Collective Scientific Mind Initiative (Draft Paper) - Project Proposal

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Abstract

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1 Introduction

The Collective Scientific Mind Initiative (CSMI) aims at organizing one or more Collective Scientific Minds (CSM). This paper has been written for two main purposes. In the first place to define the CSM concept and the context of its conception and in the second place to reach participators to take part in a potential CSM. In this introduction we will first briefly sketch the concept and the context of its conception.

1.1 Brief Explanation of the CSM Concept

A CSM is in the first place a *universal* and strongly *collectively operating* scientific community. It is universal in the sense that it is open for and strives for participation in the widest range of scientific research fields possible, whether it is physics, sociology or mathematics. It is collective in the sense that research activities are carried out collectively.

In addition, a CSM complies with five other properties: self-similarity, strong collective memory, role-following, intensive reuse and a low degree of member turnover. These properties are not posed as fixed rules, but as a point of departure for further refinement. Moreover, some properties are idealisations that cannot be completely reached, but rather state the desired *direction* of development.

The property of self-similarity is important to such an extent, that we will elaborate on it already in this introduction. In the scope of this article, self-similarity means that the constituting parts of a community, thus the individual members, reflect the whole community. Properties that are derived from self-similarity include: not only is the whole CSM universal, each subgroup of members is universal too (note: if the subgroup is an individual, "universal" translates to "homo universalis".); the CSM is developed in the "we-we-relation" (as opposed to the "we-them-relation"): all members are creators of the organisational structure of the CSM; its *collective memory* has a high degree of *knowledge self-similarity*: every member has got a "mental copy" of the knowledge that is present in the complete CSM. It might be clear that for this to be realised, a low degree of member turnover is required.

As a consequence of the property of self-similarity, a CSM can come into existence by a *bootstrapping procedure*. Starting with a minimal predefined organisational structure, the CSM develops and refines itself as a base *for* exploring collectively, *while* exploring collectively. Thus, penetrating into research problems is not the end-goal, but material to get the CSM into motion. The emerging organisational structure of the CSM will be of equal importance. Part of this process is about the CSM using its previous experiences in a variety of specific research areas as a means to "specialize in specializing".

Finally, three things are important to note. First, defining a CSM as a set of fixed rules would be contradictory with its own point of departure (to be specific: it would be contradictory with the property of self-similarity). That is why the description of a CSM, and even this complete paper, is written with the

intention of forming a "beacon" to reach potential participators that *recognise* their own motivations in this paper. Exactly because of this reason I want to urge people that consider to participate to read all material carefully, and examine critically whether there is indeed an alignment between their internal motivations and what is described here. Parts of the material will ring bells by many, but the specific combination into the philosophy behind the CSM is what matters. Secondly, it should be emphasised, that a CSM is not posed as a quest for "the right way" to cooperate in the domain of scientific research. A CSM respects and can coexist with many other approaches, and deems them to be equally valuable. Thirdly, although mentioning technology (in particular information technology) is not required for formulating the essential properties of the CSM concept, it will play an indispensable role in the realisation of these properties.

1.2 Context of the Conception of the CSM concept

It is hard to determine exactly where to draw the border between the definition and the context of the conception of the CSM concept. It is a combination of intuition, experience, rational considerations and a sense of elegance that has lead me to define the concept as it is now. However, with certainty can be identified, that a central element can be found back in the opening sentence of Visser's personal page (founder of the Learning Development Institute): "The desire to discover; the lure of the unknown; the possibility to encounter beauty and wholeness; the conviction that, for any individual, it is possible to change the world – these are some of the things that motivate what I do."[1] Three words in this sentence play a central role in the context of this initiative: "discovery", "wholeness" and "beauty". The explorative nature of a CSM should be stressed. In contrary to a more problem oriented individual, for which the path towards the goal is subdued to the goal itself, in a CSM the path towards a goal is of equal importance. Locally set goals, like problems, give the CSM handles to follow a path, and following the path with attention and awareness will give it the handles to encounter the unexpected, to experience beauty and to grow. It is wholeness that is both expressed by the collectiveness of a CSM (a group of people that form a whole), as in the self-similarity: the whole community being reflected in each of its constituting parts. It also explains why, by definition, a CSM is not a problem based community, which it might be confused with. It is closer to being "explorative based", exploring itself and the surrounding world, and growing, refining and evolving while doing this. Specific goals – which include, but are not limited to problems – are just one of the types of fuel to feed this process.

Although the conception of the CSMI is not based on the observation of problems, CSMI contributes positively to a solution for some fundamental problems that exist today in the scientific process and beyond. Specifically, it addresses the problem of the globally-spread phenomenon of the fragmentation of knowl-

[1] see the people section of http://www.learndev.org/

edge and mind and its negative consequences. This problems were and are addressed by many, amongst which people that can be considered to have a considerable overview in the field like Visser (Learning Development Institute and former director of Learning Without Frontiers Unit within UNESCO) and Morin (former director of le Centre National de la Recherche Scientifique in France). Other important properties that are envisioned to be emerging within a CSM are: high adaptability to the characteristics of each individual (with respect to learning and creating) and providing an environment in which the inner drive and gifts of individuals are aligned with the greater whole they participate in, instead of forcing them into predefined categories.

