religion in Fusion*, 2006)
- concerns expressed regarding the advantages of alternative confinement/containment designs [see alternative confinement concepts: stellarator, reversed-field pinch (RFP), field reversed configuration (FRC), spheromak, levitated dipole]

As argued by Jo Lister and Henri Weisen (*What will we learn from ITER? Europhysics News* March/April 2005):

> ITER is nonetheless a noble cause, even though its main motivation stems from our increasingly urgent quest for sustainable energy. The nobility resides equally in the physical understanding to be acquired of the complexity of plasmas and in the technical challenges to be met. The requirements for controlled nuclear fusion are potent drivers for advances in physics and technology. This quest has also brought a harvest of fundamental knowledge in physics, in such complex areas as turbulence, magnetohydrodynamics and even material sciences, with implications for apparently unrelated areas such as astrophysics, space physics and industrial plasmas, spawning applications ranging from plasma processing to space propulsion systems, the development of novel materials and superconductors.

Experimental challenge of "cognitive fusion" for ITER-8

What meaning can be associated with any notion of "cognitive fusion"?

Cognitive fusion in practice: It is appropriate to note a range of situations under which some form of "cognitive fusion" might be said to take place:

- **scientific laboratory**: certain types of laboratory, perhaps framed as "centres of excellence", in which large teams are engaged in research and development, may be recognized as developing an intensive "hot house" atmosphere of exciting, creative work in which insights from all present are fruitfully interwoven in a form of cognitive fusion
- **newsroom**: for a newspaper or broadcast media, the high pressure atmosphere in a newsroom under rigid deadlines may correspond to a form of cognitive fusion
- **creative design laboratory**: in contrast to a scientific laboratory, but with a corresponding form of cognitive fusion, design teams of whatever size may also develop a "hot house" atmosphere in which the "cross-fertilization" of ideas is an important factor
- **think tank**: such environments often correspond to a social (or policy) science variant of the scientific and creative design laboratories and may need to develop policy positions in urgent response to emerging political crises -- at the request of their funding institutions
- **hospital emergency room**: teams of people in response to a variety of urgent life-or-death cases in a hospital emergency care unit, or intensive care unit, may be functioning under a conditions indicative of a degree of cognitive fusion
- **military situation room**: in response to military challenges, whether in defence or attack, the patterns of communication in the command and control centres are typically indicative of some aspects of cognitive fusion
- **plenary emergency meeting**: whether in the form of a parliament, an executive board room, a summit, or a roundtable, the dynamics of the debate in response to urgency may be associated with a form of cognitive fusion
- **roundtable dialogue**: in contrast with meetings of decision-makers in emergency conditions, gatherings of a more reflective nature ("wisdom keepers", councils of the wise, interfaith dialogues, etc) may be associated with transformative moments resulting from a degree of cognitive fusion
- **aerospace situation room**: similar in many respects to a military situation room, the challenge for a team of controlling aerospace missions, especially under emergency conditions, may involve degrees of cognitive fusion
- **disaster emergency room**: as indicated by the challenge of responding to the Asian Tsunami and Hurricane Katrina, the coordination of humanitarian relief and reconstruction teams under emergency conditions with inadequate (or poorly channelled) resources may also be understood in terms of cognitive fusion
- **technical control centre**: the conditions, operations, urgencies and pressures of control centres for power distribution (notably in time of black out), air traffic control (emergencies), nuclear power station control, etc
- **communities**: intentional communities may be deliberately envisaged as contexts in which to enhance the possibility of some form of cognitive fusion, whether through their work, their rituals or their meditation. More generally, community development may seek to achieve a low key level of cognitive fusion.
- **collective meditation**: whether practiced regularly (as in intentional communities, monasteries, etc) or in occasional ritual gatherings, the associated spiritual attunement may be understood to be associated with a level of cognitive fusion. For example, the Transcendental Meditation group promotes such activity to alleviate problematic psychosocial conditions.
- **team:** under certain conditions a sporting team, a business team, or a team of volunteers may function at a surprisingly high level of integration -- as with their military analogues (SWAT teams, etc). In training such groups, the aim may be to "fuse" people into a team.
- **internet gaming**: multi-user internet games, calling for strategy and tactics, typically involve a degree of cognitive fusion analogous to that required of fighter pilots in battlefield scenarios (see below). For example: "Cyworld is threatening to swallow South Korea. Less than four years after its launch, 15 million people, or almost a third of the country's population, are members" (*BusinessWeek online*, September 2005).

A variety of initiatives have endeavoured to gather together the best and the brightest, under perfect conditions, in order to elicit creative collective responses -- possibly to the conditions of the planet. Examples include: Mensa International, Collective Wisdom Initiative, Project Mind Foundation, collective intelligence (Collective Intelligence, Community Intelligence, swarm intelligence, etc), indigenous "wisdom keepers", interfaith dialogues, etc

Contemporary research: As might be expected, the focus of contemporary research is on two totally contrasting, if not mutually contradictory, understandings of "cognitive fusion":

- **Psychopathology**: Experiential avoidance and cognitive fusion are considered to underlie most forms of psychopathology. In a review of Acceptance and Commitment Therapy (ACT) as a reframed variant of classical cognitive behaviour therapy, Michael J Dougher notes:

  > In some contexts, the bidirectional nature of verbal relations is such that verbal stimuli and their referents fuse together or become functionally inseparable. These contexts are called contexts of literality, and the effect is called cognitive fusion. .... Paradox is an important component of ACT because it is believed that it helps to break down the literality of language, loosens the cognitive fusion in verbal relations, and weakens rule governance when it is not useful. (see also Steven C. Hayes, et al *Acceptance and Commitment Therapy - An Experiential Approach to Behavior Change*, 2003).

  Within this framework, therapeutic emphasis is on achieving "cognitive defusion". Steven C. Hayes and Chad Shenk (*Operationalizing Mindfulness Without Unnecessary Attachments*, *Clinical Psychology: Science and Practice*, 11, 2004, pp. 249-254, 2004] note, in the case of "cognitive fusion", that for therapists its "excesses are what mindfulness helps rein in". They argue:

> There are scientific advantages to defining mindfulness in terms of the psychological processes involved. Doing so, however, necessarily uncouples mindfulness from any given technology, including meditation. Defining mindfulness in terms of the self-regulation of attention and a posture of acceptance seems progressive, but there are underlying philosophical attachments in the proposed definition that might limit its applicability if they are treated too rigidly.

