CREATIVITY: WHERE SHOULD WE LOOK FOR IT?

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Abstract. I characterize two approaches to the study of human creativity as based on the principle of Belief and Performance, respectively. Employing notions developed in the Social Sciences,I scrutinize the strengths and weaknesses of these approaches for selected problems in the theory of creativity. I look for common links between these approaches, and sketch a framework for their future interaction. The text is structured in terms of six claims, discussed from general to specific. To support one of the claims, I briefly discuss an example of my own research in computational psychomusicology.

1. Introduction

The term 'creativity' is a linguistic artifact meant to facilitate a synthesis of observations and hypotheses about the ability of humans, to validate their experience, or even to transcend their self. Whether they refer to the sciences or the arts, creativity concepts are culture-bound. In particular, they depend on one's notion of what minds are, how far a mind can be fitted to a person rather than a community of persons, and how a 'society of mind' (Minsky 1985) is seen in its relationship to the physiological and psychological substrates that undergird it. Creativity concepts have great social weight; they are part of the landscape they are supposed to help explore. It is this inextricable social interwovenness of creativity and society that makes creativity concepts hard to substantiate, clarify, and evaluate.

In most of the humanities of western society, implicit theories of creativity have been articulated for hundreds of years. In the second half of the twentieth century, two divergent efforts have been made to turn the notion of creativity into a scientific concept, and to substantiate what it stands for by way of empirical inquiry. The first effort has emerged from the social sciences, in particular from sociology and cognitive psychology, while the second is rooted in computational ideas, viz., the tradition of trying to understand human competence and expertise by designing 'intelligent' computer environments.

Following the 1950 address by Guilford, through which creativity was first admitted to the psychological research agenda, psychologists conceived of creativity as a'trait' individuals possess to varying degrees. Since the nineteen-seventeens, especially under the influence of Czikszentmihalyi, social scientists investigating creativity have veered away from the tradition of intelligence tests, to focus on individual differences. Instead, they have developed a notion of creativity as a relational construct linking Person, Domain, and Field (Czikszentmihalyi 1988; Fig. 1). According to this notion, creativity is not a trait, or faculty, of a person, but a (retrospective) judgment of experts representing social arbiters who evaluate the impact of a person's products or ideas on the structure of a particular domain.

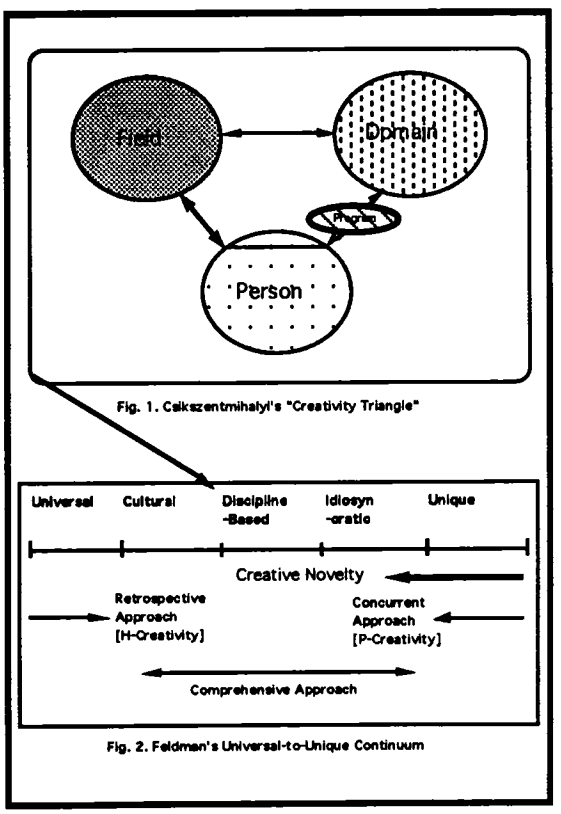

Fig. 1. Csikszentmihalyi's "Creativity Triangle"

Fig. 2. Feldman's Universal-to-Unique Continuum

By contrast, AI has continued to hold on to the notion of creativity as a quality intrinsic to individuals ('trait,' 'faculty'), only that this quality is now ascribed to individual computer programs (as embodiments of computational

ideas), not human individuals. The most enlightened definition is that of M. Boden who, conceiving of creativity as a "faculty," defines it as an aspect of intelligence in general involving many different capacities (Boden 1990:24). But this is nevertheless a person-centered definition.

