The importance of being abstract: An Indian Approach to Models

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Traditional Indian way of life is surrounded by ambiguity. This is in direct contrast to an Aristotelian approach, where polarised stands are always taken. A black and white approach tends to yield results speedily, but exhaustive solutions which can explain complexity are usually brute force procedures. Even so, their conclusions in the end are still suspect.

The author believes that rich solutions may exist when we use an 'alternate' or abstract synthesized reality to do our modelling instead of relying on analogies and other direct links to the real world. Models that allow synthesis tend to accept ambiguity.

The author presents in this paper an 'unconventional' system to represent architecture which has had some amount of success probably because it started of, on pure abstract grounds that allowed ambiguity instead of basing it on an Aristotelian, analytical model.

Keywords: *Aristotle, Buddha, Representations, abstract models*

Ambiguity in models

Most of the currently accepted approaches to models start out by basing them on interpretations of reality. The aim of this paper is to see the validity of this approach and check if it is important to isolate models from reality itself. And if so, how do we form such models? The paper largely concentrates on why a synthesis approach could be better than an analytical approach. It cites as an example, a system developed by the author for architectural designing.

There are some working definitions that are needed for the rest of the paper: A '*model*' is that construct which is used to describe and hopefully solve real life problems, before actually carrying out the real life activity itself. A '*theoretician*', is the person who proposes such models and a '*user*' is the person who uses the model. In this paper, the *'success of a model'* is associated with the implication that more people could derive meaningful use of a model in comparison to a lesser successful model. The term, *'accuracy of a model'* is used when a user is successful in communicating to other users, using the model.

Current trends in AI seem to indicate a leaning for deterministic, general purpose problem solving solutions: A natural convergence to an understanding of the workings of nature or at least some parts of it. (e.g. the working of the brain, genetic mechanisms, etc.) Many times, it seems convenient to use analogues from current understanding of the real world. The assumption here is that once we understand how nature goes about doing its work, then one can use that understanding to propose specific models to suit individual requirements. There are many examples which corroborate this observation[1]

Unfortunately, the ambiguous, real world around us does not permit readily convergent solutions.

Ambiguity is hardly a strange concept in any society. Current AI literature also talks about it. [2] But the part of being 'scruffy' (aka. Ambiguity [15]) seems to be portrayed as a necessary aberration that needs to be put to rest as soon as possible; without reinvestigating certain core premises, such as analogues being the foundations of such research. The theoreticians are reluctant to rethink the neat, logical foundations of their theories.

Minsky has given the reasons why logic-based formalisms have been widely used in AI research [2] He further goes on to state how the very theoretical neatness of logic is what could be its failing. Such a conclusion should mean that the very need for handling ambiguity should make us re-examine the basic concepts on how models are to be formed. Something that is purely founded on mathematical logic would be reluctant to handle ambiguity [8].

Even if the various factions in AI differ in the methods they use; the need to converge to a narrow range of solutions, if not a unique solution, is quite prevalent. When a convergent approach is sought, it implies that all the parameters would have to be made deterministic. Whatever other philosophies that may be used to explain current theories, such an approach is essentially *foundationalism* at work or some kind of *Aristotelian* approach. [3] I am definitely not qualified to start a philosophical debate on Aristotle; but even a faint presence of Aristotelianism does imply that ambiguity is being regarded as an unwelcome guest.

Traditional Indian life weaves ambiguity into many areas of life — not as any accommodation within otherwise pure logical solutions, but as an integral part of it. This may have been because of extremely wide variety of peoples, and the extreme fluid context found in daily Indian life. This paper attempts to distil the essence of this Indian approach —not with any rigorous proof— but more as a graceful understanding, and see if it has some relevance to the subject matter of this paper.

It is often stated that a Hindu God is both *form and formless.* Let us not digress into the theological aspect of this contradictory statement and instead look at that aspect of *God* which could signify a model. (i.e. God as a device to explain real life; just the way a model could be used to explain reality)

Such a statement would serve to increase the statistical sample of people who would use such a model: The people who believe in a form for God and those who cannot imagine a form for God, both could accept the model. All models should ideally have such a character that would increase their usage.

The formless

The 'form and formless' statement also means that the very presence of a model is what could destroy it. This is the very similar to conclusion as implied by Minsky: "To shackle yourself so inflexibly is to shoot your own mind in the foot" [2]. Pure logical reasoning is not the only ingredients for a successful model. It suggests to me that any model which is really usable should simultaneously be something that has connections with a real world situation and also *not a model* (something that stands on its own).