This understanding of mindfulness is clarified elsewhere by Lindsay Fletcher and Steven C. Hayes (*Relational Frame Theory, Acceptance and Commitment Therapy, and a Functional Analytic Definition of Mindfulness*, *Journal of Rational Emotive and Cognitive Behavioral Therapy*):

> Relational Frame Theory is described to show how human suffering is created by entanglement with the cognitive networks made possible by language. Mindfulness can be understood as a collection of related processes that function to undermine the dominance of verbal networks, especially involving temporal and evaluative relations. These processes include acceptance, defusion, contact with the present moment, and the transcendent sense of self.... Thoughts are often experienced indirectly - in the form of the change in the functions of the world they produce - rather than as a process occurring in the moment. This is termed 'cognitive fusion'. It has three important side effects relevant to the topic at hand.
>
> First, temporal and evaluative relations become attached to internal events, and people begin to predict, fear, and attempt to regulate and avoid their own thoughts, feelings, and bodily sensations even when that process is harmful. This is termed 'experiential avoidance' (Hayes et al., 1996).
>
> Second, people become attached to their own self-descriptions and seek to maintain them and to be right about them.
>
> Third, the present moment disappears into a cacophony of human thinking and its reasons, explanations, and justifications for behavior. The effect of these processes is 'psychological inflexibility' which is the inability to persist or change behavior in the service of chosen values.

- **Enhanced decision-making**: As a development of preoccupation with "data fusion" and "information fusion", "cognitive fusion" is used to describe the dynamic analysis of data combined from multiple sources in order to recognize complex dynamic situation patterns, construct models or hypotheses of unfolding situations, and take action in response to situations (cf G. Jakobson, et al. *An Approach to Integrated Cognitive Fusion*, 2004). The authors are concerned with:

  > ... situations such as those encountered in the management of a battlespace, surveillance of complex technological systems, and mobilization of countermeasures in real-time emergency situations in health care and homeland security applications. These applications involve a large number of dynamic objects that change their state in time, and are engaged in complex spatio-temporal relations. From the management viewpoint it is important to understand the situations in which these objects participate, to recognize emerging trends and potential threats, and to undertake protective actions that lead to predefined goal situations. Although information fusion has been in the focus of intensive research, particularly in the defense community, our approach emphasizes two important aspects of information fusion, cognitive information processing and fusion of information in dynamic real-time situations. We define Cognitive Fusion as a process of multi-source data fusion, where a qualitatively new meaning is assigned to the fused data. We associate three basic functional qualities with Cognitive Fusion: (i) Situation Awareness (ii) Decision Awareness (iii) Knowledge Awareness

The contrasts between these two areas of research, "psychopathology" and "enhanced decision-making", usefully exemplify the challenge of global society. **On the one hand there is a high and increasing degree of "cognitive confusion", and on the other there is pressure for higher order forms of decision-making in response to complexity**. It is regrettable that the needs for the latter are perceived by researchers primarily in terms of support for battlefield situation awareness.

"Conceptual blending": In contrast to research on "cognitive fusion", seemingly unrelated research focuses on "conceptual blending" or "conceptual integration" (cf typology in Line Brandt, *Conceptual Integration*, 2002). According to this new theory of cognition, elements and vital relations from diverse scenarios are "blended" in a subconscious process, which is assumed to be ubiquitous to everyday thought and language. Insights obtained from these blends constitute the products of creative thinking. The theory was developed from 1993 by Gilles Fauconnier and Mark Turner (*Conceptual Integration and Formal Expression,* 1995; *The Way We Think: conceptual blending and the mind's hidden complexities*, 2002) with more recent contributions of Seana Coulson and Todd Oakley (cf *Conceptual Blending: Representation, Principles, Processes*, 2006) [resources | resources]. The theory is partially based on basic ideas on the role of metaphor advanced by George Lakoff (*Women Fire and Dangerous Things*, 1990) and his work with Mark Johnson (cf *Philosophy in the Flesh : the embodied mind and its challenge to western thought*, 1999). As noted by Turner:

> Conceptual blending has a fascinating dynamics and a crucial role in how we think and live. It operates largely behind the scenes. Almost invisibly to consciousness, it choreographs vast networks of conceptual meaning, yielding cognitive products, which, at the conscious level, appear simple. Blending is governed by uniform structural and dynamic principles and by optimality constraints. The theory of conceptual blending has been applied by scores of researchers, in cognitive neuroscience, cognitive science, psychology, linguistics, music theory, poetics, mathematics, divinity, semiotics, theory of art, psychotherapy, artificial intelligence, political science, discourse analysis, philosophy, anthropology, and the study of gesture and of material culture. [more]

The relations between conceptual blending, web interfaces and the future of the semantic web are now matters of active interest as summarized by Werner Kuhn (*Why Information Science needs Cognitive Semantics - and what it has to offer in return*, 2003)

Ritual magic: One of the pioneers of conceptual blending theory has pointed to its relationship to the widespread traditional practices of ritual and magic (Gilles Fauconnier: *Magical Rituals and Conceptual Blending*, 2003):

> A basic hypothesis in this book is that ritual in general and magical rituals in particular involve conceptual blending. The blending theory has so far mostly been concerned with linguistic and artistic expressions and the theoretical and methodological problems raised by this material. I propose an extension of the model to cover a very broad range of perceptual modalities united in a solidified conceptual domain of 'ritual'... At a general level, religious and magical rituals involve a blended space consisting of elements projected from input spaces themselves created by elements from two general domains, a 'sacred' and a 'profane' domain, and structured by a ritual frame.... it is crucial to recognise that the sacred domain is not a logical consistent system of representations, but rather a formation of coherent structures around pragmatic styles like narratives and rituals, preestablished conceptual clusters, and modes of behavioural interaction, like prespecified ritual actions.