Not only are these two approaches at odds with each other; they also imply two different notions of 'psychology', --one calling itself 'computational psychology' (Boden 1990:268), the other, 'cognitive and/or social psychology.' The difference between them is straightforwardly one of epistemology. While the social scientist situates 'mind' in a historical community of persons, the AI effort is continuing the tradition of subjectivist philosophies. Such philosophies locate mind in an idealized individual 'beyond history,' out of reach of the historical cycle of forces linking Field, Person, and Domain (in the sense of Czikszentmihalyi). The 'mind' they address themselves to is equally beyond forces determining the Person node, such as emotional, moral, and social factors of human development.

2. Computational Ideas as Creative Novelties

During the last 50 years, the computational ideas deriving from Alan Turing's idea of a 'Turing Machine,' both as a formal-language description and as an effective procedure, have revolutionized the technological environment in which we live, as well as our notions of intelligence, domain of expertise, and competence. Computational ideas have started their evolutionary journey from the unique toward the universal pole of Feldman's developmental continuum, from where they now, due to AI, reverse direction toward the idiosyncratic pole, pervading other than purely technical pursuits and disciplines (see Fig. 2).

According to M. Boden, it is not the computer program per se that matters, but the fact that it is an embodiment of computational ideas (Boden 1990: 267). These ideas take two different forms, that of static representations of knowledge data, and that of 'effective procedures' generating new knowledge data. In terms of Czikszentmihalyi's creativity triangle (Fig. 1), a computer program might be seen as an extension of the Person node. With equal right, one might see it as a medium revolutionizing any Domain, at least in terms of the form of access to the Domain. In that they enable one to 'formalize' a Domain, computational ideas change the way a Domain appears to the Person, even to the Field. The structure of the Domain, heretofore implicit, becomes explicit. In the arts, interactive program may become the artist's 'alter ego' (Laske 1990), opening the structure of the Domain to systematic experimentation. Once a Domain becomes 'formalized,' it also tends to have a different relationship to the Field: judgments by the Field tend to become undergirded by highly technical arguments, and are often nearly instantaneous (in terms of historical time). This in turn creates new social forces blocking or promoting creativity in a domain. The existence of computer programs forces the culture, to redefine, or at least refine, its notion of Domain.

Not only does the application of computational ideas tend to restructure scientific and artistic domains. Through the objectivation of domain knowledge in the form of 'knowledge bases,' entirely new domains (such as, e.g., computer music, or biogenetics) are increasingly being created. At this time in history, we are witnessing a change in the nature of the 'knowledge level' (Newell), both psychologically and sociologically. Knowledge management emerges as a new discipline without which actualizing expertise and realizing creative breakthroughs, at least in the sciences, is becoming more and more impossible. In terms of creativity research, new questions come to the fore. Of these, one of the most important may be how a 'symbol system' (in the sense of Simon 1972, not Goodman 1976) that is situated in the logico-linguistic domain, --according to Piaget a universal domain,-- can become instrumental in gaining insight into other, non-universal, human intelligences in the sense of (Gardner 1983). It is the assumption of AI in the form of 'computational psychology' (Boden 1990:287) that a formalized system can shed light on human intelligences, and on creativity at large.

3. Claims Put Forth In this Paper

The foregoing narrative of the history of creativity studies, and the foregoing description of the effects of applying computational ideas derive from a certain perspective. It is the perspective of someone who has done research in computational psychomusicology for 20 years. Below, I make that perspective explicit in the form of a set of claims, or hypotheses, listed from general to specific:

[1] 'Creativity' is a concept of social meta-cognition; it takes the form of consensual judgments that are based on comparisons between some state of the art, and novel ideas and products, in some domain.