1.3 Overview

The central section of this article, section 2, is devoted to the development of the CSM concept. In section 3 matching criteria for future participants in a CSM are described. The article concludes with two concrete points of departure for a community that could evolve into a CSM (section 4).

2 The Collective Scientific Mind (Initiative)

In this section the properties of a CSM will be put forward (2.1), followed by an elaboration on its connection with possible problems in contemporary organisations (2.2) and the nature of its relation with information technology (2.3). Subsection 2.4 explains why a CSM can come into existence by a bootstrapping procedure. The section is concluded by pointing out relations and differences with work of others (2.5).

2.1 Properties of a Collective Scientific Mind

The set of properties of a CSM that will be introduced in this section must not be conceived as rigid facts, neither as an axiomatic foundation. They are indicators of an underlying philosophy, which is, as always, impossible to grasp by words only. They are open for further refinement in the evolution process towards approaching that underlying philosophy. Also, note that some properties are idealisations, which cannot be realised, but which, nevertheless, can be approached.

- *Self-similarity.* The whole organisation is reflected in each subgroup, up to the individual members. (See 2.1.1).
- *Strong collective memory.* In an organisation with a strong collective memory every member knows what the organisation as a whole knows (knowledge self-similarity). (See 2.1.2).
- *Role-following. Every* participating individual, no matter age, sex or stage is continuously in the stage of switching *formally* to any existing or newly

created role(s) that reflects best what he or she is inspired to and can express at any moment in the scientific process. . (See 2.1.3).

- *Intensive reuse.* The members of a CSM are *intensively reusing and reorganizing previous contributions in the collective memory in different contexts.* The multiplicity of stages of the collective body of knowledge is also stored and as a default, they are never erased. (See 2.1.4).

- *Low degree of member turnover.* A CSM consists of a fixed group of people. (as a consequence of a strong collective memory. (See 2.1.2).

The following subsections provide an elaboration on the first three properties. The last property is explained within the section about the strong collective memory (2.1.2). in which the following things will be treated:

1. A definition of the property.
2. The motivations behind the property.
3. A discussion about the extent to which the (idealised) property can be realised.

2.1.1 Self-Similarity

An object is *self-similar* when the whole object is reflected in each of its constituting parts. This notion plays a key role in an integrated development of the CSM. Here we define self-similarity as follows: a scientific community is self-similar when the properties of the whole are reflected in each sub-group of the members of that community, with the smallest sub-group consisting of one member. Ideally, a self-similar scientific community has at least the following properties:

- The scientific knowledge gained by one member, is immediately transferred to all the other members in the CSM. So, all members contain a "mental copy" of the knowledge of the CSM as a whole. (See also the notion of *knowledge self-similarity* in 2.1.2.)

- Gained meta-cognitive knowledge regarding the scientific process by one member of subgroup of members, is immediately transferred to all the other members in the CSM. (See also the notion of *knowledge self-similarity* in 2.1.2.)

- Every member plays every role in the same ratio as the other members. For example, everyone involved in the development of the groupware environment of the CSM, in the design and adaptation process of the organisational structure and in the acquisition of new knowledge.

Of course, no CSM can be purely self-similar, even if every member would try sincerely, as a consequence of:

- differences in talents,
- the amount of collective knowledge to be captured, leading to the necessity of dividing it over the members and
- focus and time needed to build the right mental and physical form to perform a certain task excellently. (e.g. for a sport, lecturing, performing a music piece).

A CSM explores the limits of self-similarity, while keeping these boundary conditions into account.

Self-similarity is a desirable property of a CSM, because it is essential for a development towards a state of wholeness instead of fragmentation. When a community consists of specialised parts and individuals, the individual members cannot see where their contribution fits into the whole, because they have never experienced the different aspects of that whole. When the whole is reflected in each of its parts, this will help the part of the whole moving in congruence with that whole. Specific motivations for *knowledge* self-similarity are developed in section 2.1.2.

2.1.2 Strong Collective Memory

The collective memory is a memory in which knowledge of individuals, subgroups within the organisation and the complete organisation are stored (it is a *memory*), and that are accessible to or shared among all members within the community (it is *collective*). Every organisation has a collective memory. However, the collective memories can differ in different respects.

I have designed a few definitions which make the concept *collective memory* more tangible and definable, and which will prove to be a valuable tool to explain in what respects a CSM is different from other seemingly equivalent approaches (such as multidisciplinary problem-based communities). Of course, I am fully aware of the fact that, it is based on certain assumptions that somewhat simplify reality. Consequently, the definitions should be considered to be a useful perspective *on*, instead of a complete model *of* collective memories.