The cognitive fusion sought through the practice of magic has been described as follows (*Encyclopedia of World Problems and Human Potential*):

> Magic is a set of methods for arranging awareness according to patterns; it is not a truth or a religion. Nor is it even a philosophy, in the strict sense of the word, although there are echoes of profound philosophy in most magical traditions. It is basically an artistic science in which the practitioner controls and develops imagination to cause changes in the outer world. The serious application of magical methods leads to transformation and it is the transformation which is of value and not the methods themselves. All magic derives from controlled work with the imagination. Magic does not work because its propositions are essentially real or true; it works because practitioners become imaginatively involved in these propositions. Thus for controlled periods of time under non-habitual circumstances, they behave as if they were true. It is not a question of becoming habituated to falsehood but rather of the magician growing through the patterns, whether true or not, and emerging beyond them into a clarity of awareness that was not possible before the experience of transition and transformation...
>
> A major premise of magic is that access may be obtained to many worlds or worldviews. The transformations which occur within the magician enable access to such inner worlds of consciousness in ways which transcend the limitations of purely intellectual endeavour or the inspirations of folklore. Images are deliberately evoked and cultivated as part of this process. Initially magic alters the focus or area of attention, drawing the vital; energies together with the discipline of a tradition and its restricting vessel or matrix. In a second stage the energies are redirected and gradually amplified through attuning to richer, more complex and more encompassing patterns. These integrative patterns have a resonant effect on the psyche. They may take the form of simple symbols, or may be imaginatively recreated as complex scenes, beings or other patterns. As such they may be used to focus and direct a wide spectrum of personal and group energies on many levels of awareness. In a third stage, the awareness having been attuned to various patterns normally inaccessible to everyday consciousness, begins to operate in other worlds or dimensions through the effect of the magical patterns and key symbols. Finally the practitioner is projected into the alternative worlds of experience, often with considerable energy (cf R J Stewart. *Living Magical Arts: imagination and magic for the 21st century*, 1987, *Advanced Magical Arts: visualisation, mediation and ritual in the Western magical tradition*, 1988)

Fundamental to the cognitive fusion associated with ritual magic is the centuries-old "theory of correspondences", or "system of correspondences", that is closely associated with symbolism (cf *The Magical Art of Correspondences*, 1995). In alchemy a general system of synchronistic correspondences between planets, colours, herbs, minerals, species of animals, signs and symbols, parts of the body, astrological signs, etc. was known as the Doctrine of Signatures. [more]

Fusion in the arts: The concept of "fusion" in relation to the arts is used with respect to efforts to blend together art forms, mediums, and genres. Also known as polyaesthetic art, it combines the aesthetics of more than one artform: conceptual art, visual poetry, mathematics and art, performance poetry etc. Fusion art has survived as a category for decades despite being underappreciated (and therefore underexhibited) [more].

As implied above, the fusion arts may "coopt" the sciences (as a form of art) in some way. This is illustrated by the The Bridges Conference: Mathematical Connections in Art, Music, and Science organized by the Institute of Education and the London Knowledge Lab**.** Created in 1998, and running annually since, it brings together practicing mathematicians, scientists, artists, educators, musicians, architects, writers, computer scientists, sculptors, dancers, weavers, model builders. In his introduction to an exhibition, *Fusion: Art and Science*, Peter Richards (*What if..?*, 1999) usefully clarifies some fundamental commonalities of attitude relevant to the relation between ITER and ITER-8:

> Doubt, not knowing, playful experimentation, and the excitement of finding out something, is at the heart of both doing science and making art. Throughout history, particularly from the age of enlightenment on, discoveries made by artists and scientists have provided a base for examining the relationship between nature and culture. Things these two disciplines share in common, and also share with children, are playful exploration, experimentation, and the testing of intuitions. These kinds of activities precede and are germane to all scientific and artistic creation and are crucial to the process that children use to establish themselves as individuals. Scientists move from playful, investigative actions to making statements about nature with some degree of certainty. Artists play with an idea, a material, a found object, etc., and then move forward with the intent of expressing or communicating a sense of the human experience in relation to nature. Children, using their powers of curiosity in

> finding their own place in the world, apply a process of gradually accumulating experiences, insights and understandings. All are operating, if I may be so bold, from a standpoint of not knowing and are continually asking themselves: 'What if..?' The physicist Richard P. Feynman proffered that: *'If you know that you are not sure, you have a chance to improve the situation.'*

The concept of fusion is well-recognized in music in several contexts:

- world fusion music: Matthew Montfort (*Ancient Traditions -- Future Possibilities: Rhythmic Training Through the Traditions of Africa, Bali and India*, 1985) defines world fusion music as "music that combines ideas from many of the earth's traditions." Examples include: Indian Fusion music.
- jazz fusion: Fusion has been described as the melding of jazz with rock styles, although most fusion music initially drew from the rhythmic and harmonic aspects of soul music. Other defining characteristics of fusion music include the use of funk backbeats, electric instruments, loud volumes, rock textures, and intricate ensemble compositions. [more | more]
- symphonic fusion

The above approaches have been accompanied by the emergence of:

- "fusion advertising" that endeavours to fuse strategy, design and technology into successful advertising solutions
- "media fusion" providing flash, video, web design, logos, graphic design, anination, multimedia, 3d, and photography services
- "fusion marketing", also known as co-branding, alliance marketing, and partnership models, through which the marketing of one product is tied to that of another [more]
- "fusion design" configures projects with unique solutions in corporate and brand identity, editorial design, strategic marketing and content development
- "fusion cuisine" combining ingredients such as Chinese 100-year eggs with Bavarian sauerkraut and British bangers [more]

In all such cases a key question is the nature of the "fusion" sought and achieved beyond the claims made. At its smplest level, fusion may involve no more than the juxtaposition of modes with a degree of mututal borrowings. One way of looking at the distinctions to be made is in terms of the various degrees of interdisciplinarity as explored elsewhere (*Varieties of Decision-making Arenas and Styles*, 1991; *Varieties of Dialogue Arenas and Styles*, 1990; *Typology of 12 complementary strategies*, 1998).

Synaesthesia: The term synaesthesia is normally used to indicate a condition in which the stimulation of one sensory modality gives rise to an experience in another modality. This may be understood as a form of cognitive fusion. In an auditory synaesthete, for example, an auditory experience may give rise to an experience in the visual modality. Synaesthetes often experience correspondences between the shades of color, tones of sounds, and intensities of tastes that provoke alternate sensations (see *Synaesthesia: union of the senses*; Richard E. Cytowic, *Synesthesia: phenomenology and neuropsychology -- a review of current knowledge*, 1995).