[2] Studies in creativity are inquiries of a culture into itself, whatever approach they may be following. Such cultural self-inquiry is misrepresented when it is carried out like an empirical inquiry "as any other," viz., by forgetting that one is dealing with meta-cognition.

[3] Problem solving is a matter of expertise (competence), while the fashioning of novel products and the devising of new questions

(where 'novel' is defined by a social context) is a defining aspect of creativity (Gardner 1992:74, Czikszentmihalyi et al. 1971).

[4] There exist two, mutually exclusive, approaches to research in creativity, one that is based on the principle of **Belief**, and the other that is based on the principle of **Performance** (Laske 1992b), ultimately a difference between Being and Doing. The social science approach follows the principle of Belief, as do the humanities, while the AI approach follows the principle of Performance. The Belief approach assumes that creativity exists; it is geared to answering the question of what it is. By contrast, the Performance approach assumes creativity as an hypothesis, and then attempts to show how processes worthy of the epithet 'creative' might be structured and might function. In short, while Belief approaches *demonstrate* creativity, Performance approaches actually want to *generate* it, e.g., by simulation (synthesis by analysis). What both approaches share is the need for the interpretation of their preconceptions and findings. In other words, both have a hermeneutic component, and thus a social dimension.

[5] Studies in AI and creativity have a double focus: investigations [1] into the structure of domains, and [2] into the relationship between Person and Domain. Approaches focused on [1] utilize 'analysis by synthesis,' or simulation, while approaches focused on [2] employ knowledge acquisition in the framework of interactive task environments. (By 'interactive' I mean the use of programs not as a medium embodying creativity, but for facilitating creative action.) Both approaches may be combined.

[6] Documenting work of individuals in interaction with computer programs generates knowledge data that is in need of interpretation. Interpretation is a hermeneutic task that poses the same creativity problem that it is supposed to solve. This seems to mean that 'absolute answers' to questions regarding creativity may not be forthcoming, especially since "nothing is creative in and of itself" (Gardner 1992:74). Rather, finding what creativity might be requires one to be creative.

[7] The discipline of AI seems uniquely suited to clarifying issues having to do with the Domain (Czikszentmihalyi 1988), while the social sciences seem better equipped to further insight into Person and Field. Focusing on one of these topics alone is a one-sided undertaking; for arriving at a comprehensive theory of creativity, both roads need to be taken.

4. Discussion of the Claims

4.1 CREATIVITY IS A CONCEPT OF SOCIAL META-COGNITION

Simply, this amounts to saying that creativity is a concept by which a culture reflects upon itself, and thus transcends itself. It is thus not an 'empirical concept' (such as a concept denoting a newly found gene). Rather, it is a concept that is perhaps demonstrable, exemplifiable in terms of what a culture has viewed as creative in the past, cherishes as creative in the present, or may want to encourage as creative in the future. It is basically a value (i.e., axiological) concept, not a scientific one (see also section 4.3). The conceptual gulf between the noun 'creativity' and the adjective 'creative' is unbridgeable; it reflects the gulf between human notions of Being and Doing (which, especially in western culture, exclude each other). Therefore, creativity is, and will remain, a 'speculative' concept that surpasses 'what is' in search of a way to characterize what, at the time of writing, makes certain ideas or products seem revolutionary within a particular domain, or even the entire culture. Another way to interpret the claim might be to say that theories of creativity address the present in the guise of speaking about the past, clothing 'what could be' (in some future) in garments of history. While these theories pose as though they were telling historical truths, they contain a utopic residual that addresses a societal state of affairs. To expunge this residual would rob such theories of much of their social value.

4.2 CREATIVITY STUDIES ARE A WAY OF CULTURAL SELF-INQUIRY

If studies in creativity are ways in which a society inquires into (the driving forces of) its own culture, it seems unlikely that such studies can do more than 'demonstrate' (or exemplify), rather than 'explain,' creativity. Explaining creativity would mean for a culture to be able to transcend itself and look at itself from the outside, as though explaining itself to a being from another planet.