A piece of knowledge, an experience or skill, will be called a "*knowledge-item*", or simply an "*item*". An individual has *internalised* a knowledge-item, when he or she has a piece of knowledge in his "mental" possession (in case the item is a piece of knowledge), has acquired a certain skill (in case the item is a skill), or has gone through a certain experience (in case the item is an experience). An item that is stored on a (nonhuman) medium, is *externalised* in that medium. Three dimensions will provide us with handles to determine the properties of the storage of a knowledge-item.

1. *Accessibility*: to what extent do the members of the organisation have access to the item that they have not internalised as yet?
2. *Duration*: over what period of time will the item be stored in the organisation?

3. *Spreadedness*: the ratio of members that have internalised a certain item to the total number of members of the organisation.

Next, I will introduce the concept of *degree of knowledge-self-similarity*: the average spreadedness of *all* items in the collective memory. The choice for this term is based on the fact, that if the degree of knowledge-self-similarity is equal to 1, each thinkable subgroup of members – up to the individual members – of a CSM contains exactly the same knowledge as the complete CSM. In other words, the *knowledge* of the complete CSM is reflected in each subgroup of members.

Important and interesting observations are:

1. Many items cannot be externalised, or can only be externalised partly. Externalisation requires a reduction to something that can be expressed in some sort of language, and this is not always possible. The knowledge that bees are involved in creating honey can be externalised quite well, by writing this fact down (for the sake of this example, we assume that the meaning of the individual words to express this knowledge are already shared throughout the community). The skill of shooting with an arrow can partly externalised in an instructional paper, but this paper is not equal to the skill. The muscular development and body coordination cannot be externalised. Writing the paper will only increase *accessibility* to the skill of shooting with an arrow.

2. Items that are stored in internalised form only, survive as long as there is an individual alive with this knowledge internalised. This type of knowledge is at risk of having a low duration, unless there is a strict policy of transferring this knowledge from generation to generation with enough people.[2]

3. Items that are stored externalised in a "permanent" medium, have a high duration.

Other essential definitions are:

1. In a *perfectly strong* collective memory accessibility to each item is perfect, duration of each item is infinite, and the spreadedness of each experience is at any moment complete (or equivalently: the knowledge self-similarity is equal to 1). A collective memory is stronger than another, when it exceeds the other in all three dimensions. However, this is a sufficient, but not a necessary condition.

2. A member that strives, out of his or her own will, for optimising all three dimensions, is *striving for a strong collective memory* for the organisation. If a substantial part of members of an organisation strive for a strong collective memory, then *the organisation strives for a strong collective memory.*

[2] An excellent example is the systematic oral transfer of the Indian epos of "Mahabharata".

Even in a community that strives for a strong collective memory, the ideal of complete knowledge self-similarity can only be approached. This is, amongst other things, caused by:

1. Differences in gifts and limitations between individual members.
2. Limited capacity for knowledge-absorption by individual members.
3. Focus and time needed to build the right mental and physical form to perform a certain task excellently (e.g. for lecturing or performing a piece of music).

(see also 2.1.1)

The following considerations are some of the motivations behind choosing a strong collective memory as a property of a CSM:

1. A strong collective memory enhances the possibility to integrate, abstract from, simplify and generalize knowledge, because every individual member has an overview of the complete body of knowledge.
2. X people containing the same knowledge is something more than X copies of this knowledge.
3. A strong collective memory gives each individual a less fragmented overview over the collective knowledge, promoting the emergence of activities of individuals that are in harmony with the whole.
4. The process in which each individual is trying to get an overview of the knowledge contained in the CSM is not only considered to be a step towards wholeness, but in itself as being an expression of wholeness.
5. The desire for a strong collective memory is consistent with the explorative nature of a CSM. Individuals in it are eager to interact with new knowledge, to meet and interact with the unexpected, even if it is not directly useful for their local problems.

I will elaborate on the first point, by drawing an analogy with the theory of artificial neural networks. One of the central questions is epitomised by the "grandmother-neuron problem". Are single neurons or bundles of neurons devoted to remembering your grandmother (comparable with modern computer memory chips) or is this knowledge somehow dispersed over the brain? Suppose that a so called *Backpropagation network* has learned to reproduce a symbol, let say an 'R'. Remarkably, shutting off one neuron, will not lead to an 'R' with some pixels missing, but to an 'R' that is distorted *over its entire surface*. Shutting of more neurons will cause the 'R' to become distorted more and more, until no 'R' is recognizable anymore. In other words: a neuron doesn't take care of a specific area of the 'R', but each neuron somehow contains an imperfect reflection of the complete 'R'. The reflection of the complete 'R' into many neurons builds a very sharp image of the 'R'. Complete this analogy, by replacing the 'R' with "knowledge in the CSM", "neuron" with "individual", "pixel" with "knowledge-item" and "surface" with "collective body of knowledge".

2.1.3 Role-Following

I will define an organisation to be *role-following* when roles are dynamically connected to persons, in such a way that they fit the activities that a person could best be carrying out as a consequence of the *actual* situation. The best activities form an alignment of state of mind of the individual, including his or her background and the whole she or he is part of. People are continuously switching roles when interacting with themselves and their surrounding environment, roles that reflect what they are really doing at that moment. A "student" (the formally assigned "role") is in fact operating in the role of an "educator", when he helps a fellow student answering a question; a "professor" is in the role of "student", when confronted with a new research area that is new for her.