"The other tradition is represented by the Buddhist denial of substance (*Atman*) and all that it implies. There is no inner and immutable core in things; everything is in flux. Existence for the Buddhist is momentary (*ksanika*), unique (*svalaksana*), and unitary (*dharmamatra*). It is discontinuous, discrete and devoid of complexity. Substance (The universal and identical) is rejected as illusory; it is but a thought-construction made under the influence of wrong belief (*avidya*)" [4]

Buddhist philosophy may sound like a convenient escape mechanism to avoid explaining anything. But a closer look will reveal rich meanings. For example; if we were to go back to an era as recent as the forties, and explain someone there, the concept of the Internet, s/he would have a tough time even trying to conceptualise it. S/he may even protest at the preposterousness of something like it. Today, the Internet is not strange; but it is still not regarded as something entirely tangible. However, it may be possible that some future generation would consider

the Internet or some manifestation arising out of it, a very tangible *substance*.

In short, one should be eventually able to state that the person from the forties was under the influence of "a thought-construction which was made under the influence of wrong belief" Similarly, we would also have own set of misfit thought-constructions and so would everyone at any point in time.

Such '*illusions*' alluded to earlier, pervade everyone and therefore can also bias theoreticians. The motivation for many theoreticians is that an ideal model is *just around the corner*. Again, this implies that convergence is the way to go; something that gives the process a direction and a measure of success. (AI literature dwells quite in detail, on measurement methods; yardsticks for convergence) The theoreticians forget to realise that they may end up constructing a model which is fated to be just a 'thought-construction' Such a motivation asks for an analytical approach which is usually deterministic and hence, Aristotelian and hence, incapable of handling ambiguity. [8]

Even if some kind of disagreement is found in one model, proposing an alternate model using some other analytical methods to take care of the deficiency would not mean that the problems would get sorted out. Even opponents of a theory could also be prey to the assumptions of that point in history. [5]

Infinite regression in the explanation of nature is another danger of adopting *natural* analogues. This is a famous unsolved, philosophical problem: When one arrives at an explanation of one layer of nature, there would always be another unexplained layer lurking beneath that first one, with an infinite number of further layers beneath still waiting to be explained. This puzzle could be one of the reasons why analytical approaches are usually resource hungry.

So if one does adopt a model that links (analogues, etc.) to the real world, there is always the danger of combinatorial explosion of factors that need to be considered. This can only be resolved when the theoretician decides to stop at some convenient layer of explanation. That can only mean a cultural/temporal bias in the model and once again it would be a fallible "*thought-construction*".

Hindu mythology also refers to the dangers of the purely analytical: the famous story of Narasimha; the half-beast, half-human incarnation of God. It speaks about a demon king who was under the false impression that he was invincible: He was granted a boon that he would not be killed either by a human or a beast, during day or night, on land or water, neither inside nor outside. Unfortunately for him, God (Narasimha) appeared in the form of a half human, half beast and killed him during twilight on a threshold which was half in land and half in water!

Suppose we personify society as our *theoretician*, then individual knowledge domains would be the logical constituents of a large *model* of the real world. A false sense of security lures society into believing that the problems of the real world are actually being modelled.

The story of the *Narasimha* exposes this illusion: nature comes into our experiences not in clear cut, Aristotelian divisions but in many shades of grey which is *half of this and half of that* metaphorically speaking. Lately, this characteristic of nature has been acknowledged. [6]

I believe that one such artificial schism is also found between the constituents of the model as contributed by the theoretician and the contributions of the model user himself/herself. I want to postulate that instead of looking for a model that will itself yield answers, a system where answers could be found by the user, at the very moment when the user of the model seeks out one, should be more relevant. In short, the inputs of the model user should also be part of the model itself. (Note that I am not implying that the roles of the theoretician and user gets intermixed.)

In such a system, answers would naturally be suited temporally/culturally to the user for his/her point in history. That is because a complete answer was never handed down by the theoreticians of that field. It would be formed only within the '*primal soup*' occurring naturally at the instance of handling a real

life problem. This would also ensure that the overriding issues of that moment would get the chance to be incorporated into the system.

