Hexagons for systems thinking

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ABSTRACT: This article describes an approach to bridging the gap between the generalist thinking of decision makers and the specialism of modellers by concentrating on the preliminary issue conceptualisation stage of modelling. A new type of visual facilitation is described using hexagons as a flexible mapping technique to bridge the gap between thoughts and models. A typical team application is described and a link is also made to creative thinking techniques, including the use of cognitive colour-coding. These techniques are supported by new use of magnetic hardware and a specially designed mapping software. In conclusion, the idea of the transitional discipline is introduced as a way in which a variety of specialist decision support methods can be made more user friendly.

KEYWORDS: Clusters; cognitive mapping; collaboration; colour coding; concept mapping; decision support; dynamic representation; facilitation; generative thinking; idon; knowledge capture; magnetic hexagons; software for visual thinking; team learning; transitional disciplines.

Hexagons for systems thinking

Picture a group of senior executives of a major company standing around a whiteboard and debating intensely where brightly coloured hexagons should be placed in relation to one another on the board. Is this speculation or a real working session? Actually, events like this are becoming more frequent. It is a manifestation of a new approach to systems thinking which is finding favour with managers faced with high levels of systems complexity combined with high levels of uncertainty; in brief - fuzzy problems.

In this paper I will explore some of the underlying theory and technique which makes such an unlikely activity a potent method for advancing executive thinking, especially in teams. But first, let us look at the activity in a little more detail from an observational standpoint.

An example of a workshop process

A leader (typically a chief executive or functional head) and team identify that there is an area of challenge they face and for which their stock of past responses is not adequate. New ground needs to be broken. Recognising that breaking new ground will require the stimulus of non-traditional methods, the group appoints a facilitator consultant who takes

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on the role of designing and carrying out a group process, usually in the form of a workshop.
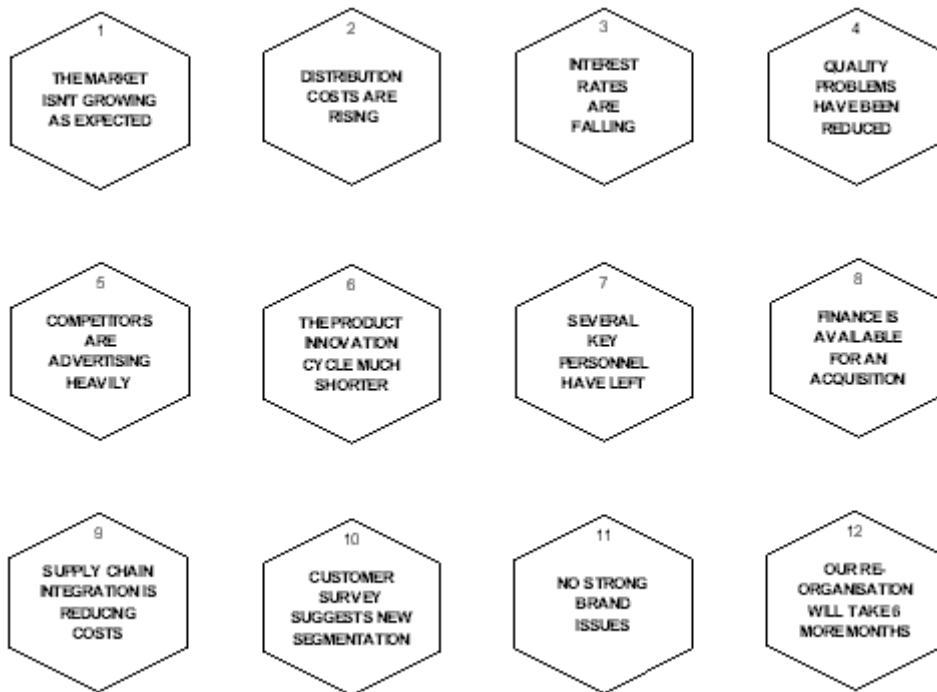
The facilitator realises that, given a relatively undefined arena of discussion of some complexity (which has been identified more by intuition than analysis), each team member will have implicit mental models of that arena. These implicit models represent an untapped wealth of data, understanding and judgement which is hidden and not shared. Furthermore, the facilitator realises that the normal level of conversation in a management meeting will be unlikely to tap into more than a small fraction of this potentially rich picture. A process that visually shares mental models will be more effective.

To prepare for the workshop each member of the team is interviewed briefly on his or her initial reactions to the subject, and, through open-ended questioning, the first layer of deeper thought is mapped individually, giving the facilitator a feel for the emergent natural agenda and also the degree of congruence and dissonance between the mental models of the individuals. This helps tune up the entry into the workshop and establishes a psychological contract.