A cultural self-inquiry is a useful 'what-if' proposition. It is well exemplified by (Boden 1990). In her book on The Creative Mind, M. Boden distinguishes four ("Lovelace") questions about AI and creativity. These questions regard the status of computational ideas in creativity studies. The first question is specifically about computational ideas; it formulates the main issue the book is about. The three remaining questions center around 'computers' as implementations of computational ideas. In brief, these questions ask (Boden 1990:6-7):

[1] can *computational ideas* help us understand how human creativity is possible (Answer: Yes).

[2] could *computers* (now or in the future) do things which at least appear creative (Answer: Yes).

[3] could *computers* ever appear to recognize creativity (for instance in a poem). (Answer: Yes).

[4] could *computers* ever REALLY BE creative (as opposed to merely producing apparently creative performances whose originality is wholly due to the human programmer). (Answer: No).

These four questions are engaging in that they distinguish aspects of creativity that are often merged; appropriately, they also have a utopian flavor that I noted about creativity studies above. Let us consider each of these questions in terms of social science concepts, especially the Chikszentmihalyi creativity triangle (Fig. 1).

The first question is formulated in the tradition of Belief approaches, but is really meant to endorse the Performance approach. (It thus obscures the difference between the two approaches). Questions 2 and 3 are formulated from the perspective of the Performance approach. The fourth question is, once more, formulated in the tradition of Belief.

The first Lovelace-question asks whether computational ideas have matured to a point where a computational psychology can use them to "understand" how such a thing as creativity "is possible." Thus, psychology is cast into the role of a 'science of the possible,' or, to speak with H. A. Simon, a 'science of the artificial.' Such a science is not concerned with 'what is,' but "with how things ought to be--ought to be, that is, in order to attain goals, and to function" (Simon 1969:5). Such a science will tend to characterize creativity "in terms of functions, goals, and adaptation" (op. cit.:6), giving "functional explanations" that are demonstrations of the possible. The science pursues a generative, or Performance, approach to creativity.

In terms of Chikszentmihalyi's creativity triangle, the question of 'how creativity is possible' is hard to situate at either the Person, Domain, or Field node. This ahistorical question about 'psychological' creativity (P-creativity, Boden 1990:32) is not addressing the historical situatedness of creative individuals that is topical in social science research, nor is it directly about the Domain, although it could be construed as being about how the structure of the Domain makes creativity possible. Nor is this question one that one would ask regarding the Person node, except if 'Person' were viewed as an idealized individual beyond time and space that is engaged in creative pursuits viewed from the vantage point of a Martian culture. Clearly, this question is speculative in the sense that what is possible does not always materialize. For me, the question comes closest to inquiries of a 'theory of composition' (Laske 1989) conceptualizing composition as the art of the possible and compossible in some domain (e.g., a pursuit of 'possible musics,' in contrast to 'existing musics').

The major emphasis of Boden's first question is, however, on *understanding:* can WE, being part of this culture, and accepting its implicit notions of creativity, understand how creativity may be possible. This question is more about us than about creativity. Since creativity is assumed to exist, what remains to be seen is how we, as social individuals, can understand it, using computational ideas. 'We' (who want to understand) are neither at the Person, the Domain, or the Field node. Our question is situated at Feldman's universal node. We want to understand creativity once and for all, as something common to all humans (P-creativity), not creativity that is specific to a particular historical person (H-creativity) of which no systematic account can be given at all (Boden 1990:33-34).

The term 'understand' in the first Boden-question (which is borrowed from the humanistic Belief tradition), then, is a very emphatic one, in that it requires us to synthesize (generate) what we want to understand. Anything short of that would be, in AI jargon, "mere handwaving." This stringency is characteristic of what, in claim #4, I have called the principle of Performance. Only a culture such as ours, which is centered around the notion of humankind as 'homo faber' could possibly give birth to a concept of understanding by generating, rather than understanding based on belief.