I believe that theoreticians need not strive for a predetermined convergence. The work of theoreticians along with that of practitioners (users) would jointly yield a solution. In short, a system allowing synthesis is better than an analytically laid out approach at least as far as handling the scruffy aspects of the real world is concerned. (Actually, it does not preclude the handling of the neat, logical, analytical parts of problem either) If the theoretician refrains from fully mapping or giving form to the system, few cultural/temporal aberrations would bias the system.

I entered the field of architectural design using computers initially as a user of the model; before I realised the need for becoming the proposer of a suitable model. One can hardly have a more '*primal soup*' and more ambiguity in the practice of architecture in India. There was hardly any system for archiving design data which would allow one to step back and extract general purpose lessons. I acutely felt the need for proper archiving of information so that the same mistakes are not repeated.

That need made me propose some initial models for inputting architectural information. (Existing computer aided drafting systems were investigated but quickly discarded because the data within them is obviously fragmented if one seeks semantic connections with different aspects of an architectural situation)

But as the *unfolding of the moment* kept happening in my architectural practice, (i.e. more and more unimaginable situations needed to be tackled as I took on various projects) it became obvious that the theoretical neatness of the model itself was becoming its own enemy. For example; if for one project I needed a model that was to be visualised in 3D immediately then for another project, some other information/analysis was urgently needed even before the arrangement of architectural elements in 3D was final. If a data structure that allowed quick 3D modelling was suitable for the former situation then the same data could become an unnecessary hindrance for the latter.

TAD (***T**he **A**rchitect's **D**esktop*), the software that I developed, naturally gravitated through all these years finally to settle down as a system where it does not offer a pre-decided framework, but a system where the user adds the rest of the model himself/herself at the time of using the model itself.

I am of the opinion that to achieve effective synthesis, a model should be as formless as practically possible. In practical terms, it means inviting the user to fill into the data structure and procedures. TAD uses a Prolog-based language, ARDELA (***AR**chitectural **DE**sign **LA**nguage*) which provides the meta capabilities to describe attributes and behaviours.

Minsky hints about this open endedness when he describes the example about the armchair in his paper. [2] I believe that such ordering is to be done by the user and never by the theoretician who proposes the system. [7, 14] So, if that is done by the user then what would be done by the theoretician?

The form

If a system refrains from giving a pre-decided form to the model, then how would be the subject matter be actually discussed using the model? After all, each user may synthesise unique, idiosyncratic solutions using the system. Obviously, disparate models will prevent communication and o we do need some kind of *form* for the model.

If we were to model a real life situation (namely, '*beta*') where we perceive some actions *A, B, C,* etc. happening, then the analytical approach would have been to speculate on the ingredients of the '*beta*' situation ; and after having arrived at some suitable analogues (or other types of links) then hopefully the actions *A, B, C,* would get emulated.

On the other hand, the synthesis approach would be to look at the analogues of *A, B, C,* etc. instead of trying to find analogues to the ingredients of the '*beta*' situation itself. [12]

To avoid all the associated limitations of an analytical approach, the model should therefore generate analogues to the end effects found in the real world. Or in other words, the work done by the model (verbs) is what need to be made analogous to the real world and not really the constituents (nouns) of the model itself. The more end effects that can be emulated over time and culture spans, more would be the accuracy of the model.

It is not the scope of this paper to work out the actual methods to determine the ingredients of the model by studying the actions that are to be emulated. It is too large a subject. I don't want to give the impression that such model construction can be done very easily.

A certain amount of serendipity could also be involved (*revelation* is a word often used by the Hindus) It also could mean that theoreticians need to get fully immersed into what their models actually gets used for; it would ensure that the holistic model would not get analytically broken up. (My guess is that terms such as *knowledge level* and *task-oriented but domain independent approaches to building knowledge-based systems* are used in AI literature for the same reasons [13])

So, then, it is possible to give a *form* to the *formless* model. But, then we have already established that the form we need cannot be some kind of a mirror of the real world. Therefore, the model needs to take an abstract form; something that can be discussed only in context of the model itself and not really as analogues from the real world. Such models are also possible and I suspect many, if not all, successful models in our history could be interpreted in such a fashion.