At the workshop, the facilitator introduces the main themes and tendencies in their thinking to date about the challenge. What then follows is a process we can call 'issue conceptualisation', (a description coined by Kees Van der Heijden at Shell Group Planning). Often, the hardest part of modelling is to get a hold of what the issues really are. A process of elicitation is more effective than the customary methods of debate. The mood is more like that of creative thinking where temporary suspension of judgement is encouraged until sufficient breadth of material has been aired. Concept mapping with hexagons is used as a technique.

Conversation, which happens in a linear way, places on memory the burden of recollecting patterns of connection. It is an inefficient medium, unsupported by visual representation. We are all constrained here by the 'magic number seven plus or minus two' as the inherent limit to short term memory and attention (Miller, 1956). The recording of statements on flip charts or white-boards has become customary to help limitations of attention and memory. This skill leaves us, however, with a memory which tends to be a check list or a diagram of some kind, both of which are inflexible.

By using movable hexagons for capturing data, a simple visual medium for handling flexibly the content of conversation is created. To return to our team: as the statements come out in conversation the facilitator captures each distinct idea as a summary headline on a magnetic backed hexagon which can be placed initially at random on a large steel whiteboard, clearly seen and accessible to the group. Each point is checked, as it is written up, for mutual comprehension but without at this stage debate about its validity. The guiding principle is that if someone in a responsible team thinks it, there must be something in it

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THE MARKET ISN'T GROWING AS EXPECTED	DISTRIBUTION COSTS ARE RISING	INTEREST RATES ARE FALLING	QUALITY PROBLEMS HAVE BEEN REDUCED

5	6	7	8
COMPETITORS ARE ADVERTISING HEAVILY	THE PRODUCT INNOVATION CYCLE MUCH SHORTER	SEVERAL KEY PERSONNEL HAVE LEFT	FINANCE IS AVAILABLE FOR AN ACQUISITION

9	10	11	12
SUPPLY CHAIN INTEGRATION IS REDUCING COSTS	CUSTOMER SURVEY SUGGESTS NEW SEGMENTATION	NO STRONG BRAND ISSUES	OUR RE-ORGANISATION WILL TAKE 6 MORE MONTHS

In this phase, association and exploration are encouraged so that stones are not left unturned in the team members' minds. A layer deeper than that of the interviews begins to emerge through the mutual stimulation of different angles of approach. The phase draws to a close with anything from twenty to fifty hexagons arrayed on the board. There has been a kind of catharsis of the minds, a memory owned by the group has been formed and it is represented visually. But by now it is quite unmanageable conceptually. (Figure 1 shows a hypothetical example, constrained to twelve hexagons for ease of illustration).

A pressure now falls on the facilitator to come to the rescue by indicating some kind of order to remove the chaos. Yielding to this pressure, however, would remove the ownership of the process and the thinking from the executives. They are now challenged to explore their own mutual perception of order in the chaos. The simplest technique for doing this is to start grouping the hexagons, a process called clustering. It is at this stage that a pioneer in the group has to come forward and make a first step at introducing some order. This spurs other members of the group to differ, to join in through demonstrating alternatives, to reach agreement, and to express their reasons why. The conversation reaches a deeper level and brings implicit thinking into the open. At this stage also, well worn theories may emerge as ordering principles (safe ways out of the chaos) but these are then seen to be leading round in circles giving opportunity for the facilitator to provoke exploration of alternative more adventurous groupings. These new clusters, in turn, stimulate the formation of new higher order concepts to embrace the combination in

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the cluster. (Figure 2 shows how the hexagons in Figure 3 might end up from such a process, having been reshuffled a number of times).

What now emerges is an 'issue map' which represents a quite new perception and grasp of the 'vague concern' and provides a platform for the formulation of the next steps of thinking and decision making needed by the group.

The issue map will tend to point to the interconnectedness of things. The team will now have unearthed some of the systemic implications of the field and be set on a course that may well lead them to consider feedback or even further conceptualisation of a system dynamics model. Such a course of development in the team's thinking could be represented with connecting arrows as shown in Figure 3. On the other hand, the issue map may lead to a number of other disciplines of group decision support (Rosenhead, 1989).