Transdisciplinarity and interdisciplinarity: The challenge of interrelating the disciplines in some meaningful way has been addressed in many studies and programmes. A number of classical papers have endeavoured to clarify the different possible relationships between disciplines (to distinguish *inter-* from *trans-*, *multi-*, *cross-*, *meta-*, etc) using diagrams. That of Erich Jantsch (*Towards interdisciplinarity and transdisciplinarity in education and innovation*, 1972) is especially helpful. He identifies different patterns of relationships between a set of boxes (representing disciplines) laid out in contrasting patterns which resemble the standard hierarchical organization charts. It is however difficult to detect any genuine cognitive fusion resulting from the variety initiatives since that time, despite claims to the contrary and a plethora of methodologies and projects claiming to be interdisciplinary, transdisciplminary or metadisciplinary -- and widespread recognition of the possibility of some breakthrough (cf *Metaphors as Transdisciplinary Vehicles of the Future*, 1991). It is also import to recognize different degrees of ambition for such cognitive fusion -- between belief in the value of "transdisciplinarity", various forms of "transdisciplinary-lite", and recognition of the cognitive complexity to be addressed (cf *Transdisplinarity-3 as the Emergence of Patterned Experience Transcending duality as the conceptual equivalent of learning to walk*, 1994) [more]

Knowledge organization and management: A key set of distinct understandings of "cognitive fusion", derived from a comprehensive range of international constituencies, has been variously considered within the context of the *Encyclopedia of World Problems and Human Potential* developed over the past 30 years. Five separate sections (online version) encompass:

- **Integrative knowledge** (unitary and transdisciplinary concepts) -- some 600 profiles. Here the emphasis is necessarily on the "objective" integrative organization of knowledge, however that is variously understood (eg general systems, unified science, integrative education, etc). These approaches necessarily emphasize conceptual methods with little attention to the variety of content calling for integration or to the experiential implications of such integration

- **Human development concepts and integrative modes of awareness** -- some 4000 profiles. Here the emphasis is on how humans develop into maturity and wisdom as variously understood by education, psychoanalysis, spiritual disciplines, and the like -- and the "subjective" nature of the integrative insights that emerge as a consequence. These approaches emphasize the experiential methods and their cognitive implications but with little attention to the variety of content calling for integration.

- **Human values and wisdom** -- some 2200 profiles. Here the emphasis is on the nature and configuration of the guiding principles offered by either of the above cognitive processes, whether emerging from religious doctrine or sensed subjectively as strange attractors -- and of how seemingly contradictory and polarized values can be configured into any coherent global ethic. They are however only implicitly related to the problematic content that emerges in the light of such values and the initiatives to which they may provide coherence.

- **Metaphors and patterns**. Here the emphasis is on cognitive devices, especially sets of such devices, that help to focus a variety

of apparently incommensurable insights

- **Transformative processes**: Here the emphasis is on processes to underpin the above, whether in the form of mathematical analyses, visualization (and sonification) techniques, management of discontinuity (cf complexity theory), configuration of incommensurable complementarities (notably strategic dilemmas), patterning procedures, dialogue processes, aesthetic resonances in integrative design

These configurations are juxtaposed with the most comprehensive databases on the networks of thousands of "world problems" as perceived by the thousands of international constituencies and the latters' "global action strategies" in response to them -- in a project most recently funded by the European Union

The work builds on a century of effort pioneered by international documentalist Paul Otlet (1868-1944), notably through the Union of International Associations (cf *Simulating a Global Brain: using networks of international organizations, world problems, strategies, and values*, 2001). Otlet was one of the originators of the Universal Decimal Classification system. Author of *Monde* (*Essaie d'Universalisme: Connaissance du monde; Sentiment du monde, Action organisée et Plan du Monde*, 1935), he is now recognized as an early visionary of what has become the world wide web (cf *Union of International Associations -- Virtual Organization: Paul Otlet's 100-year hypertext conundrum ?* 2001). Clarification of further possibilities of aspects of this work has been the subject of recent presentations:

- *Meta-challenges of the Future for Networking through Think-tanks* (Conference of the UNU European Millennium Project on the *Futures of Europeans in the Global Knowledge Society*,Louvain-la-Neuve, April 2005)
- *Union of Intelligible Associations: integrative design metaphors enabling strategic comprehension of the global brain* (Panel on *Organizing Knowledge for Human Benefit* at the World Academy of Art and ScienceConference on the *Future of Knowledge: Evolutionary challenges for the 21st Century* (Zagreb, November 2005)
- *Exploring Intelligible Associations: ontological issues, integrative metaphors and knowledge organization* (Workshop on the UIA databases at the German Research Center for Artificial Intelligence, Saarbrucken, December 2005)

Cognitive implications of this work have been separately explored in:

- *Union of Intelligible Associations: remembering dynamic identity through a dodecameral mind*, 2005
- *Reframing Sustainable Sources of Energy for the Future: the vital role of psychosocial variants*, 2006
- *Dynamically Gated Conceptual Communities: emergent patterns of isolation within knowledge society*, 2005
- *Comprehension of Requisite Variety for Sustainable Psychosocial Dynamics: transforming a matrix classification onto intertwined tori*, 2006
- *Psycho-social Significance of the Mandelbrot Set: a sustainable boundary between chaos and order*, 2005
- *Council of the Whys: emergent wisdom through configuration of why-question dynamics*, 2006
- *Cognitive Feel for Cognitive Catastrophes: Question Conformality*, 2006
- *The Isdom of the Wisdom Society: embodying time as the heartland of humanity*, 2003
- *Tank-thoughts from Think-tanks: constraining metaphors on developing global governance*, 2003
- *Coherent Policy-making Beyond the Information Barrier*, 1999

Beyond the "encylopedia": The fundamental cognitive challenge for a knowledge society might be framed in terms of whether the centuries-old "encyclopedia" metaphor is now appropriate to the integrative psychosocial engagement required by the challenges of the 21st century and its psychosocial "energy" needs (cf *Reframing Sustainable Sources of Energy for the Future: the vital role of psychosocial variants*, 2006). It could be argued that the fruitful connotations of *encyclopedia* have been distorted in three ways:

- **degradation to linearity**: the root significance of *kyklos*, meaning "circle", has been lost in the tendency to organize knowledge linearly in an alphabetic sequence. The implication of general education, originally associated with "training in a circle", or implications of an integrated or comprehensive perspective (through the mythical one-eyed *Cyclops)*, have been very much diluted. Where some effort is made to provide an overarching structure through which an overview can be explored (cf *Encyclopaedia Universalis*), the emphasis is currently placed on branching hierarchies with merely incidental links to related topics rather than on any organic understanding of such connotations (cf Christoph Pingel, *How Natural are Trees?* 2004)
- **perversion of education**: the root significance of *paideia* (notably in "*encyclopaedia*"), as associated with caring "education" and "child rearing", is readily confused with unfortunate connotations such as the conceptual "grooming" now linked with "paedophilia". The obscured notion is the intimate engagement of the individual with knowledge in its entirety rather than the simple, detached acquisition of information..
- **suppression of dynamic emphasis**: a circular movement has long been associated with learning (as with "training in a circle", the "Grand Tour", the apprenticeship journey of a journeyman and *compagnonnage*, "learning in the round", "well-rounded education"), implicit to a degree in the root notion of *kyklos*, and implied by the Aristotelian "peripatetic" approach to academic learning/teaching (*peripatoi*). This is however suppressed in favour of the "look up" approach of the "blip culture". It may indeed be combined with the dynamics of "cruising" the information highway, or "surfing" the web, possibly via web rings, but with little emphasis on any cognitive synthesis -- namely without "encompassing" what is learnt within the cycle (cf *From Information Highways to Songlines of the Noosphere: Global configuration of hypertext pathways as a prerequisite for meaningful collective transformation*, 1996) .

In searching for a more powerful metaphor for the organization of knowledge than "encyclopedia", the significant role of web encyclopedias (such as *Wikipedia*) or search engines (such as Google) is a striking phenomenon of considerable merit for 21st century society. They emphasize a networked organization of knowledge developed in a participatory mode in which all can engage. As with the inspiration of Wiki-pedia (*wikiwiki* means quick in Hawaian) or of Google (meaning the large number 10^{100}). They may prove to be a

vital complement to the dynamics of the semantic web. Missing however are:

- any form of "encirclement" of knowledge -- drawing education or knowledge into a circle -- through which it is encompassed (as necessary in principle for plenary organs of governance)
- a more than "pedestrian" approach to knowledge (as suggested to some degree by the "pedal" element of "encyclopedia", and its echoes of the peripatetic approach -- notably with the binary dynamics of walking, and in contrast with the "cycle" connotation)
- a means of rendering explicit the unusual dynamics behind an open participatory knowledge initiative such as *Wikipedia*, both causing instability and ensuring sustainability (cf *Wikipedia history flow*)
- any ("slow food") approach to knowledge based on the complementary inspiration of "slow" (a *Lohi-pedia* ?) -- namely a "slow knowledge" characteristic of of sustainable traditional societies, as extolled by their "wisdom keepers"
- a capacity to enfold the organization of knowledge into smaller numbers of elements (one, two, or three?) (cf *Representation, Comprehension and Communication of Sets: the Role of Number*, 1978)

Nuclear fusion processes are framed as occurring within a "reactor" -- a vessel from the origins of the industrial revolution's factories, with associations to the reactors of early chemistry, notably the *athanors* of alchemy. No container, other than the human mind, is specifically envisaged in modern research on "cognitive fusion". However "conceptual blending" evokes the blender as a metaphor implying the possibility of a "conceptual blender" -- suggesting "mechanical" blending and bonding in contrast with "chemical" reactions and bonding or those associated with "nuclear" reactions.

It may be argued that if humanity can best engender and **explore new energy frontiers through highly dynamic cyclic devices adapted to complexity** (such as the cyclotron, synchrotron, synchrocyclotron or the tokamak and other containment devices) then there is a case for **exploring the appropriateness of the structure and dynamics of such devices for the organization and management of knowledge,** access to it, and the insight to be engendered as a consequence of interacting with them. This is a reason for exploring the role of the torus in knowledge organization and comprehension (cf *Comprehension of Requisite Variety for Sustainable Psychosocial Dynamics: transforming a matrix classification onto intertwined tori*, 2006). This approach is to be contrasted with the decades of "world modelling" so successfully initiated with the insights of systems dynamics by Jay W Forrester (*World Dynamics,* 1973), as promoted by the Club of Rome through the work of Donella H. Meadows, et al. (*The Limits to Growth*, 1972). [cf *Global Modelling Perspective* of the *Encyclopedia of World Problems and Human Potential*]

Cognitive fusion in a semantic and memetic context: Understood in terms of ITER's complementary challenge of engendering and managing "burning plasma" fusion processes -- as outlined above -- the challenge is to comprehend the set of dynamic processes basic to enactivation of ITER-8. These necessarily have to do with cognitive significance understood in semantic and memetic terms. To the extent that these are intimately related to creativity and imagination, and their possible framing through metaphor, they are also intimately related to confidence in cognitive constructs -- in the sense of being an outcome of the psychosocial construction of reality. ITER-8 may then be understood as dealing with the ordered interplay of the following concerns relating to what might be termed "burning attention" fusion processes:

- **"Excitement"**: This may be variously understood as the experience associated with "happenings", "accidents", "threat", "competition" (even "business"), "sex", "creativity", "discovery" or some "peak experience" including spiritual "illumination". The phrase "psyching up" may be used in preparation for a challenge (sporting, military, dramatic, etc). In sports psychology this is recognized as "arousal control". It may lead to engagement or entrainment (*Attitude Entrainment: Communicating thrival skills and insights*, 2004). A major challenge, notably in contemporary industrialized society -- whether for the individual or for communities -- is the extent to which such experiences, or their quality, is inaccessible to many. Depression and anxiety have become a major concern for many. This is liable to increase with the expected future energy shortages. Clearly those living in deprived circumstances, notably in developing countries, may be even further deprived in this respect. The general question is how to engender excitement as a dimension of quality of life. Political apathy is a major social consequence of the absence of excitement.