What Boden is trying to understand is a domain-specific ideal-type of creativity, which expresses our culture's pre-occupation with doing, making, fashioning, rather than being. The question stresses 'understanding by doing.' In that sense, the first Lovelace-question is culturally affirmative, in that it confirms a pre-existing, implicit concept of creativity. Predictably, then, Boden's inquiry, affirmative of the tenets of this culture, rejects the possibility of 'computers' ever being really creative (Lovelace-question #4). Czikszentmihalyi answers 'No' to the fourth Lovelace-question on account of what Boden calls 'the non-human argument.' The argument is based on "a certain attitude toward computers, an uncompromising refusal to allow them any social roles like those enjoyed by people" (Boden 1990:281). But this attitude is also a social science stance. It requires that beings to whom creativity is ascribed to be "motivated to compete with us in our ecological niche" (Czikszentmihalyi). And computers clearly are not "automatic members of the human community, in the way that member of the biological species *homo sapiens* are," although, in Boden's view, "they could have honorary membership in human conversational groups" (Boden 1990:281-282).

4. 3 PROBLEM SOLVING IS A MATTER OF EXPERTISE, PROBLEM FINDING ONE OF CREATIVITY

One of the merits of AI inquiries into creativity, in my view, is that they pose the question of how expertise may relate to creativity. Today's empirical sciences justify the link between expertise and creativity by the assumption that creativity is domain-specific, that a person is not creative "across the board" (Gardner 1992:73). In Czikszentmihalyi's thinking, this is expressed by the Domain node. In contemporary social science discussions of creativity, a touchstone for the distinction between expertise and creativity often is the notion of novelty. Finding solutions to existing problems is contrasted with finding new problems. Boden distinguishes 'first-time novelty' from 'radical originality', the latter being something that cannot be produced "by the same set of generative rules as other familiar ideas" (Boden 1990:49). When discussing novelty, Boden asserts: "novel outputs are neither *necessary* nor *sufficient* to make a program a strong candidate for creativity. The are not necessary because ... psychological creativity (P-creativity) often produces ideas that are not historically novel (H-novel). They are not sufficient because a novel output may have been generated in an uncreative [sic!] way. Whether a program models creativity depends more on its inner working than on the novelty value of its output. The crucial question is whether the output was generated by processes that explore, test, map, and/or transform the conceptual space inhabited by the program concerned" (Boden 1990:135).

Previously, Boden had defined creativity, in close agreement with D. Perkins (1981), as "not any special power, but a greater knowledge (in the form of practised expertise) and the motivation to acquire and use it" (Boden 1990:24). Her definition of creativity in terms of conceptual spaces is a computational version of the previous one, which emphasizes creativity as an "aspect of intelligence in general, which in turn involves many different capabilities" (ibid.).Boden's definition of creativity as P-creativity accomplishes several things:

[a] being person-centered, it removes the social dimension, or Field, from considerations of creativity

[b] it isolates psychological creativity (as an individual's experience) from its historical context, encasing it as 'P-creativity'

[c] it binds creativity closely to problem solving in a Domain, or even identifies the two notions

[d] it assumes we already know what is an "uncreative way" of producing outputs--but, if we did, we would not have to study creativity!

[e] it considers a 'program' a potential embodiment of creativity

[f] it declares that AI's forte in studying creativity lies in the exploration of the structure of a Domain, viz., of what are the "processes that explore, test, map, and/or transform the conceptual space inhabited by the program concerned."

Put differently, creativity, nearly indistinguishable from "creative problem solving," is a "trait" of, or "faculty" of, performing idealized mental processes situated within the context of a transhistorical Person-Domain relationship.

It is in the aspect of novelty that one may locate the crucial difference between the Performance (AI) and Belief (social science) approach to creativity. For the AI approach, novelty is "P-creative," for the social science approach, it is "H-creative." The two will never meet, unless one pauses to consider that H-creativity is as much a (culturally affirmative) reconstruction as is P-creativity. As to the distinction between expertise and creativity, only empirical studies of the Person-Domain relationship could throw light on the conditions under which expertise 'transcends' itself, to become creativity.