Generative thinking

The above account of a group thinking process that moves from implicit to explicit modelling assumes the outcome of the process to be of requisite quality. However the impact of sharing the modelling process may not, of itself, lead to a breakthrough. Decision making increasingly needs a creative step for which structural thinking prepares the way but does not get there. Here it can be useful for modellers to use techniques which increase the chances of breaking out of an implicit mindset into new ground. This breakout is what we call 'generative thinking' (to contrast it with deeper insight into what is already there).
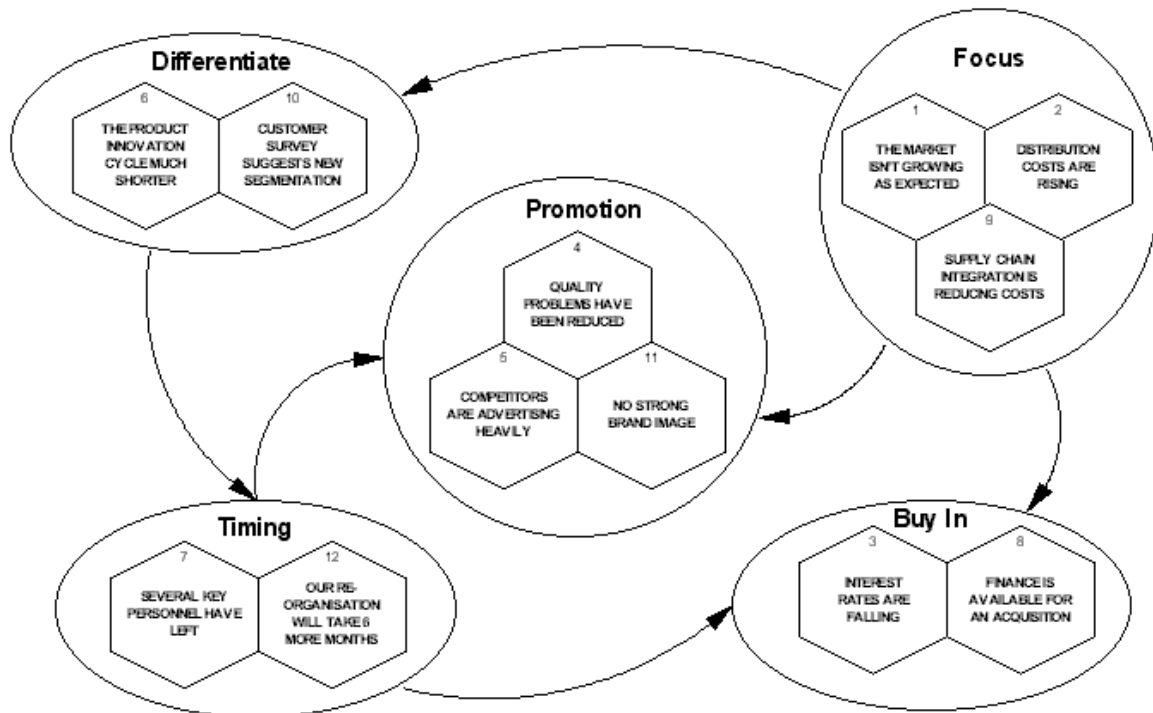

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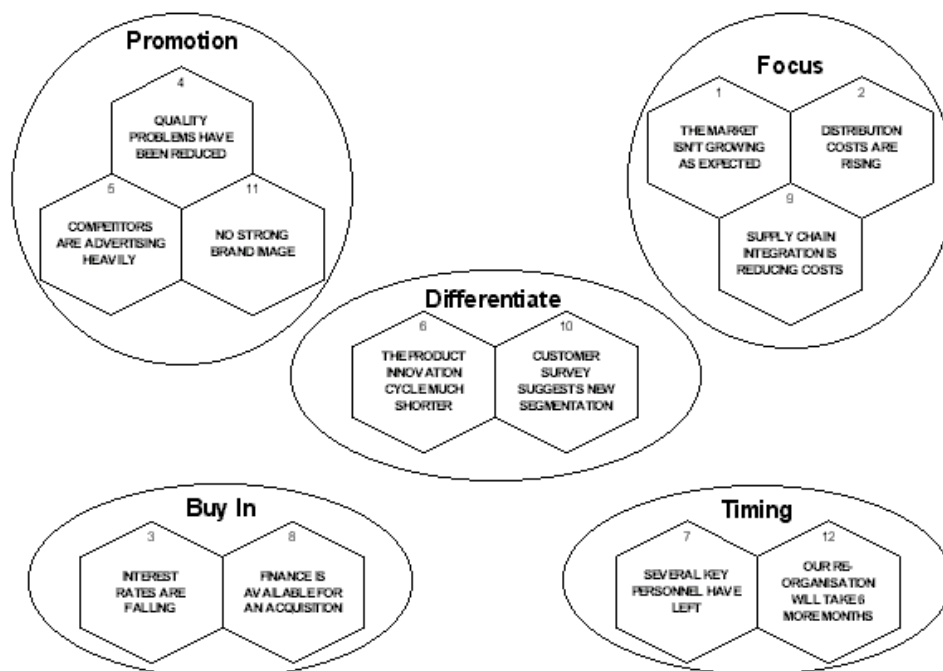
Figure 3. Influence diagramming

