The Evolution of Group Decision Support Systems to Enable Collaborative Authoring of Outcomes.

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Abstract

This paper draws on analysis of a variety of problems emerging from practical applications of Group Decision Support Systems (GDSS) to propose a fundamental evolution of decision support models from the traditional single decision-spine model to the *decision-hedgehog*. It positions decision making through the construction of narratives making the rhizome that constitutes the body of the hedgehog with the fundamental aim of enriching understanding of the contexts of decision making. Localised processes constructing and exploring prescriptions for action within a plethora of decision spines are rooted in this rhizome. It identifies a synthesis of theories that influence decision-making within organizations and proposes a comprehensive system of Group Decision Authoring and Communication Support (GDACS). In doing so it proposes that the iterative development of collective narrative within an organising system engaged with complex decision making leads to active engagement with implementation – a process we call Collaborative Authoring of Outcomes. Throughout, the paper outlines the implications for the organisation of GDACS and proposes a comprehensive architecture that enables this approach.

Introduction: Challenges for GDSS in supporting problem solving

The discourses that have been established as the foundations of Group Decision Support Systems (GDSS) are called into question not only in the interests of advancing the academic GDSS field but also out of the perceived need to plug gaps that sophisticated GDSS systems throw up in practice (Huber, 1981; Stabell, 1987; Humphreys and Brezillon, 2002).

The limitations of rational perspectives of "decision-making as choice" have been raised (Cyert and March, 1992; Nappelbaum, 1997; Carlsson, 2002). The challenges relate to failures of implementation, the rise of unintended outcomes, the impact of cultures of fear and failure within organisations (Humphreys and Nappelbaum, 1998), and problems associated with externalisation of decision systems designers who 'play god' by designing from outside the game for those who are inside (Humphreys, 1989).

Alternative discourses have emerged. The attention-based view of the firm (Occasio, 1997) has its origins in the work of Herbert Simon (1960), who conceptualised organisational decision making processes as linear, moving through three stages: intelligence, design and choice. *Intelligence* involves a search for "the conditions that call for decisions". *Design* focuses on "inventing, developing and analysing possible courses of action" through the construction of "a model of an existing or proposed real world system." Conventionally the axioms of the model are founded in rational choice theory: and involves modelling and comparing alternative courses of action as pathways towards goals or future states of the world which can be evaluated such that preferences can be formed between them. Finally, the *Choice* phase focuses on "selecting a particular course of action from those available" according to what has been represented in the model. Savage (1955) characterised such "courses of action" as pathways through future states of a " small world", constituted by the subset of future states in a grand world" (comprising all possible future states) that are imagined by the participants in the model building and linked and assessed within the model according to the underlying logic of its construction (Phillips, 1989). Decision-making is thus cast as organisational problem solving, the model provides a representation of "the problem" which can be "solved by" implementing a prescribed course of action identified as "preferred" or "optimal" within this representation. Yet the small world is imaginary, and the "solution" is chosen on the basis of a collective fantasy, located in the planes of the i*maginary* and the *symbolic* developed by the participants in the "problem" representation process (Humphreys and Berkeley, 1986) who often lack the resources for adequate "reality testing" before committing to a prescription for action (Humphreys, 1989).

In practice, the process of problem definition has its roots in the formulation of the issues of concern and spirals within what Nappelbaum called "the circular logic of choice" (figure 1) as the decision-making group sharpens the description of the problem by cycling through option descriptions, value judgments and instrumental instructions, reducing discretion in how these may be defined in developing structure and spiralling toward prescribed choice.