Successes in traditional Indian problem solving also seems to have similar characteristics described above. For example; *Ayurveda*, the system of medicine uses an abstract classification set (with 3 elements) as its foundation. Using those 3 elements they have explained the end effects, i.e. the symptoms of diseases, etc. It has to be noted that in the extremely long unbroken history of *Ayurveda*, it must have been possible to derive analogues; but still the *Vaids* (doctors) desisted from deriving analogies and stuck to the very abstract foundations. Many treatments prescribed by *Ayurveda* are now gradually being accepted. [10] Other examples from Indian music and even daily life exists which are beyond the scope of this paper.

TAD

TAD allows creation and maintenance of architectural elements as objects in an object oriented data structure. The tree shaped hierarchical class structure allows for single-inheritance and inputting of attributes to the objects; just as in any OOPS system. This class tree is also shown visually within TAD. An abstract classification system (called the SFA classification system) ties up all the objects together into a semantic network which allows further queries using the built in Prolog based language called ARDELA (***Ar****chitectural* ***De****sign* ***La****nguage*)

In the SFA classification system, all architectural elements are volumes that can either be spaces or solids. Spaces are further divided into what are known as *atoms* (the smallest, undivided volume of space in that model), *envelopes* (a space which is used to encompass other spaces) and *connectors* (spaces that connect one another). Solids are further classified as *artefacts* (solid matter that has specific meaning to the user and which exists independent of other such solids), *linked nodes* (solids which are interconnected with other solids into their own private system) and *leftovers*.

A *leftover* is a hypothetical solid that appears in the model as a CSG (or Boolean) operation of subtracting the volumes of the *atoms* and *connectors* from the volumes of the *envelopes*. Detailed discussion of this classification system is beyond the scope of this paper; but the use of this model for the last twelve years has yielded explanations for many end effects found in the real world. (Detailed paper on this classification system is available on the Internet [9])

An architectural model within TAD is typically used in 4 stages: *Creation*, *Manipulation*, *Enrichment* and *Query*.

Figure 1 shows the model of a church within TAD Designer Lite (a lite version of the designing component of TAD [11]). The church has hyperbolic-paraboloid shell panels as its roof. Each panel consists of a set of rectilinear extrusions in order to reflect the hypar geometry

In *Figure 1*, the class tree is shown at the top left. That is where the objects are conceptually arranged as '*leaves'* or instances of individual classes within a class tree. The area where the geometry of the building is seen is where all the *creation* and *manipulation* (or editing of the geometry) happens. The bottom left contains the GUI used to *enrich* the objects of the project. All *enrichment* is stored as ARDELA meta-data and it is open ended. Even 3D information as well as new information required by the user on a case to case basis can be given here. My office would be developing and maintaining a thesaurus for the meta-data used for various kinds of enrichment on a public platform such as the Internet. That would ensure that properties/behaviours are named consistently in all such models.

The open ARDELA window at the bottom right of Figure 1. shows the simple code which was written for the system to calculate the relevant extrusion levels for each incremental part of the hypar panel. The code is given to the class, and therefore all the instances of that class would also acquire it. A crucial piece of meta-data is the *isKindOf(...)* ARDELA predicate for determining the semantic meaning of individual objects. This particular predicate would be the one referring to the SFA classification system; which ties up all the individual objects into a semantic network.