For example, the hexagon method can be used with great effect as a tool for stimulating lateral thinking. The technique, which runs counter to our logical mindset uses random association of what seem to be unconnected ideas to evoke the mind's rich store of associations and new ideas. Invention often proceeds along these lines. A simple example of this '1 + 1 = 3' thinking is shown in Figure 4.
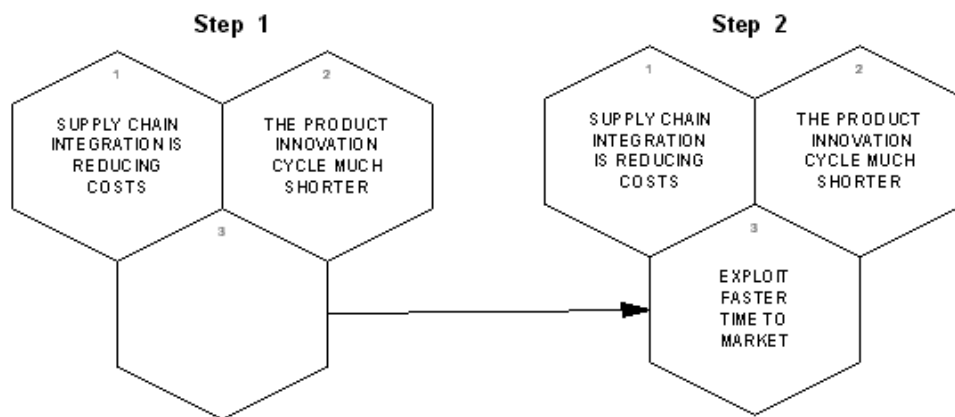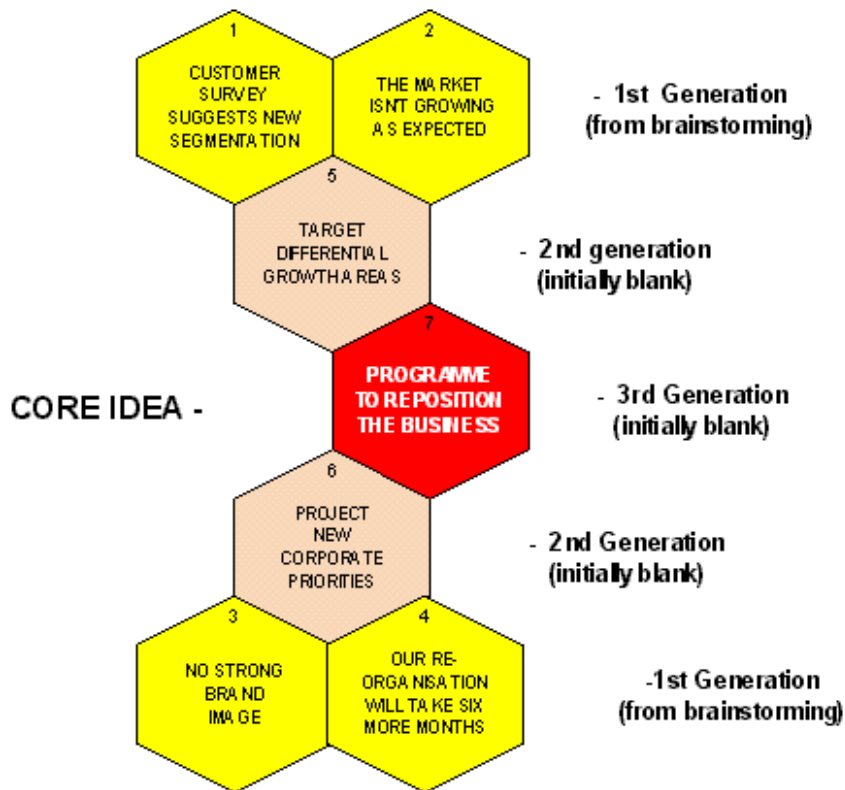

Figure 4. Generating new ideas

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   In conventional brainstorming we capture the ideas as they come out in bullet statements on flip charts. In the hexagon method we capture them as headlines on the magnetic hexagons which are then free to be moved into any paired association we choose at random. The third blank hexagon then invites a lateral thought (see Figure 4).

This method has proved very effective to trigger a new wave of ideas when a session 'dries up' or when the quality of ideas is inadequate. It acts as an unblocking device. When a group doing this is asked to select the most interesting ideas, it usually chooses the second generation of laterally stimulated ideas.