The opposite of the role-following organisation, is the *role-assigning* organisation, in which roles are assigned and fixed over a period of time, regardless of the actual situation a person is in. Examples are: people employed as "researchers" for an indeterminate period of time, people that are subscribed as "students" for the coming six years (see also [Visser and Berg, 1999], p. 17).

An *explicit* role is a tokenised role concept, that is to say, a concept of a role abbreviated by a language expression that is connected to a person (e.g. "teacher", "scientist" or "lecturer") They can both be used in role-assigning and role-following organisations, but their interpretation is different. In a role-following system, the explicit role is descriptive, whereas it is prescriptive in a role-assigning system. In a role-following organisation, roles could even be seen as emergent properties of activities that people are involved in, which diminishes the necessity to make the role they are fulfilling explicit.

An important motivation behind the choice for striving for realizing role-following to the greatest extent possible in a CSM, is the fact that what a person is doing can never be abbreviated by one word only. Language constructs, as used largely today, produce an oversimplified and rigid picture of an infinitely nuanced and continuously developing and changing reality. From this perspective, role-assigning can be seen as applying this distorting and simplified language mechanism to the part of reality that is concerned with people and their identities. This process will lead, almost by logical necessity, to frictions between the inner drive of individuals and the simplifying labels that are imposed on them.

Thus in a CSM, roles that are assigned to persons as an abbreviation for their knowledge, experience, accomplishments, type of their activities and skills (e.g. scientist, writer or a nurse), are used as sparsely as possible. However, sometimes assigning roles can be handy, for example to divide practical tasks over persons. These roles are sometimes practical, and will be used in a CSM.

Role-following must not be confused with doing whatever one likes to do. Role-following can only exist when there is a strong feeling of responsibility of each individual member to find congruence between the whole and the part, and to contribute to an environment in which this congruence is progressively easier to find. If this congruence requires facing tough challenges now and then, then this is what they will be driven to do. The motivation for doing so, however, is

internal, emerging from the individuals themselves and are not imposed. This implies that the seed for carrying this responsibility must already be present in the individual, and cannot be created, but only be fed by the structure of the organisation.

2.1.4 Intensive Reuse

An organisation is making intensive reuse of its collective memory, when it reuses and reorganises the collective knowledge to the maximum extent when it is involved in processes. The property of a strong collective memory alone is not enough: it does not state anything about the *source* of knowledge that is used while going through processes; it only states that gained knowledge will be stored and shared. If the property of intensive reuse is added, the members first attempt to make use of the collective knowledge that is already present in the CSM, by transforming this knowledge for the new purpose, before resorting to external resources.

For example, when involved in learning Chinese words, one would first attempt to reorganise previous contributions of other members that are already present in the collective memory, instead of using lists of words composed by external parties.

There are two important motivations for associating the property of intensive reuse with a CSM. First, one of the main goals of a CSM is to grow and refine itself as a base for collective scientific research while going through it. Intensive reuse can be considered as a form of growth and refinement of the collective memory. The second motivation is that resorting to external resources would diminish the collectiveness of the CSM, and specifically, the process that I will coin *collective thinking*.

Collective thinking is in fact a form of intensive reuse of knowledge in the collective memory on a very fine-grained level. When a member records his or her smallest "informal" thoughts, drafts, intermediate results and so forth in the collective memory, and the other members actively absorb, extend and reorganise that information, the process of collective scientific thinking is occurring much more intense and on a larger scale than it has occurred before.

Poincaré, a great mathematician, seemed to possess over the extraordinary gift to passively see his unconscious thinking process at work: "Ideas rose in clouds; I felt them collide until pairs interlocked, so to speak, making a stable combination." (as cited by [Hadamard, 1945]). In a sense, the process of collective thinking could be considered as scaling this process up to much larger groups of people. The help of information technology will proof most probably to be indispensable (see 2.3). Berners Lee, the creator of World Wide Web, stated [Berners-Lee, 1999]:

> The thing that does not scale when a company grows is intuition, the ability to solve problems without using a well-defined logical method. A person, or a small group brainstorming out loud, ruminates about problems until possible solutions emerge. Answers

> arrive not necessarily from following a logical path, but rather by seeing where connections may lead. A larger company fails to be intuitive when the person with the answer isnt talking with the person who has the question.
>
> Its important that the Web helps people be intuitive as well as analytical, because our society needs both functions. Human beings have natural balance in using the creative and analytical parts of their brains. We will solve large analytical problems by turning computer power loose on the hard data of the Semantic Web.

These continuous collective reorganisations of shared and stored thoughts, is envisioned to lead to fully fledged scientific theories and applications. It is important to note, that the reorganisation and reuse property even holds for these theories: they are not conceived as end-goals, but nothing more than a specific organisation of the content in the collective memory, that proved to be very valuable in a specific context. The surrounding "tacit" information seen from the perspective of this specific organisation, is still present in a persistent form, ready for reorganisation and reinterpretation. For example: valuable parts might become less valuable from a new point of reference, and seemingly dead branches or side-effects in (collective) thought, might come into full focus in the future.