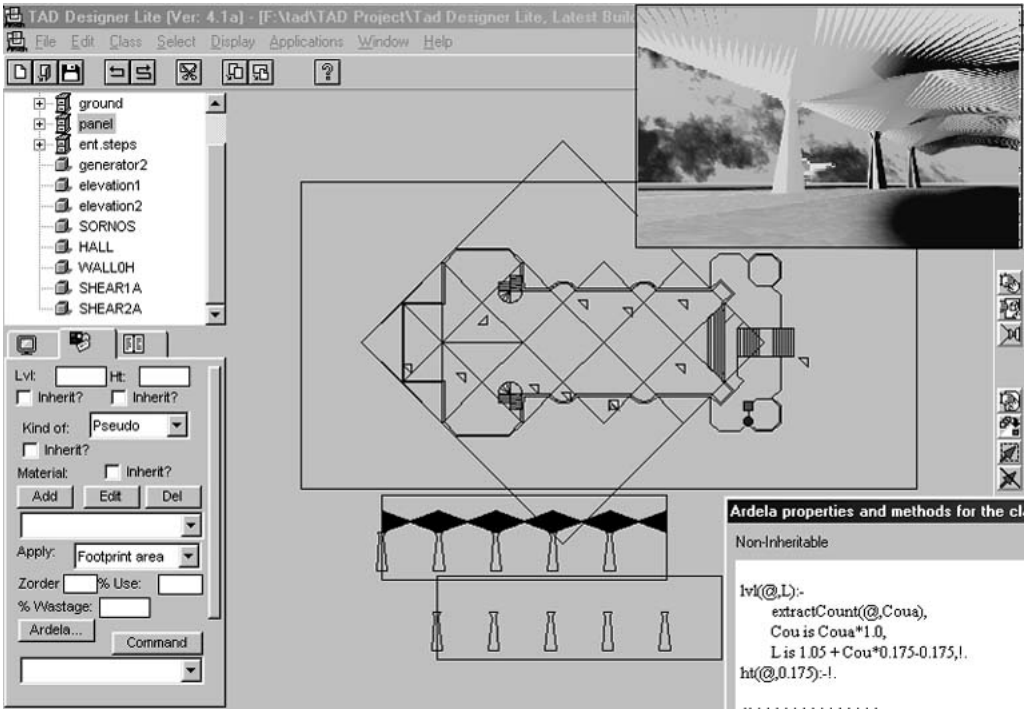

Figure 1 (left). Screenshot of TAD Designer Lite showing the structure of a church, and a rendered image of the church (separately generated) in the top right.

An ARDELA application is a set of predicates written outside the model. This application looks for the missing predicates within the meta-data of the model itself. To produce the rendered image shown at the top right corner of *Figure 1*, I ran such an ARDELA application for visualising the model, which picked up all the meta data, processed it and automatically set up the correct boolean pipeline in POVRay (a useful freeware renderer).

Without any modification to the geometry and the semantic structures, the same model could have also been used for determination of other end-effects, say calculation of heat load due to the hypar roof, etc. (However, some additional enrichments may be required)

Advantages of the synthesis model

The modelling system in TAD has the necessary characteristics to achieve holistic synthesis: It does not depend on any direct analogy or any predetermined set of attributes. At the same time the abstractness of the SFA classification system makes it reasonably unbiased.

TAD allows ambiguity in two ways: Firstly, it does not dictate the procedure or any prioritisation of required attributes/behaviours. Secondly, the abstract classification system talks about a hypothetical type of solid matter, called *leftovers,* that actually signifies that part of the built matter in an architectural design which the architect was not sure of in his/her design. As the design progresses, most of the *leftovers* (solids where the user was not really concerned with) are replaced by the user with *artefacts* or *linked nodes* (solids with real meaning to the user)

This model also allows for hermeneutic cycles [3] which are much needed in any designing. Many '*creation-manipulation-enrichment-query*' cycles can be carried out as per the needs of the user. There is no predetermined end state which would indicate any completeness of the model.

If you look closely at mankind's progress it seems to me that all the major advances came about due to intrinsically abstract models. For example; the wheel and the axle have no analogies in the real world. Many other innovations can also be looked at similarly, the last significant one being the computer which is the epitome of an abstract model; where the user adds his own experiences (programs) to flesh out a complete model as and when s/he requires it. Without any programs and other inputs from the user, a computer would be a quaint, purposeless machine.

Notes and References

[1] **Gero, J. S** ,Concept Formation in Design, *Working paper* Key Centre of Design Computing, University of Sydney, Australia,1998 http://www.arch.usyd.edu.au/~john/
"The loosely-wired brain model is a formalisable approach based on an analogy with one view of brain development. It assumes that the computational system operates within a world it can sense through its sensors."

[2] **Minsky. M**, Logical vs. Analogical or Symbolic vs. Connectionist or Neat vs. Scruffy, 1991 http://minsky.www.media.mit.edu/people/minsky/papers/SymbolicVs.Connectionist.txt

[3] **Ross, K .L**, Foundationalism and Hermeneutics, *Working paper*
1997,1998 http://www.friesian.com/hermenut.htm
"Traditional 'foundationalism' was the view that knowledge could be started, or started again, from nothing by finding pieces of certain and infallible knowledge, the "foundation," upon which all other knowledge could be constructed…originally conceived by Aristotle."