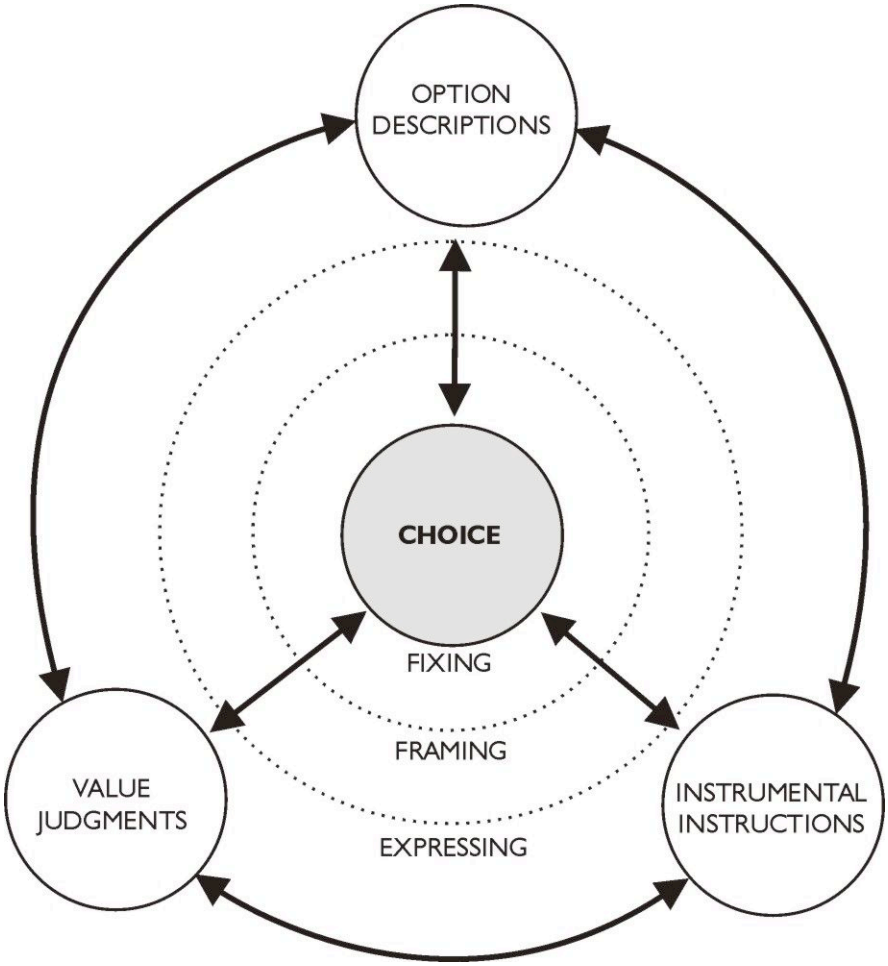


Figure 1: The Circular Logic of Choice

The desire to take prescribed action is generated from a feeling that there is a lack (or a gap) between the actual state of affairs (as perceived by the decision maker) and some imaginable preferred state. In theory, the participants in the decision-making process can start out, at the level of feeling, with complete freedom about how to think about translating this desire into action. At the outset all imaginable courses of action are candidates for implementation. The group process, aimed at developing a single, collectively agreed, representation of "the problem" then relentlessly employs the logic of choice to progressively strengthen the constraints on how the problem is represented until only one course of action is prescribed: the one which "should be" actually embarked upon in the *real*.

Five qualitatively different levels of constraint setting may be identified, each associated with a different kind of discourse concerning how to structure the constraints at that level (Humphreys, 1998). The nature of the knowledge represented at each level, and the cognitive operations involved in generating these knowledge representations, has been discussed in detail elsewhere (Humphreys, 1984, 1989; Humphreys and Berkeley, 1986). These levels have been presented in a point-down triangle as shown in figure 3, indicating the progressive decrease in discretion in thinking, as one moves downward from level 5 (exploring fantasy scenarios and dreams with conjecturality beyond formalization or structure) towards fixed structure and zero discretion at level 1 (making "best assessments"). At this point the problem-representation model is developed to the extent that the "best" course of action is inevitably prescribed. In the actual decision making process, movement through the levels is not linear, but corresponds to a spiral through the circular logic of choice

(fig 1) to the point where a particular course of action is prescribed as the "true solution" to the decision problem.