There is a tendency to believe that only divergent processes are creative and that convergence is antithetical to creativity. This is at variance with creative design experience, where the creative act is often in synthesis.

The introduction of hexagon templates for creative convergence is a further technique we have found very powerful. This method uses the results from a '1+1=3' exercise as a building unit for several generations of thought as shown in Figure 5.

This is a 'four-fold' generator, where 'four-fold' refers to the number of selected starting ideas. In this case, from the brainstorming session and subsequent clustering, the four most interesting and diverse ideas were selected and then placed in the outer circle of the template. Then the blanks were filled by the search for new ideas which strongly embodied qualities from both source ideas. The central idea is a core insight. (Note that wording can be deceptive here to the reader outside the working session. Unknown blood, sweat and tears will have gone into the consensus insight which will be packed with all the associated ideas and experiences for that particular group. Meaning is not really transferable by wording alone.)

Figure 5. Core idea from hexagon generator

Generative thinking is lateral thinking plus intuitive judgement. As well as being a breakthrough device, it is a very powerful support tool for decision makers, particularly when time is scarce, the decision criteria are qualitative and the results of diverse advice need to be quickly synthesised. In the latter case it is the advice which is placed in the outer perimeter of the generator pattern.

Colour-coding cognitive maps

So far we have considered the cognitive mapping process as a two dimensional surface where all hexagons are equivalent. We can now introduce colour-coding. Codification is a crucial process in any effective thinking. The simplest scheme is a binary code such as accept/reject (green : red) or opportune/dangerous (yellow : black). By introducing a judgmental framework and colour coding it, we can then assign colours to ideas and read a further layer of significance into our cognitive map. This also provokes a deeper layer of interchange in the working group.

One powerful application of colour coding is to show working groups their style of thinking. There appears to be some correlation between the quality and effectiveness of strategic thinking and the extent to which a range of cognitive styles is invoked by the thinker. This is reflected, for instance, in Russo and Schoemaker's decision traps (Russo and Schoemaker, 1990). The failure to exercise a cognitive mode may lead one into a trap.

In dealing with unknown situations we need, as well as flexibility, ways of directing mental energy to fruitful areas. This is where the cognitive pairs fulfil a role. We recognise that in assessing situations we find these pairings expressing themselves. For example we might elicit how far a client group perceived areas in a cognitive map (see Figure 6) as:

1. Opportunities: yellow.
2. Problems: black.
3. Innovations: green.
4. Improvements: brown.
5. Environmental factors: blue.
6. Internal factors: orange.
7. Strengths: white.
8. Ambiguities: grey.
9. Strategic views: purple.
10. Tactical actions: red.

The advantage of colour-coding is that it gives a non-verbal signalling system which empowers the thinking of the team using it. Frequently, the propensities of people in a team will bias the range of considerations going into a decision process. For example,

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over-focus on threats and tactics with neglect of externalities. The 'colour balance' of contributions will reveal these biases and enable the facilitator to carry out balancing activities.

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lateral thinking	*yellow*	opportunity spotting
critical thinking	*black*	innovation
imaginative thinking	*green*	innovation
judgemental thinking	*brown*	quality appraisal
holistic thinking	*blue*	Environmental scanning
systems thinking	*orange*	designing
metacognition	*white*	Thinking about thinking
chaotic thinking	*grey*	ambiguity
strategic thinking	*purple*	directing
decision thinking	*red*	action

Figure 6. A scheme for colour-coding cognition of models

Although developed pragmatically, evidence is accumulating that senior managers do indeed draw on a variety of cognitive capabilities - their mental portfolio - when making decisions and judgements (Isenberg, 1987); some other practitioners have explored the use of colour coding as the basis for practical methods of identifying and switching mental modes (Rhodes and Thame, 1988; de Bono, 1986).

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The five pairs of cognitive styles also reflect the way the mind, in decision making, is a 'dilemma resolution system' (Hampden-Turner, 1990). The attribution of colour code to these modes has some basis in colour psychology.