4.4 BELIEF VERSUS PERFORMANCE IN CREATIVITY STUDIES

Belief is manifest in social science studies in at least two ways. First, to investigate creativity empirically, within specific historical contexts, one already has to 'believe' that it exists, and one has to accept the noun 'creativity' without a tremor. Second, as a social scientist, one must be convinced that others, by reading books or papers about creativity, can be further convinced of its existence. People who read such books and papers, on the other hand, must already believe that creativity exists, and only want to find out more about how precisely one might construe it in a particular case. Therefore, just as the musicologist assumes in his writings that the reader already 'knows' what 'music' is, so the social scientist writing about creativity assumes that the reader, at least implicitly, 'knows' what 'creativity' is. In short, we are engaged in an exercise of cultural self-affirmation (using accepted empirical methods).

What is the concept of mind underlying research based on the principle of Belief? It is a mind that constitutes itself within the triangular relationship between an individual (Person), a Domain of expertise (competence), and a social group of judges called the Field that monitors the Domain for revolutions within its structure of knowledge (Fig 1). Belief mind is a discipline-based, "professional," and thus social, mind, viz., a mind whose psychodynamic, cognitive, moral,

and social development is monitored by a battery of social sciences that attempt to map its development, its break-downs, and triumphs.

Performance, --the question of HOW such a mind 'functions'-- is quite a different matter. In performance studies, the underlying notion of mind and creativity is "based on an intersubjectively verifiable modeling of the psychological processes of the individual human mind" (Seiffert 1992:219), especially in as far they can be verbalized and, further, "formalized" (Balaban et al. 1992:x). This Cartesian notion of mind is that of a "logical mechanism" in which knowing is separated from action (acting upon what is known), except for action idealized in a computational sense, of 'effective procedure.' The 'performance mind' is also a social mind, but its social substance is rather thin: it is restricted to the "intersubjective verifiability of modeling psychological (or socio-psychological) processes." In fact, the 'performance mind' fits well within the 'belief mind' (see Fig. 3a). It is a logico-linguistic intelligence whose situatedness within an emotional, moral and social context is explicitly acknowledged only when questions such as "can computers share the privileges of homo sapiens" arise. At that point, the "impertinence" (Boden 1990:281) of artifacts such as computers impinges on the 'belief mind' which maintains that "computers are not automatic members of the human community" (ibid.).