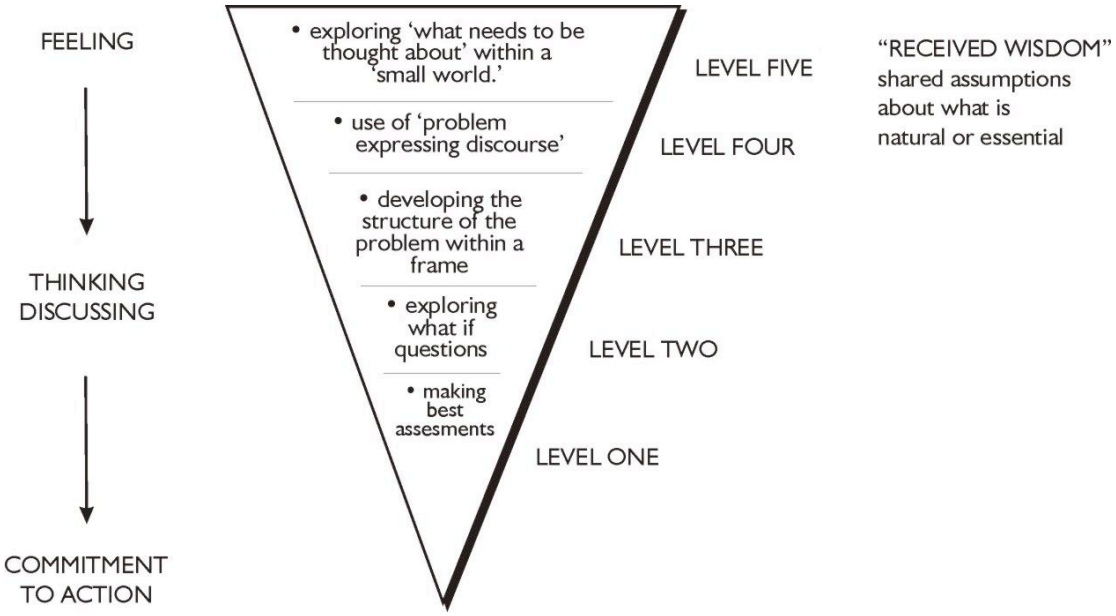


Figure 2: Five levels of representation of decision problems

At the top level (level 5 in figure 2), the roots of the decision problem are imagined through explorations through the rhizome carried out within the 'small world' (Savage, 1955,Toda, 1976) whose bounds are defined by what the participants in decision making within the spine is prepared to think about. Explorations within these bounds are made within what Sandler and Sandler (1978) called 'the background of safety', and are themselves beyond language (Lacan, 1977a), which can only be used to describe what is found during such exploration. The results of what is encountered in this exploration form the material basis for the content elements of problem representations that are manipulated in problem structuring at lower levels.

At the next level down, (level 4 in figure 2), problem-expressing discourse may be employed to make claims that particular elements of what was explored should (or should not) be included in the representation of the decision problem (Vari, Vecsenyi and Paprika, 1986; Van Eemeren et al., 1997). Claims are supported by warrants and backing the problem-expressing discourse of spine-construction advocates in order to gain their acceptance by all those party to the decision making process. The claims thus established through problem expressing discourse need to be linked into frames, so that their collective implications for potential prescriptions for action can be explored (Beach, 1990).

At level 3, framing discourse is employed to develop the structure of the problem within a frame (this is sometimes, called 'conceptual model building'; c.f., Checkland, 1981; Humphreys, 1989), Framing discourse focuses on developing structure until sufficient coherence is reached where it is possible to explore the structure so developed using 'what-if?' discourse at level 2 to see the impact of changing the assessment of one element within the structure. By the time level 1 is reached, sufficient constraints have been set for the remaining task to be only to make best assessments of 'the most likely value' at those points in the represented problem that have been represented as 'uncertain' within the constructed decision-making frames, such that a particular course of action is prescribed.

Figure 2 is not intended to indicate a prescriptive methodology for decision-making (i.e., 'start at level 5, establish constraints, then go down, one by one through the levels until action is prescribed at level 1'). All that can be established, *in general*, is that the use of the employment, in decision-making practice, of the discourses identified at each level in figure 2

serves to constrain what can be explicitly considered at the levels below in establishing the 'truth about the decision situation'.

According to Foucault, 'truth is a thing of this world: it is produced only by virtue of multiple forms of constraint' (Foucault, 1980, p.131), and in this sense, all these discourses identified at the various levels in figure 2 are involved in developing the structure of the problem and prescribing choice of the one and only best course of action (the "true solution) can be considered as particularised and, sometimes, artificial discourses of truth. Conversely, the representation of the problem constructed through the use of this discourse does not reveal the 'real' situation. Rather it is an artefact, which, as we have shown elsewhere (Humphreys, 1998), is generally advanced, in organisational communications, through the other, more general, kinds of discourse of truth which may be coercive or rely upon cycles of seduction, challenge and ruse between those party to the decision.

Within these discourses of truth, naming identifies particular subjects and objects, thus giving them implicitly fixed identities extending through time and space (Lacan, 1977a). Information about the relationships between them is provided entirely in the terms specified by the communicator (Eco, 1985). Such *telling* about what "is" or what "will be if these prescriptions are implemented" may be useful for establishing control or coordination in local decision making processes, but locks out consideration and exploration of potential resources and pathways that are not described explicitly and exhaustively in the structure of the problem representation (Humphreys and Brezillon, 2002).

In sum, the whole process constructs, and spirals within, a *decision-spine,* by analogy with the structure and characteristics, in the real world, of the spine of a hedgehog (or urchin), as illustrated in figure 3.