For this process to be successful, it is important that there is a minimum of redundancy in the *external* part of the collective memory. (The external part refers to things that are stored on external media.) In other words: there are no duplicates stored of knowledge items stored in the external part of the collective memory, unless there is a special reason for it. In this way, reorganisation and extension activities will have a lower probability of becoming fragmented, with all its negative consequences. It should be noted, this is not a trivial remark, because it is almost the oposite of what we are used to, by storing the knowledge we produce highly distributed and unconnected. For example, we use a given important term in different articles in different journals, in different emails addressed to different persons, and on top of this hold private notes which again contain many duplicates of the same term).

2.1.5 Role-Following as a Consequence of a Strong Collective Memory and Intensive Reuse

Very central to the philosophy of a CSM is the property of role-following (see 2.1.3): also the conventionally tacit roles played by members while they are going through processes come to their full right within the CMS. A strong collective memory and intensive reusing the knowledge in this collective memory are the key properties to realize this. Role-following could be considered as reusing the knowledge items in the collective memory (= intensive reuse property), which is only possible to a full extent when most items are present in this memory (= strong collective memory). The properties allow the realisation of an even stronger form than role-following: even roles never anticipated, nor explicitly

neither implicitly, by the members that carried out certain activities can be *post-connected* to them. High accessibility and high duration, can be achieved by externalising the knowledge item in an ICT system.

Lets proceed with an example.[3] Diana wants to learn Chinese in the context of a study of language theory. She implicitly connects the role "student of Chinese" to herself for a period of time. As a part of functioning within this role, she makes a list of words she could not remember. Normally, students would throw these lists away. In terms of the collective memory, the knowledge item is stored, inaccessible and with a short duration. We will call these products *side-effect* of activities. Later in a different context, however, a side-effect may well be interpreted as a main-effect . In the CSM situation, Diana's side-effect of the process of learning Chinese (the list) is recorded in the collective memory as accessible as possible and with a permanent duration. Practically this could be realised by externalising the list in a suitably configured networked ICT-environment of the collective memory. In retrospective, Jesse could reuse the list to train himself, after discovering Diana and he have a great overlap in learning style and problems. At that moment he reuses the same material, implicitly post-connecting the role of "educator" to the Diana and reinterpreting the list of words as a main-effect ("educational material") of "educator" Diana. A year later, Yusra and Jan use the data of Jesse, Diana and others that occupied themselves with the same challenge as part of a large scale experiment to investigate the problems in which Western people learn Chinese, post-connecting the roles "test persons" to Jesse and Diana. The side-effects, seen from the perspective at creation, are now again elevated to main-effects in the form of output data of an experiment. All this rests on the fact that contributions – even considered to be side-effects at the moment of creation – are stored and made accessible for manipulation at any future point in time by any member operating within any context.

The previous example makes clear that is crucial that members also record contributions they don't think to be necessary for accomplishing the goal they defined at that moment. Recording also side-effects, so the supporting activities, in the collective memory, makes it possible to post-connect *roles* to people and *categories* to contributions afterwards.

2.1.6 The Paradox of Self-Similarity and This Proposal

In an ideal case, self-similarity demands that all participants are equal creators of the environment. This document, however, already contains a list properties of a CSM, putting the writer of this proposal already in the position of a "we", and possible future collaborators in a "them" position.

This problem can be solved by interpreting the set of properties as a "beacon", instead of a set of properties that people should follow. This paper is call to people with an inner drive that already aligns with the properties as they are put forward, or better, with the underlying philosophy. I try to find other inde-

[3] Any similarities to actual persons are purely coincidental.

pendent and original thinking "wes" with corresponding ideas for collaboration, and not "thems" that would like to passively follow the described properties as if they are fixed rules. An interesting point of view to read this article is interpreting the CSM as described here as a natural phenomenon, and not as something that is designed, created or implemented. A CSM has *emerged*, when what we observe is congruent with the underlying philosophy that is developed in this paper. An example: self-similarity can be at odds with the property of role-following in some cases. For example, when a CSM is composed of a group of members that tend to specialize when following their natural inner tendency, the CSM would definitely become an interesting organisation, but it would evolve to something that lies outside the scope of what is intended here.

Also, this implies that people fall outside the scope of this proposal, when it is their intention to implement these ideas within the group they are leading (like teachers or managers trying to introduce new ways of collaborating within their group). In this way, they indirectly introduce "thems".

2.2 Solution to Problems in Contemporary Organisations

The mentioned properties of a CSM could contribute to solving a number of problems that exist in mainstream organisation and communities. However, it should be emphasised, that the CSMI does not find its conception in an observation of problems, but in positive motivations. Moreover, the CSMI goes beyond the goal to solve the problems that are formulated below. There are other approaches that could also help to overcome these problems.