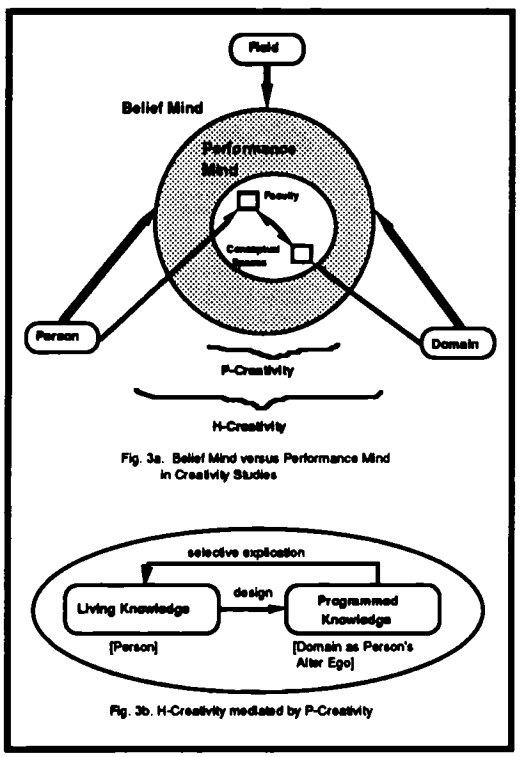

Fig. 3a. Belief Mind versus Performance Mind in Creativity Studies

Fig. 3b. H-Creativity mediated by P-Creativity

4.5 THE DOUBLE AI FOCUS: STRUCTURE OF DOMAIN AND RELATIONSHIP PERSON TO DOMAIN

Work in AI and creativity seems to have two different foci: investigations into [1] the structure of the Domain, and [2] into the relationship of Person to Domain. As can be seen in Fig. 3a, the 'Performance Mind' assumed in AI is situated within the 'Belief Mind' assumed in social science studies. The Performance Mind is an hypothesis meant to help 'explicate' the Belief Mind by 'generating,' in contrast to 'demonstrating,' creativity (which, in AI terms, is "mere handwaving"). What, in the Performance Mind, is called a 'faculty' (creativity as a faculty), is an aspect of the Person that omits motivational and social constraints on the creative individual. What is called 'conceptual spaces,' is a formalized version of Domain regarding which emphasis falls on artificially designed mini-domains in which effective procedures and/or person-computer interactions can be observed, and their outputs scrutinized. Ultimately, interpretations of results of such scrutiny fall within the universe of discourse sanctioned by the Belief Mind.

A. Focus One. I would agree with Boden that AI is well suited to a "study of conceptual spaces" defined in terms of constraints, in terms of both human failures and successes (Boden 1990:82, 91). I would also concur with her in saying that AI researchers are in a privileged position "to identify a number of clearly stated hypotheses (regarding P-creativity) which psychologists can investigate" (Boden 1990:92): "AI concepts can help us think more clearly about conceptual spaces of various kinds" (Boden 1990:72).

B. Focus Two. However, there is one kind of study that neither Boden nor Czikszentmihalyi seem to think relevant, or be aware of, which I would consider a second avenue for AI research in creativity. I refer to studies in the relationship of Person and Domain. More precisely, I mean studies in the relationship of Person and 'formalized' Domain, i.e., domains of competence whose structural contents has been objectified to some extent by way of knowledge bases, or at least a computer program. Exploring that relationship requires a methodology sui generis, viz, task-based knowledge acquisition and modeling (Laske 1992a).

In my previous studies of this relationship based on my experience as a computer-based composer, I have referred to the computer qua mediator between Person and Domain as "the artist's Alter Ego" (Laske 1990). Another way of formulating this relationship of Person to formalized Domain (knowledge) is shown in Fig. 3b. In the figure, creativity is 'situated' within the interaction between two

species of knowledge: "one that is alive in us, and another that (cognitively) embodies us in the form of an external 'knowledge base'" (Laske 1992c:242). We are dealing with a dialectical relationship between Person as "living knowledge" and Domain as "knowledge base," where the knowledge base is that part of living expert knowledge that we have been able to account for, verbalize, formalize, and implement by way of a computer program. The relationship between these two parts of "our" knowledge is a dialectical one, in that new insights arrived at through Person-Domain interaction can directly be fed back into the Domain in the form of extended and refined knowledge bases (Truax 1991). Studies of this kind are especially suited to investigating 'problem finding' (versus problem solving), and the 'scaffolding' that computer systems can provide for creative pursuits.

4.6 INTERACTIVE CREATIVITY IN PRECOMP

Fig. 4 depicts an environment for creative work in music composition called PRECOMP (Laske 1990). The name indicates that the system is an interactive device meant to facilitate the "pre-compositional" decision-making about the design of a musical form. This decision-making precedes composition proper in the sense of writing a score. The Preprocessor (never built) poses an AI problem, viz., how to permit a composer to state a musical idea in natural language that the preprocessor can 'understand' so as to generate an input 'formula' triggering the generator in Module A. The generator creates an alphanumeric list of 'events' comprising between 2 and 6 'tones,' together with temporal, timbral, and dynamic specifcations for each event. An event can be interpreted as a melody, a chord, or some hybrid syntactic configuration. In order to be able to use the event list, the composer must therefore give harmonic, melodic, and rhythmic 'interpretations' to the alphanumerically encoded events, employing his knowledge of counterpoint, harmony, orchestration, and musical form. Since it is not straightforward, even for an expert musician, to interpret an alphanumeric list of symbols, module B displays, in visual form, the main music-analytical characteristics of the event list text, using graphs and time-specific analyses (such as number of tones per real-time second, predominating tone center, etc.). By employing module B, the composer can 'make up his mind' about the musical form she wants to build, using a variable number of event lists to define sections or movements. In this pursuit, it is helpful to do a segmentation analysis of event lists, in order to find out where in such a list to locate 'breakpoints' around which to structure a musical form (e.g., a shift in tone center, or rhythmic flow). This purpose is served by module C. The module stores the composer's segmentation decisions and utilizes them to compute a list of events that, in light of the decisions made, can serve as potential breakpoints. With the aid of this information, the composer can then formulate the input to module D which transcribes the event list into the form of a conventional 'note list' score. In this score, the events initially generated are interpreted as actual 'voices,' aggregated into form sections. The segmentation decisions the composer feeds to module C together form "action protocols" that document the composer's step-by-step design deliberations. These protocols constitute empirical knowledge data that one can scrutinize and model in order to investigate creative decision-making.