[4] **Ramkrishna Mission**, The Cultural Heritage of India, published by Ramkrishna Mission, Calcutta
There are significant differences between Buddhist and Hindu philosophy as regards the meaning of reality. For example; Hindu philosophy does talk about the unchanging. But that is more closer to the 'ideals' of Plato rather than the

empiricist's understanding of reality. There are similarities between Hinduism and Buddhism too, maybe because both these philosophies originated in India. I have deliberately chosen to highlight those aspects that are pointedly relevant to this paper. Moreover, a complete discussion on these philosophies is not the intent of this paper, neither am I fully qualified for it

[5] **Magee, M.**, Confessions of a Philosopher : *A Personal Journey Through Western Philosophy from Plato to Popper, p*ublished by Modern Library, ISBN: 0375750363
"R.G.Collingwood made much of the point that in any given historical period there are likely to be deep lying assumptions that contemporaries share, not even conscious of them as assumptions, so taken for granted are they; and that these are sometimes not accepted by later generations. Because of this the great intellectual debates that go on between contemporaries are sometimes not what the participants take them to be. They believe themselves to be fighting for mutually contradictory positions, and if this were so, whatever the truth is would have to lie, at least broadly speaking, on one side or the other. Yet in the eyes of their own posterity they are sometimes both wrong, because of some fundamental assumption which they are both accepting."

[6] **Senge, P .M.**, The Fifth Discipline: *The art and practice of a learning organisation,* published by Currency/Doubleday, 1994, ISBN: 0385260954
"Systems thinking is a discipline for seeing wholes.... Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace."

[7] In 1997, I was investigating a hierarchical system of classifying doors which was published on the web as part of a leading research project from California, USA. It contained seemingly plausible sets of attributes that were neatly gathered into a class tree in order to assist quick and accurate modelling. By some sheer coincidence, during the same time there was an incident concerning the main door of a church I was designing. The sponsored main door was fabricated outside and delivered to the site directly - six inch longer than what the opening had been. When I went to the site, the management had taken the decision to make a hole in the ground rather than cut the door to size and incur the wrath of the influential sponsor! It struck me that unless we effectively handle such 'scruffy' incidents, we would be inadvertently forced NOT to describe some important design decisions. It goes without saying that the classification of doors put up on the web could hardly describe such a situation. In TAD, I could have left an attribute on the 'door' indicating the reason for the design decisions, as a record for the future analysis.

[8] **Cohen, J and Ian Stewart** , The Collapse of Chaos, publisher: Penguin Science, 1995, "Either because the laws of nature are couched in mathematical symbolism, or because science cannot progress safely in the presence of ambiguity and imprecision, scientists tend to express natural laws as mathematical statements. It would be wrong, however, to read too much into this"

[9] **Francis, S. V.** , A Taxonomy for Architecture,1991 http://www.archsfa.com/tangent/tad/PAPER.HTM

[10] "medicine, history of" Encyclopædia Britannica Online
< *http://members.eb.com/bol/topic?eu=119072&sctn=3*>

[11] TAD Designer Lite, a free design component of TAD is available from: http://www.archsfa.com/tangent/tad TAD has been used for practically all of my projects; which is more than 3 million square feet of work, as well as a few other offices in India

[12] Imagine reality to be 'a spinning wheel' (or a buzzing furiously working mechanism) where one

cannot really focus on any one aspect of it, because the moment one does some other part of the 'spinning wheel' comes into the focus. Now this 'spinning wheel' (buzzing mechanism, whatever) is throwing off a lot of end effects which weperceive. For example; when we see rain falling down, we really don't know what is behind it. Let us take the worst case situation where the 'spinning wheel' was so obtuse, that we give up trying to pin down the ingredients. Now instead of probing deeper into the ingredients that cause rain, we work out our own very special 'spinning wheel' or alternate reality. At first we get it crudely. (Probably we are always doomed at getting it crudely!) What is the motivation? To generate the same end effects as we see in the real world. In this case, to produce the equivalent of rain within our own model.

[13] **Brown, D. C.** , I'm Scruffy and at the Knowledge Level , AI in Design Research Group, Computer Science Dept., WPI, Worcester, MA 01609, USA. http://www.arch.su.edu.au/kcdc/journal/

[14] From another angle, proposing the model for TAD can be seen as an example of what I mean by the joining of the 'theoretician' with the 'user', because that is what I was (practising architect as well as the person proposing the model). TAD therefore could be seen as an outcome of Buddhist philosophy; one used to synthesise various factors together and respond to each moment's 'avidya' (*lack of knowledge*).

[15] The word scruffy is used in this article synonymously to mean 'ambiguity'. Dr. Marvin Minsky had used it in his influential paper. So did Dr. David Brown, and hence the usage.

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