- Efficient redistribution of creative energy of people. As a result of locking creative force of people down in rigid role-patterns, the right creative piece of person A will not easily combine with the creative piece of person B. Compare it with a puzzle, in which different persons have the possession over different pieces. In regular practice people of these pieces will not know each other and are assigned roles by their direct environment in which they are not even respected or seen for holding that piece. They have to develop the missing pieces themselves, while they might not be the best person to do that at that moment, or they have to go through a hard process to find other persons holding the other pieces, if they have the luck to be in a societal role that assigns them the privilege in the form of time and some sort of encouragement and confirmation that many of them might need to do so. Many pieces will probably never find their way through the rigid structures in which they are trapped.

- Adaptive environments for creating and learning. The activities of the members in a CSM will yield a variety of personalised pathways towards scientific understanding of the same theme. Not everyone has the same background knowledge, personal properties and so forth. Another problem is that the production of educational material (like good surveys and textbooks) is often years behind the cutting edge of research. Therefore, it

would be a great advancement if multiple pathways would be provided towards the understanding of a specific theme, in a much more fine-grained way than in present days, and closely following the cutting edge. The growth of these multiple pathways would be achieved automatically as a consequence of the property of a *strong collective memory* (2.1.2) combined with the property of intensive reuse (2.1.4): every one going into a "theme" leaves a trace of side-effects, that are – in contrary to the conventional situation – always accessible for reuse by others. Note that this is reached without anyone at any point even playing the role of an educator. The role emerges from the post-connecting new purposes to the side-effects that members produced while exploring the theme.

- The experience gained by an individual that has operated in different roles will have a positive influence on the development of an enhanced insight in the way aspects of his surrounding world are interconnected. Such individuals are essential for a healthy and sustainable society.

2.3 Information Technology

Although the properties of a CSM can in principle be formulated without mentioning information technology, it would be virtually impossible to bring their realisation within closer range without the use of this technology.[4] The essence of information technology is mechanised storage and manipulation of symbols. Networked information technology adds to this the possibility to access the result of these processes from anywhere. Paper can provide us with a means for storage, but accessibility is extremely low compared with digital information, and reorganisation is very laborious.

Information technology will play a fundamental enabling role in a CSM, among others because: it provides the means to record (externalisable) contributions of anyone permanently with a minimum of effort; it makes the complete collective record accessible for every member, no matter at which location they stay (= knowledge self-similarity, role-following); it allows for a quick reorganisation of contributions and stores previous stages of organisation automatically for reflection or unforeseen reuse (= intensive reuse property).

2.4 Bootstrapping a CSM

A CSM can come into existen its own development, growing from embryonal stage to a mature form and needing toys (scientific research questions) to play with as material to grow and adjust itself. Playing with the toys are not a means within itself, the role they play in the opportunity for the (collective or individual) to grow is equally important.

[4] I do not exclude possibilities like psi phenomena, for example telepathy or a collective consciousness. However, a fully developed form of the required psi phenomena does not seem to be available for most of us.

In a centralised model, with followers and leaders, planning and design is much more important for the leaders. Bootstrapping is undesirable, because the followers are waiting for well-developed structures to be followed. Another possibility is a community with a minimum of structure, which is neither intended in a CSM. With self-similarity, every single part, up to each individual member, are actively involved in refining and structuring the *whole* organisation. Self-similarity implies that each single participant plays the role of manager.

2.5 Related and Unrelated Work

2.5.1 Building the Scientific Mind of the Learning Development Institute of Jan Visser

The CSMI can be brought in relation with the goals of the Learning Development Institute of Jan Visser in general and his "Building the Scientific Mind" (BtSM) project in particular. Visser defines the scientific mind as comprising "... attitudes and skills that disposition people to question the facts and critically challenge the giveness of any a priory knowledge and authority, and moreover represents a high level of aesthetic and moral conscience." [Visser, 2000]. It is only by conceiving the world as a unity through developing a conscience that relates different aspects of existence with each other, that we can make mindful decisions. Visser urges that the development of an integrative perspective on the world, of which a scientific mind is a part, is especially crucial in meeting the challenges of this century, more than ever before in human history. It might be the difference between reaching a sustainable society – or to go *"vers l'abîme"* as Morin puts it [Morin, 1997].

Morin stated "Our thought system, which permeates education from primary schools to universities, is a system that breaks down reality and renders our minds incapable of linking up the knowledge we are made to pigeonhole into disciplines. This hyper-specialisation of knowledge, which consists of carving out a single aspect from reality, can have considerable human and practical consequences in the case, for example, of infrastructure policies, which all too often neglect the social and human dimension. It also contributes towards dispossessing citizens of the right to take political decisions and transferring that privilege to experts." [Morin, 1997]. We can conclude that defragmentation of knowledge *and* mind, is what is considered by both Visser and Morin as a fundamental condition for the emergence of a sustainable society.