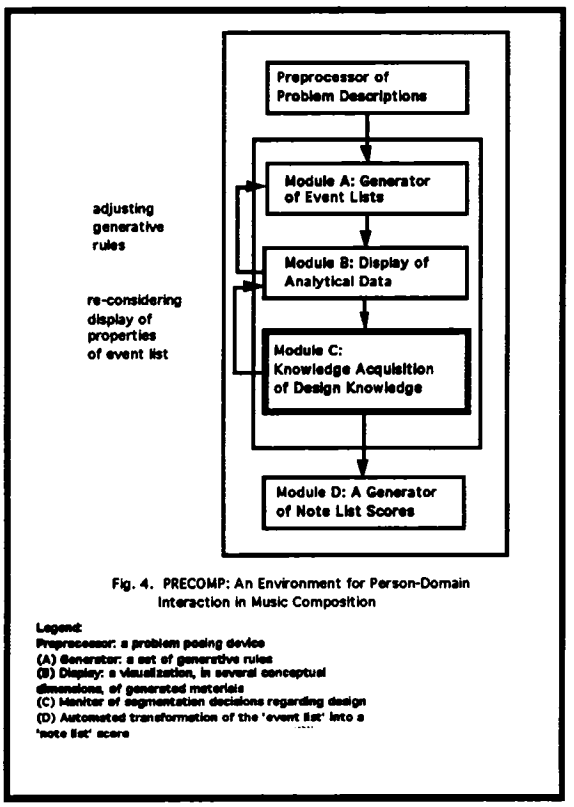

Fig. 4. PRECOMP: An Environment for Person-Domain Interaction in Music Composition

Legend:
Preprocessor: a problem posing device
(A) Generator: a set of generative rules
(B) Display: a visualization, in several conceptual dimensions, of generated materials
(C) Monitor of segmentation decisions regarding design
(D) Automated transformation of the 'event list' into a 'note list' score

A computer system such as PRECOMP can be employed to gain insight into some of the questions raised by Czikszentmihalyi. For instance, the question of 'how the structuring of information affects creativity' could be studied empirically with the aid of module B which recasts analytic information about compositional material (event lists) into visual form, to faciliate deliberations about musical form. Analyzing and modeling action protocols generated by module C requires a theory of domain knowledge, as well as a hypothesis of musical creativity int he context of the PRECOMP task (Laske 1992a:278-286).

In both cases, the link between expertise and creativity can be empirically investigated.

4.7 SUMMARY

There exist two on the face of it mutually exclusive approaches to creativity, viz., the Belief and the Performance approach. As the language used in (Boden 1990), who represents the Performance approach, demonstrates, practitioners of the latter find it difficult to formulate what they want to say without borrowing vocabulary indigenous to the Belief approach. Practitioners of the Belief approach, on the other hand, have difficulty being really specific about notions such as 'relationship of Person to Domain,' unless they have recourse to the Performance approach. Methodologically, then, it might be fruitful to regard both approaches as complementary rather than mutually exclusive. However, enacting both approaches as mutually supportive of each other is beyond the state of the art of the theory of creativity at the present time. One might hope, however, that a deepened knowledge of the 'other' approach to creativity on both sides might, in time, lead to an artful merger of the two approaches. Such a merger would be a creative act by which one would enrich the theory of creativity.

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