- **"Concentration" and "Focus"**: The experience of "excitement" is associated with some form of "concentration" and "focus". The low-key, diffuse experiences of ordinary living need somehow to be brought into an integrative relationship so that attention is in some way focused, as with using a magnifying glass to focus sunlight. It is this process of focus that ensures that the meanings of otherwise diffuse experiences interact to a much higher degree and with greater intensity -- thus engendering "excitement" of some kind [more | more]. In terms of an optical metaphor, the challenge of "focus" lies beyond that of ensuring "resolution" (a term preferred in policy-making arenas). Although forms of concentration of attention are cultivated in many tasks, including academic reflection and research, a higher order of self-reflective concentration is typically the preoccupation of meditative spiritual disciplines. It is considered a prerequisite for unusual transformative insights.

- **"Coherence"**: The ability to focus calls for a degree of coherence that may be ensured by an integrative configuration of meanings that collectively reinforce each other. An obvious metaphor is an antenna, especially an antenna array. The coherence may be ensured through a configuration of:
  - practices (as in spiritual or military training, or apprenticeships)
  - institutions (as in coalitions or "networks of excellence") or groups (as in a mass gathering or demonstration)
  - strategies (as in global action plans like *Agenda 21*)
  - information relevant to a (strategic) challenge
  - concepts permitting some form of transdisciplinary organization
  - ethical insights in some form of global framework
  - spiritual insights

- **"Constraint"**: To achieve coherence, seemingly incompatible or incommensurable elements may need to be brought into relationship and held together. Typically these include polar opposites of some kind whose very opposition engenders tensions that have to be constrained by corresponding pressure.

- **"Comprehension"**: Holding incommensurable, opposing elements of significance together calls for forms of comprehension that are not locked into particular polar perspectives. This may call upon the ability to deal with paradox and uncertainty, notably by integrating a degree of self-reference into the process of comprehension. The comprehension called for may involve "lateral thinking" and be necessarily "counter-intuitive". Indeed **the necessary "excitement" may derive from the degree of self-implication.**

- **"Containment**": The above processes call for a form of containment that is typically incompatible with the qualities of common or conventional containers -- whose qualities are effectively called into question by the processes they seek to contain. This is especially the case where the container is overdesigned or overorganized according to a particular set of dogmas or principles. As with the tokamak, the key is ensuring total separation of the processes from the containing walls. Scientific disciplines seek to achieve this through "objectivity". Spiritual disciplines seek to achieve this through "detachment" within a bounded domain from which the irrelvant preoccupations of other disciplines are excluded (cf *Dynamically Gated Conceptual Communities: emergent patterns of isolation within knowledge society*, 2004). The inhibiting nature of conventional institutional contexts and processes for such endeavours encourage some to develop "containers" such as "think tanks" or intentional communities (monasteries, etc).

- **"Cognitive fusion"**: The above elements are necessary precursors for fusion -- for the emergence of "creativity" and "insight", possibly extending into such forms labelled as "illumination". Elements of significance interact so intensely in the "cognitive plasma" (or perhaps "semantic plasma" or "memetic plasma") that unforeseen integrative patterns associated with "insight" are engendered. This is typically recognized as a desirable consequence of appropriate meditative discipline. The container could then be described as a "cognitive fusion **reactor**" complementary to the physical counterpart. However, given the creativity, the notion of "reaction" may be less appropriate than "proaction", suggesting the term "cognitive fusion **proactor**". This also omits a significant dimension, however, namely that arising from the self-referential implication in the fusion process that may be associated with some form of "transformation" of both the semantic object and the observing subject -- and of their relationship. Forms of this are evident in drug-enabled "peak experiences". Such considerations are notably explored with regard to the "embodied mind" by Francisco Varela and others under the term "enactivism" [more more] . The more appropriate concept may then be "enaction", suggesting the term "**cognitive fusion enactor**". This emphasizes dimensions beyond those of a "cognitive blender". It is for this reason that the challenge of ITER-8 is framed as "Enactivating a Cognitive Fusion Reactor".

- **"Insight capture"**: A major challenge is to ensure that insights engendered in this way are somehow "captured", where "capture" may be precisely the wrong metaphor. Enactivism may be understood to respond to this challenge by reframing it.

- **"Continuous self-awareness"**: Another major challenge is to design the "cognitive fusion" process so that it is a continuous "steady state" process rather than only occasional, or even exceptionally rare -- as implied by the phrase "peak experience". Such continuity may correspond in part to that identified by Mihaly Csikszentmihalyi (*Flow: The Psychology of Optimal Experience*, 1990) experienced by athletes and executives seeking peak performance and excellence. For athletes it is referred to as being "in the Zone." Daniel Goleman identifies it as the "neurobiology of excellence." Csikszentmihalyi defines flow as being completely involved in an activity for its own sake. Every action, movement, and thought follows inevitably from the previous one, like playing jazz. The whole being is involved. Flow, whether in creative arts, athletic competition, engaging work, or spiritual practice, is a deep and uniquely human motivation to excel, exceed, and triumph over limitation.

- **"Application"**: Experiencing insight of any form -- and having "captured" (and possibly embodied) it -- raises the question of how to apply it strategically to any perceived problematique. This is a matter of stepping down and adapting the insight transformatively to circumstances.

The indications above suggest that **it might indeed be fruitful to consider the extent to which humans, and their groups, are all "tokamaks" -- operating continually but suboptimally**. The alternative proposals for plasma confinement may also offer insightful metaphors for attention confinement. On the other hand, especially interesting is that **any comprehensive formulation by a coherent school of thought may well be understood as a particular containment design for cognitive fusion** -- with the necessary "parameters" conducive to fruitful creative reflection. A good example, given his mathematical background, his attention to quantum issues, and the challenge of managing attention dynamics to achieve cognitive fusion, is the process philosophy of Alfred North Whitehead (*Process and Reality: an essay in cosmology*, 1929).

Modes of failure of cognitive fusion: These may be understood in various ways:

- **Integrative failure**: This may occur for the individual but also in groups (cf *Evaluating Synthesis Initiatives and their Sustaining Dialogues Possible questions as a guide to criteria of evaluation of any synthesis initiative*, 2000):
  - **Reduction in variety**: A simple way to ease the integrative problem is to reduce the diversity of elements present in the situation using an argument for standardization and against any "hodge podge" mixture of elements. This of course eliminates some minority interests. In the extreme case of destructive or "meltdown" synthesis, all variety is eliminated.
  - **Reduction in quantity**: By eliminating a significant number of the elements, the problem may also be eased. The argument that can be used is that they are well-represented by the variety of elements that remain and that any "proliferation" of elements is disorderly. In practice this results in the absorption of some elements by others, such as in the case of minority groups.