Two different relations can be uncovered between CSMI and defragmentation. Firstly, the CSMI can be seen as a case-study in the development of a *collective* (and not a *fragmented*) mind, in this case applied to the domain of scientific inquiry. The technological and behavioural dimension of a mature CSM could be of help for other collective minds in other domains (like music, arts, politics, engineering etc.). Secondly, it can be seen as a contribution to the development of a *scientific* mind, in the sense of TSM of Visser. This development of a scientific mind in citizens and societies as a whole, as argued before, is in itself a part of the process of defragmentation of society.

Moreover, Visser formulates two important aims of the TSM. The first goal is "to raise the level of understanding of what the scientific mind entails and how it relates to, and is relevant for, multiple aspects of human endeavour, including, but not limited to, the advancement of scientific knowledge, insight, and know-how". The second aim is "to generate ideas and strategies about what the key conditions are that promote and facilitate the continual development of a scientific mindset as an essential ingredient – but not an isolated or exclusive component – of the human capability to deal with complex problems in context".

There is a positive relation between the two aforementioned aims and the CSM. A natural consequence of a CSM is a deepened understanding of what a scientific mind comprises. As the philosopher Bergson stated about metaphysics: "if metaphysics is possible, it can only be a laborious, and even painful, effort to remount the natural slope of the work of thought, in order to place oneself directly, by a kind of intellectual expansion, within the thing studied: in short, a passage from reality to concepts and no longer from concepts to reality." [Bergson, 1903]. Most people follow the natural slope in many processes of thinking within and beyond the borders of scientific inquiry. They model (or take over models of) reality, and integrate insights unconsciously to a great extent. Valuable insights are lost, and cannot be transferred easily to others. However, a CSM requires an externalisation of the scientific thinking process to enable a stronger collectiveness in thinking. This externalisation of thought prohibits following Bergson's "the natural slope of thought" to an important extent.

2.5.2 The Difference Between CSM and Problem Based Communities

Problem based communities have things in common with a CSM, nevertheless, they differ in some fundamental respects. Just as is the case in a CSM, they provide participants with the opportunity to cross boundaries between disciplines. However, problem based communities derive their existence from a specific set of problems to solve, as opposed to a CSM, that regards problems only as one of the type of inputs to get engaged in a process of exploration and refinement. Soly based on its definition, a problem based community has no reason to stay in existence after their problems are solved.[5] This difference is clearly visible in the differences in desired properties of the collective memory. A problem based community does not strive for a *strong collective memory* like a CSM (see 2.1.2), but optimises the three dimensions (accessibility, duration and spreadedness) to the extent it helps them to solve their problems. For example, knowledge self-similarity does not have to be complete, if it is sufficient for arriving at the level of insight needed to solve the problem. A high turnover is extremely problematic for a CSM, because knowledge self-similarity can hardly be reached under that condition, while a problem based community would be willing to pay that

[5] Of course, this doesn't exclude the possibility that a problem based community derives a reason to continue its existence from its social context. But these are all circumstantial, and not included in the definition of "problem based".

price to come within closer range of the solution of their problem.

2.5.3 The Difference Between CSM and Multi- or Transdisciplinary Research Teams

Multidisciplinary or transdisciplinary research teams are often implicitly problem based communities. They are often formed *after* people have discovered that solving specific type of problems requires crossing traditional boundaries between disciplines. For this reason they differ in the same way as problem based communities from a CSM (see previous subsection).

2.5.4 The Difference Between CSM and Problem Oriented Societies

Many assume that the main driving force of (individuals and groups within) society is problem oriented. We will coin the term "problem oriented society for this perspective on society. A natural question that arises from this perspective is how to create an environment in which everyone can find the right piece of knowledge needed to solve the problems in his or her specific context. The difference between CSM and a problem oriented society, can again be pointed out by investigating the differences in the desired properties of the collective memory of a problem oriented knowledge society and that of a CSM. In the problem oriented knowledge society, we strive for an accessibility of 1, just as in a CSM, a high duration would also be preferred in both, but knowledge self-similarity is not relevant in the problem oriented knowledge society, where it is optimised in a CSM. Concretely: a member in a CSM would also make a "mental copy" of the knowledge gained by another member that is not needed for solving his or her specific problems, whereas members of a problem oriented knowledge society are not considered to be doing this. They are considered to be mainly or exclusively driven by solving the problems in their problem context, and not playing a part in the integration of knowledge.

3 Properties of Participants

As the introduction of this paper suggests, this proposal is both a first development of the notion of a CSM, as an invitation for participants to start a community that could grow into a CSM. The following list enumerates properties of matching participants. The list should not be read as a set of *requirements*, but rather as a mutual investigation to find out if there are *matching conditions*. You are invited to contact the author when you have questions, or if you would like to participate. Please suggest reading this paper to anyone who you think might be interested in participating.

- The participants are *not interested in following* the properties of the CSM as a set of fixed rules, but *recognises* her or his motivation and ideas in the underlying philosophy.