The dynamic representation paradigm

The above sketch is just one illustration of an emerging field which may be crucial to the wider acceptance and utilisation of modelling, namely 'dynamic representation'. This is thinking with visual idea-representing icons (idons) which are capable of being manipulated, combined and re-arranged as a continuous process of formulating thought. The idon is a combination of idea and icon.
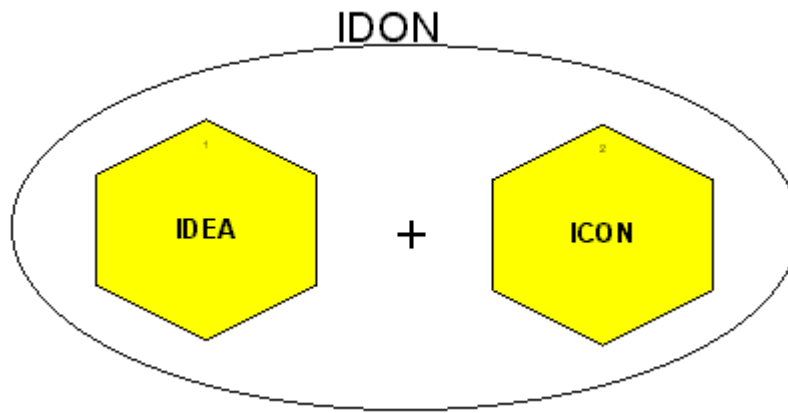
Idons can be realised in simple form by such things as magnetic plastic hexagons or in more complex form as a new type of representational software: idonic software, such as the Idons - for - Thinking.

Idons used in a combination are a powerful way for us to express the deeper layers of thought from our mental models. They are a new medium for thinking. Up to now the expression of thought for interacting groups has been limited to black-board and chalk and conversation, the two most user-controllable media we have.

Modelling is considered to be one way of describing what we do in our minds, as a function of having cognitive capability. Language, mathematics and drawing (of diagrams) are our traditional cultural ways of externalising and communicating thought. We do not yet understand very well how the brain does this, how subjective constructs are generated and how internal models affect behaviour. It does seem, however, that the brain operates with inductive rules and that complexes of these rules in some way form the mental models (Holland et al., 1990).

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A further feature of expressing thought is that it has static and dynamic aspects. The static aspect is the encapsulation of knowledge as words, mathematics or diagrams. This is the 'known'. This paper and this Special Issue are examples of a static representation. The dynamic aspect is the process whereby we deal with the 'unknown' through continuous exploratory behaviour. Here we refer to word-ing, deriv-ing, doodl-ing. The 'ing' is important here since it implies a process which is never finished. Where we are concerned with problem solving, decision making and strategising in the face of the unknown, it is this process side which needs to be paramount. This might be summarised in a phrase like "How do I know what I think until I see what I am modelling?".

Our common culture sets for us here a peculiar trap which binds us, most of the time, to the static media. Thought or knowledge is expected to be presented as coherent and accurate and able to stand up to criticism. This forces thinking to be private and only so-called 'finished' thoughts are overtly presented. Thus our verbal thinking is embodied in papers, our mathematical understanding is embodied in algebra and our view of the way things work is drawn in diagrams. These in turn become fixed beliefs, objective laws and representations of the way things are. Power relationships in hierarchies reinforce this state of affairs since to progress professionally and socially we need to be seen to be 'right' more often than 'wrong'. This is not helpful for dealing with the unknown.

A dynamic representation medium inverts this state of affairs. It is not just a presentational gimmick but a revolution in thinking and communicating. Dynamic media, by their nature, give permission for continuous change.

In the presentational culture, it is seen as a weakness to change one's mind. In the explorational culture, it is a weakness to remain fixated. In the fixated state, statements become dogmas, equations become truths and diagrams become 'dogmagrams'. But the map is never the terrain. And if the terrain itself is undergoing change then mapp-ing as a process becomes more significant than any given map.

As an example, the hexagon method, using magnetic objects movable at will on a whiteboard surface, exemplifies a breakthrough in dynamic representation. So do emerging examples of rapidly user-configurable softwares. But these are precursors of what will become a whole new range of dynamic media. The hexagon stands in relation to thinking as a brick does to building. It is simple and modular.

The core idea of the hexagon method is the 'semantic unit', the atomic object of meaning. From the static paradigm we value the coherence whereby words are joined in sentences, symbols compute with each other and parts are defined in diagrams of the whole. But we are now prisoners of syntax. In dynamic thinking we are dealing with chaoses of meanings, unconnected symbols and fragmented thoughts. Beneath our conscious mind is also a chaos of mind as well as an order of mind. It is often out of this chaos of mind that creativity springs (Nonaka, 1988)**.**

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Chaos and system in the mind

By acknowledging the chaos in our minds as a resource and not a failing, we can set out to catch, as butterflies in a net, odd thoughts, the significance of which we have yet to realise. We can state them in isolated hexagons without having any pre-determined order. We do this, for example, when we write associative check lists or bullet charts. But check lists do not support the emergence of the new order out of the chaos. With the freedom to move any object anywhere, we can re-iterate experiments forming different patterns and develop new meaning. We challenge the mind to entertain new organisations of knowledge hitherto unattempted (de Bono, 1990). The medium is the flexibility not the unit itself.