    - **Simplification**: Subtleties and nuances, possibly defended by specific minority groups, may be ignored. Interconnecting webs of relations can be ignored.
    - **Tokenism**: Emphasis may be placed on the image or desirability of synthesis in order to conceal inability to achieve any steps towards it.
    - **Temporary synthesis**: In a dynamic situation it may be possible to achieve some measure of integration in the short-term by ignoring factors temporarily absent or only emerging over longer time cycles.
    - **Coloured synthesis**: A significant degree of synthesis may be achieved, but from a particular viewpoint or in terms of a particular mode, approach or strategy. The narrowness of such a synthesis, coloured by the perspective of those who achieve it, may be difficult to communicate within the framework established by that synthesis.
    - **Enforced synthesis**: In some instances, as with a dynamic set of minority interests, a form of integration may be imposed by constraining the dynamics (although without reducing the number or variety of the elements).
    - **Dogmatic synthesis**: An impression of synthesis may be achieved by stating frequently and forcefully that it has been achieved and thus eroding expectation that a greater degree of synthesis is possible.
    - **Laissez faire synthesis**: By reinterpreting the nature of synthesis or integration, it may be deemed to exist under any circumstances as the pattern of interaction amongst the elements. No intervention is required, although if undertaken it would merely add to the pattern of interaction.
    - **Agglomerative synthesis**: Appropriate integration may be assumed to have been achieved simply by ensuring the juxtaposition of the various elements or viewpoints. This corresponds to the use of the prefix "multi" (*eg* in multidisciplinary). In books reflecting such a multidisciplinary synthesis, it is the binding which provides the synthesis, given the absence of any relationship between the constituent disciplinary chapters.
    - **Comparative or cross-referential synthesis**: Integration may be assumed to have been achieved by recording comparisons between the perspectives or elements. This often corresponds to the use of the prefix "cross" (*eg* in cross-cultural).
    - **Cross-impact synthesis**: Integration may be assumed to have been achieved by taking into account the constraints and feedback loops emerging from other disciplinary perspectives. This may correspond to use of the prefix "inter-" (*eg* in interdisciplinary). Note however that it is only with the emergence of a new level of order that a synthesis breakthrough may be said to have occurred (this may correspond to the use of the prefix "trans-" as in trans-disciplinary).

- **Quenching enthusiasm**: This is the widely condemned process of "being negative", generating "bad vibes", being a "wet blanket", agreeing with qualification ("but..."), etc. It is also the consequence of any encounter with unforeseen real world constraints. In collective initiatives it may directly discourage further participation (cf *Being Positive Avoiding Negativity: management challenge -- positive vs negative*, 2005).

- **Containment failure**: This may result from the quenching process or be due to the unexpected build up in excitement and pressure. It may be notably due to failure of adequate detachment, namely deliberate and inappropriate interaction with the constraining framework

- **Incoherence**: Here the excitement is chaotic and is not attracted to any coherent ordering focus. Lateral thinking capable of interrelating incommensurable elements may be absent -- as with any aesthetics or humour catalyzing analogous integration. Particular biases may predominate. Consequently the cognitive fusion becomes impossible.

- **Spontaneous combustion**: In unusual circumstances it is possible that failure may take the form of "spontaneous human combustion" or of a psychotic analogue beyond that implied by "burnout".

Contextual relevance: Significant contributing factors to successful cognitive fusion potentially include:

- use of the best of contemporary insights into complexity and into the design and management of energies that otherwise are potentially destructive (hence the value of ITER as providing a template)
- sets of values, precepts and other guidelines may need to be taken seriously as attitudinal "operating instructions", necessary if there is to be any possibility of cognitive fusion (cf *Navigating Alternative Conceptual Realities: clues to the dynamics of enacting new paradigms through movement*, 2002)
- serious detection and use of guiding metaphors (cf *Guiding Metaphors and Configuring Choices*, 1991) from:
    - non-scientific disciplines (especially the arts, and spiritual disciplines)
    - non-western cultures (Susantha Goonatilake, *Toward a Global Science: mining civilizational knowledge*, 1999; *Enhancing the Quality of Knowing through Integration of East-West metaphors*, 2000)
    - indigenous knowledge systems (Darrell Posey, *Cultural and Spiritual Values of Biodiversity*, 1999)

Reservations: The controlled cognitive fusion emphasized above, through its parallel to "burning plasma", explores what might be termed a "hot" metaphor for managing attention. Just as ITER-8 does not exclude other approaches to "confinement" and "containment", nor does it exclude insights that may emerge from a "cold" metaphor -- as suggested by controversial research into "cold fusion" (also known as Low Energy Nuclear Reactions or Chemically Assisted Nuclear Reactions). A relevant insightful distinction was notably made by Marshall McLuhan (*Understanding Media: The Extensions of Man*, 1964):

> There is a basic principle that distinguishes a hot medium like radio from a cool one like the telephone, or a hot medium like the movie from a cool one like TV. A hot medium is one that extends one single sense in "high definition.' High definition is the state of being well-filled with data. . . . Hot media are low in participation, and cool media are high in participation or completion by the

> audience. . . . The hot form excludes, and the cool one includes. [cf Scott Rosenberg, *Taking the Internet's Temperature: what would Marshall McLuhan have said: Hot or Cold? Digital Culture*, May 1995]

Complementarity and self-reflexivity

Discussed in Annex A

- Complementarity between ITER-8 and the ITER fusion project
- ITER-8 self-reflexive design
- Torus dynamics common to ITER and ITER-8

Dematerialization and virtualization

Discussed in Annex B

- Dematerialization
- Virtualization
- Correspondence between the virtual reality of ITER and ITER-8
- Complementary fusion metaphors: "plasma dynamics" and "attention dynamics"
- Towards a language appropriate to dynamic engagement
- Helical threading of "incommensurables" -- the snake metaphor