- The participant, if he or she happens to have a leading position (like a teacher or a manager), does not intend to extend the CSM with the group he is leading (see 2.1.6 for an explanation.)
- The participants are at least equally interested in the construction of the CSM, as in the content of the specific chosen research-topic itself. Sometimes, a participator has to spend time to processes that will slow down the process of his or her individual penetration into the scientific topic, although it will be beneficiary for the CSM as a whole. An example is sharing and explicitising gained knowledge in relatively fine-grained level in a shared computer-environment. This will take time.
- The participant should have enough time available to dedicate to this project.
- A critical mind that is willing to look beyond established frontiers. It is easy to state a goal is reached with an uncritical mindset, but with doing this the real development stops. Not working roads have to be recognised sharply, and reached goals evaluated critically. On the other hand, it is also easy to dismiss the possibility of the realisation of aspects on the basis of challenges that seem to be insurmountable on first critical sight. The right roads have to be found.
- The participant is consistent with regard to communication and appointments, something which is especially crucial for the sustainability of a CSM, in which participants most probably will be living far from each other.

4 "Appetizers" for a CSM

Until now the CSMI has been defined on a high conceptual level. Since a CSM is a collective effort, all participators being developers of the system, this is exactly what is required (see also 2.1.6). However, a negative side-effect might be that without a tangible suggestion for where to start, there are too many interpretations possible. Firstly, this makes it hard to come to an initial coherency that is strong enough for providing a sense of unity among the participators. Secondly, abstract terms may lead to a gathering of individuals that in closer inspection do not seem to be so much on the same line. Thirdly, the concrete projects to start with are based on an ongoing survey study, and provide a head start for the community.

Nevertheless, they are put forward as suggestions, so it is possible to choose other appetizers depending on the future participants in a community that could evolve into a CSM.

4.1 Appetizer I: Explicitised Argumentation on a Specific Scientific Topic

Definition After selecting a scientific topic to explore (e.g. how to proof some mathematical problem, or a prediction for the possible future of Cuba after Fidel Castro) the CSM builds a *knowledge-graph* that is built and shared through a self-developed ICT-environment. The knowledge-graph contains nodes, which can represent concepts, and links between the nodes that describe their argumentative relations. For example: "A is a proof for B", or "B is inconsistent with C". This graph epitomizes the collective knowledge of the CSM about the subject at any stage. It is a result of individual members making their complete process of thinking about the topic as explicit as possible in this knowledge-graph, at the same time as making a "mental copy" of the incoming contributions of others. Given this basic structure, there are many parameters left open to explore, like:

1. Which social behavioural mechanisms are needed to reach a shared vocabulary?
2. How can we adapt our information communication technology to support it?
3. What is the right way to explicitise the knowledge unambiguously?

Connection With CSM-principles In fact, the knowledge-graph represents (an important part of) the collective memory of a CSM in a very tangible form. This allows for experimenting with almost all properties of a CSM (see 2.1):

- Role-following and self-similarity: there are no fixed roles. Firstly, anyone is allowed to put in knowledge items (compare with role of "scientist"), or to read any of the other items (compare with "student" or "scientist" conducting a survey-study). This allows any member to contribute at the moment he or she *receives* a consideration or insight from his or her own natural internal mental processes after interaction with the knowledge-graph, instead of being forced to answer specific questions at specific moments of time. Secondly, not only the knowledge expressed by, but also the vocabulary of the system is developed by all participants. Thirdly, the system itself may be improved and adapted by any member while using it. (see 2.1.3 and 2.1.1).
- Strong collective memory: knowledge items are put into the knowledge graph at whatever state they are in, and include considerations and incomplete thoughts and they are permanently accessible for any other member. Both provide handles to indicate to what extent knowledge self-similarity has been reached with respect to the chosen research topic (it can even be calculated automatically). (see 2.1.2).

- Intensive reuse: the knowledge-graph can be reorganised and improved continuously during the process, while at the same time old states are backed up, so that they are still accessible at any moment in the future for unforeseen reuse (see 2.1.4).

4.2 Appetizer II: Collaborative Article Conquering

Closely related to the previous point is "collaborative article conquering", only in this case the starting point is the collaborative study (and with this a transformation and enrichment) of an *existing* written piece of knowledge. A self-contained set of articles and books are chosen about a specific topic. "Self-contained" refers to the fact that it doesn't rely too much on other work to be understood.

Every individual reads the work and while doing so, making his understanding, insights, thoughts, questions and alternative explanations, however informal or simple, explicit and accessible for other participators in a knowledge-graph structure as described in 4.1. In fact, this process leads to a conversion of the text into a collectively shared knowledge-graph, enriched with all thoughts, considerations, unclarities and alternative explanations. Just as described in 4.1, the provided rudimentary environment for constructing these graphs will be refined further by the participants, while going through this process.

This process also serves as a demonstration and exploration to what extend a CSM could contribute to the emergence of an adaptive learning environment (see 2.2). Parts of the material to be studied will be considered unexplained by one will be considered trivial background knowledge by the other. This will lead to different sets of questions. In a sense, every member will make another part of the knowledge contained in the written material "visible", enhancing its accessibility for a wider variety of people.

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