So how does this notion of chaos relate to modelling, decision support and systems thinking? The crucial connection is that our understanding of systems is more often buried in our subliminal mind than ready to hand in our surface mind. Both the chaos and the order of our mind are 'out of consciousness'. They take place, so to say, in the backs of our minds. The generation of new thinking, by whatever means, requires that we tap into this reservoir of insight and information, and form new patterns of understanding from it. We need ways of continuously rendering the implicit explicit.

One area where we know this to be the case is in the development of expert systems. To create a knowledge based inference engine, we have to elicit rules from an expert. This elicitation of how the expert does what he does is never easy, since most of the effectual knowledge is implicit. Practical knowledge is often buried in the obscurity of the brain.

Modelling is essentially a dynamic activity of thinking out to the point where we can test our understanding, whether it be by simulation or by life itself. The tools of cognitive mapping, like hexagons, are a stepping stone from tacit mental perception to communicable mental work-in-progress. This work-in-progress notion is critical. Continuous improvement is the mark of a thinking environment.

Summary of essential techniques

Concept mapping with idons is the process of rendering tacit models visible and shareable by the use of representational mapping. This mapping is done by means of a variety of techniques which are like 'moving diagrams'. They exploit both basic wisdoms that a picture is worth a thousand words and that thinking includes the power to influence patterns of ideas. Idons create a flexible medium where change of pattern is facilitated.

1. each unit of meaning (statement, fact, opinion) is recorded on one single object: we call this an **idon** (from idea plus icon).
2. the idon object is persistent throughout the process and is movable at any time thus encouraging flexibility.
3. idons can be added, subtracted, revised and moved at any time; they can be augmented with clusters, arrows and text overlays.

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4. various conventions, especially colour, can be used to create additional layers of meaning especially about connectivity and significance.
5. these conventions can carry meaning in terms of both frameworks of thought (e.g. a planning concept) and even of the nature of a particular thought (e.g., a cognitive mode).
6. the process can be carried out simultaneously by more than one person in collaboration, interrelating their thoughts in common models.
7. the representations of maps are practical control tools for:

   a) live discussion;
   b) group memory;
   c) task organisation;
   d) building shared models;
   e) decision support;
   f) information retrieval.

Thus concept mapping with idons, seen initially as something like an extension of brainstorming and mind mapping, turns out to be much deeper in its scope and implications.

Conceptual mapping with idons is a flexible medium which -

- increases the brain's capacity to handle complexity;
- enables people in groups to share their thinking 'aloud';
- provides a basis for new dynamic user-determined computer interface (for example Idons - for - Thinking software);
- enables computer based methods and information to be run from individually configured mindmaps.

The combination of these aspects in suitably designed methods, skills and computer software creates a new visual working environment which enables a bridge to be built between implicit mental models and conscious modelling techniques like system dynamics.

The role of hardware, software and environment

The visual facilitation methods described here require a supportive environment which can accommodate a series of work processes from issue conceptualisation to simulation. In the early stages, the use of physical tools such as coloured plastic magnetic hexagons on whiteboards is excellent for gaining the 'hands-on' involvement of a group. The hexagon is only one example of a range of symbols which include system dynamics symbols, circles, clouds, rectangles, triangles and so on, each suitable for different thinking techniques.

However, this medium is most unsuitable for memory and documentation. Graphical software can provide tracking and memory as well as flexible feedback and review.

Normal graphics software, however, does not lend itself to rapid and flexible manipulation. The Idons - for - Thinking software has been specially designed for this and its use also raises the potential for live on-screen facilitation.

For example, clients have run conferences based on a room equipped with both large screen and 20" colour monitors linked to a computer. A process facilitator takes them through the material. A skilled facilitator captures the key points and builds a group map on the screens. The executives take over and direct the structuring process. The intensity and productivity of the interaction is high and the captured data enables instant documented feedback of the deliberations.

Already the way is open for business teams to have group decision support systems transform the nature of the boardroom. Further, by using cognitive software to link boardroom to personal and institutional modelling data bases and to conduct mapping and modelling interaction via electronic mail and computer conferencing, the level at which telecommunicated decision making processes can be conducted is greatly enhanced.

Creating transitional disciplines for learning

Effective decision making needs to be supported by both tentativeness and rigour, by both elicitation and expertise, by both tactile technology and electronic technology. These are not either/or; they are both/and requirements. This paper has introduced a number of ideas and practical methods for bridging the gap between clients and practitioners. But there is a great deal more to do in this bridging operation.