Coactive contextual relationship

Discussed in Annex C

- ITER-8: a necessarily underdefined entity
- Resonant associations to other "ITER" projects
- People / "players" / non-participants
- Institutional "dancing partners" / non-participants
- Technologies and "modelling partners"

Cognitive fusion through myth and symbol making

Discussed in Annex D

- Myth and indigenous knowledge
- Archetypal symbolism indicative of the fundamental dimensions of ITER-8

Conclusion

Like it or not, governance in the 21st century will be significantly influenced by the imagination -- whether as manipulated by news management and media phenomena, by the faith-based articulations of different belief systems, or by the search for imaginative relief from the constraints of simplistic governance, insensitive planning and the incompatible preferences of others. "Urban myths", notably regarding "immigrants" and minority groups, may have increasing influence on social unrest and remedial policies. Imagination will be called upon, through self-reflexive processes, to reframe depression, anxiety and existential doubt. Relief will be increasingly sought in alternative realities, whether private (including drug-enabled), virtual or elective communities, in which primacy is given to imaginative connectivity to provide coherence.

The relevance of the aesthetic organization of music to the challenge of contemporary governance has notably been evoked by Jacques Attali (*Noise: The Political Economy of Music*, 1978/1985) -- prior to taking the role of first president of the European Bank for Reconstruction and Development. He explores the manner in which the organization of music prefigures social and conceptual organization [more] (see also *Aesthetics of Governance in the Year 2490*, 1990). Recent indicators include:

- popular rejection in 2005 of the European Constitution (for which foreign ministers, meeting in May 2006, had no imaginative suggestions) -- for a European Union whose values have only been articulated musically through a classical anthem (Beethoven's *Ode to Joy)* or celebrated by concerts of classical music
- worldwide support in 2005 by the younger generation for the Live-8 music-based campaign -- in contrast to that for the unpromising agenda of the simultaneous G8 Summit
- popular European rejection by the younger generation of over 30 songs in the Eurovision Song Contest as bland, unimaginative expressions of classical "positive" values -- in favour of historically unprecedented support for a rank outsider in the form of a self-questioning, humorous presentation of "satanic" lyrics by a Finnish heavy metal rock group masked as demons -- in the week in 2006, when ITER partners reached final agreement

Such indicators raise the question of what kind of psychosocial organization is sustained by "fusion music" -- and the organizational implications of the didjeridu, now played worldwide to a greater extent than by indigenous Australians [more]. Curiously, in the light of its "demonic success" in 2006 -- Finland's well-recognized uptake of information technology was acknowledged in the accession speech of the Finnish President of the European Commission on the New Dimensions of Learning in the Information Society (July 1999) -- by referring first to the influential role of archetypal figures in the *Kalevala* (cf *Newsweek*, May 1999; *Wired*, September 1999). These factors may be especially relevant to non-western cultures (cf *Knowledge Gardening through Music: patterns of coherence for future*

African management as an alternative to Project Logic, 2000). Such considerations suggest the inappropriateness of assumptions regarding the simplicity of ensuring sustainability through "silver bullet" remedies.

ITER-8 is conceived as a process to function at the interface between abstract framings of the challenges, or the responses considered appropriate, and the concrete approaches articulated through the most insightful responses to complexity (exemplified by ITER). It is an imaginal device through which the generation of psychosocial energy is catalyzed. It uses highly disciplined thinking, employed to manage the most fundamental sources of energy, such as to order the thinking necessary to manage subtler forms of energy that are also fundamental, notably in their elusiveness. It points to the need to alternate flexibly between "hot" and "cool" processes to cognitive fusion -- and to the challenge of the interface between them.

ITER functions at on one extreme understanding of "energy" generation. Contolled "cognitive fusion" points in another direction, cultivated by ITER-8, in which possibly four forms may be conflated from more conventional, reductionistic perspectives:

- activation of interdisciplinary relationships and credible knowledge transfer pathways, perhaps supported by metaphor
- further activation and excitation of resonances that can be interpreted in terms of the "heat" of creativity and flashes of insight.
- forms of cognitive fusion associated with "peak experiences" and spiritual insights, possibly to be considered as permanently embodied as "flow experience" or subtler forms exemplfied by the "man of light" (cf Henry Corbin, *The Man of Light in Iranian Sufism*, 1971; *The Gospel of Thomas* (11,2): "There is light within a man of light, and he lights up the whole world"; Pierre Gohar, *From the man-of-matter to the Man-of-Light: myth or reality ?* 2002)
- a form of energy associated with life itself -- very partially understood in terms of the biochemical energy of metabolic pathways, seemingly quite unrelated to the cognitive sense of being "alive" and "conscious". In this sense, life may be the ultimate form of energy-engendering "cognitive fusion" (cf Jeremy Narby, *The Cosmic Serpent, DNA and the Origins of Knowledge*, 1999).

Concretely such a progression would be consistent with what physicist David Peat has recently proposed under the term Gentle Action -- " an action that arises out of the whole of the situation and is not fragmented or separated from it", based on a "very gentle, but highly intelligent 'steering' of the system, in which each one of us assumes responsibility" (cf F. David Peat, *Non-Linear Dynamics (Chaos Theory) and its Implications for Policy Planning*).

A variety of simulations, notably when widely accessible as part of the proliferating set of internet and video games, would elicit insight, understanding and skills regarding engagement with "snake-like" dynamic challenges relevant to sustainable governance (cf *Playfully Changing the Prevailing Climate of Opinion: Climate change as focal metaphor of effective global governance*, 2005). Cultivating their mythological context (cf Hermann Hesse, *Magister Ludi*, 1943), or their imaginative dimensions, can only enhance their relevance. The science fiction work of a missile launch officer (M A Foster, *Gameplayers of Zan*, 1977) highlights, for example, the challenging cognitive boundaries between conventional bureaucratic thinking, nature-sensitive thinking, and the strategic game-playing fundamental to ensuring sustainability -- especially the paradoxical skills required to "drive" a powerful vehicle such as to keep it in one place, and accessible. Such game-playing calls for the kind of understanding highlighted by James P. Carse (*Finite and Infinite Games: a vision of life as play and possibility*, 1987).

As a collective social initiative, ITER-8 responds to the need to invest imaginatively in the metaphors that can sustain psychosocial energy in such conditions -- with appropriate attention to feedback loops necessary to the sustaining process.

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