Once we have given ourselves permission to be chaotic, tentative, provisional and carry out work-in-progress, we can bring in all kinds of methods to support the bridging process. These methods can be related to various decision-making disciplines, not just systems thinking or system dynamics. But, being dynamic, they encourage a different style of thinking than conventional modelling disciplines. They are more abbreviated, less rigorous and less expert dependent. The term we prefer for them is *transitional disciplines* and their symbolic tools are transitional objects.
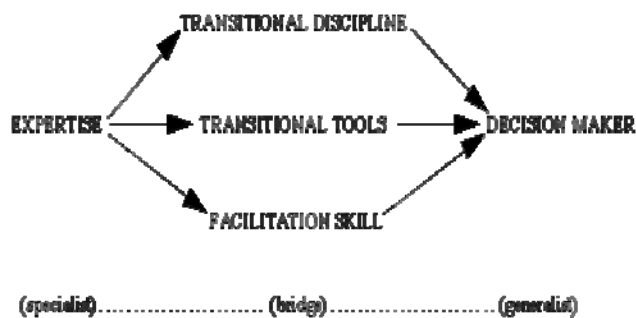
The purpose and role of a transitional discipline is to provide a bridge between an area of specialist expertise and the mind of a generalist decision maker. In directing complex organisations, a senior manager cannot know all the expertise that may be relevant to a decision. Neither can he appreciate all the inputs supplied by experts, unless he has some way of making a conceptual link. A mental model generated by a manager or by a management team in a collaborative session provides the cognitive bridge which connects information with insight. Introduction of the transitional discipline in the right form and at the right time can accelerate that insight. An example is the use of archetypes of systems thinking (Senge, 1990).

Through those links the necessary nourishment for the decision process can be obtained. Without it, the decision maker is at the mercy of the experts or his or her own arrogance, and so may equally either over-value or under-value given advice (de Geus, 1988).

To communicate a transitional discipline to executives is not a matter for academic courses. Time and mental energy are too scarce. This is where the power of visual facilitation comes in. Through matching understanding of the task, selection of appropriate mental frameworks, use of flexible tools (such as the idon method) and interactive skills in stimulating and managing thinking processes in groups, we create an acceleration of learning that gets the job done. The role of a transitional discipline is to act as a provocation for creative insight as well as a better-framed judgement. The transitional discipline has to provide scope for those using it to play with options and test innovations. There needs to be scope in modelling for creativity. This may take the form of innovative ideas or the form of deepening insights. The transitional tool kit serves the same role for the adult mind as the learning toy does for the child's mind. The scope to manipulate symbolic objects encourages free play. It is a kind of conceptual Lego kit. There is an imaginative design component to decision making (Friend and Hickling, 1987). Imagination is an ingredient of entrepreneurial strategy. If our strategic modelling has no room for this, then it will simply add to the list of predictable strategic methods which are vulnerable to more imaginative competition.

It is this need, especially in business management, to combine expert input, conceptualisation and imagination that makes the idon such a powerful tool. The range of symbolic objects - circles, rectangles, triangles, pentagons, and so on - can be tailored to correspond to particular decision support disciplines. In so far as it is also becoming codified as a set of effective practices, we can also look at creative thinking itself as a form of transitional discipline. There are many varieties of methods developed in this area (Adams, 1986), but creative processes have been generally implemented through the traditional media of the blackboard and the chart pad. New tools, such as magnetic hexagons and other shapes, add dimensions of flexibility and speed to the constant rearranging that goes on when creative thinking is made visible.

Facilitation skill is the special expertise that supports people in representational thinking. In a formal discipline, sequences and procedures emerge which are part of the expertise, just as much as the knowledge content (Rosenhead, 1989). Facilitation is more informal and to do with matching well designed procedures for thinking through a problem with the start points, concerns and needs of the working team so that a sequence and procedure can be found that works well for them. It is the art of empowering the team to engage properly and productively with the transitional discipline. The facilitator is required to be a catalyst for the interaction of expertise, conceptualisation and imagination. To do this he needs the corresponding techniques of frameworks, cognitive mapping and creative thinking methods. This can be viewed as a cognitive bridge.

Figure 8. The cognitive bridge

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One of the functions of a transitional discipline is to provide a framework for facilitation. For example, a two-dimensional grid can be a framework for establishing relative positioning against two criteria; an interconnected set of 'balloons' can be a system for the elicitation of the content of its components. The simplest form would be brainstorming against a list of categories

Such frameworks need the practitioner to have a firm grasp of the essentials of any discipline and understand the 'cognitive gap' between the client group and that discipline. It also requires the innovative skills to create the transitional framework in such a way that (a) the compromise of the technical methodology is reduced to a minimum and (b) the level at which it is pitched is not going to frustrate the client group. The role of the framework is not to show off the practitioner's grasp but to stimulate appropriate thinking in the client. Many of the papers in this Special Issue indicate that system dynamics expertise is reaching out to generalist decision makers and, through innovating processes and softwares, is generating its own transitional discipline.

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