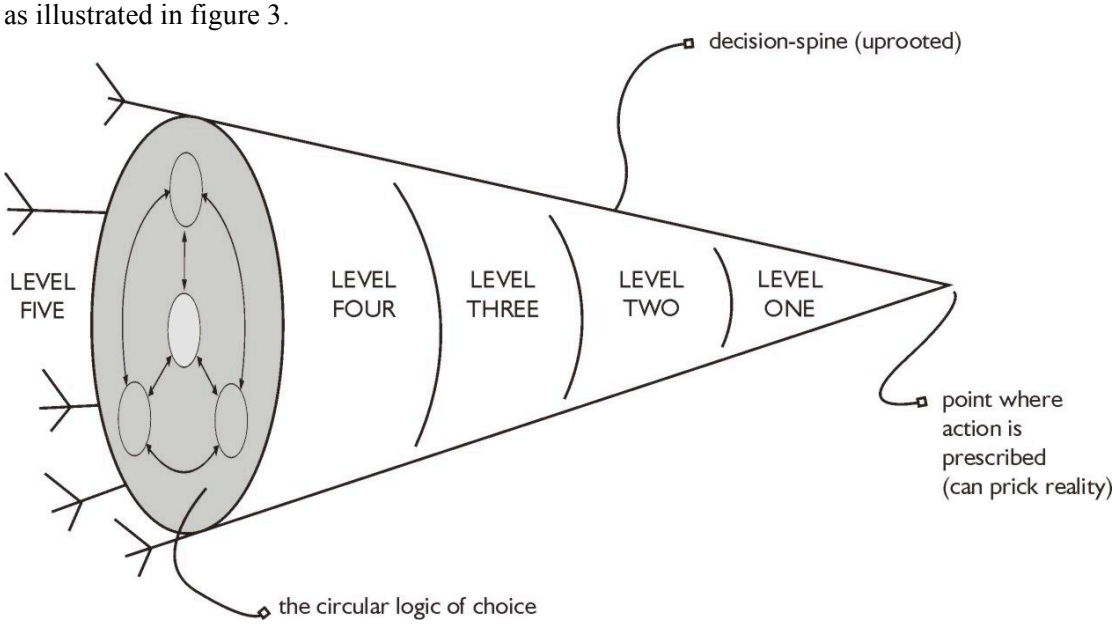


Figure 3: Decision-spine (located in the *symbolic/imaginary,* capable of pricking the *real* at its point) – by analogy with an uprooted spine from a real hedgehog)

However, this decision spine is rooted in cognitive operations at level 5 - "exploring what needs to be thought about"- (see figure 2), which, as we shall see in the following sections, are *not* necessarily bounded within the spine, but extend throughout the unbounded body of a imaginary and symbolic *decision-hedgehog* – " a body without organs" in the language of Deleuze and Guattari (1988, pp 149-166),

Drawbacks of the Decision-Spine as the Hegemonic Structure for Supported Group Decision-Making.

In a survey of attempts to implement, in a wide range of organizational contexts, courses of action prescribed as "true solutions" through decision conferencing and related group decision

support techniques, Humphreys and Nappelbaum (1997) identified the following typical outcomes:

- Failure within the implementation scenarios to identify properly and provide for handling side effects of the main, intended, effect;
- "Throwing the baby out with the bath water" through focusing on the rolling back of initial scenarios without the opportunity to create innovative pathways to goals, as they lie off the roll-back route;
- Missing of opportunities and creation of problems for change implementation management;
- Underestimation of the value of (or even the existence of) local skilled knowledge in place within the organization.

Not surprisingly, the view that the core of successful organizational decision-making lies in constructing and prescribing the solution to "the decision problem" within the hegemonic structure of a single decision-spine has come to be contested. Qualitatively different views of the core process have emerged including Decision making as learning (Schein, 1987; Argyris and Schon, 1996; Senge, 2003) and, most recently, decision making as an integral function of the authoring of collective narratives in a literary view of organisation (Imas, 2004).

The Decision-Hedgehog

In the following, we do not challenge the useful, and indeed, essential function of constructing decision spines and spiralling within them in moving from feeling that "something has to be done, experienced in the in the plane of the imaginary, through symbolic structures, that reduce the variety of the group imagination about "what is to be done" to the prescription of a single course of action to be implemented in the real. The ability of this decision technology to enable the group's imagination to "prick the *real*" is invaluable as this is crucial for effective reality testing of the collective fantasy about the context of the decision making which, in the first place, identified the action to be taken in the real as "preferred" or "optimal".

However, we do contest the hegemony of the single decision-spine as the sole fundament of support for effective, innovative and creative decision-making – understood as a rich and continuing process at the core of organisational and social life.

According to the conventional decision-theoretic logic, the act of choice within a single spine (i.e., gaining commitment of the participating group to implement the course of action prescribed within the spine as "preferred" or "optimal") "solves the problem" and therefore terminates the decision-making and the processes that support it (Kleindorfer, Kunreuther and Schoemaker, 1993; Nappelbaum, 1997). Narrative accounts of the decision making process which led to the chosen action tend to be justificatory (Humphreys, 1998). Tracing back along the paths modelled within the frame for the point of choice, ignoring (as "irrelevant" or "confusing") any narratives which traverse pathways which were not connected to the "mainline" trajectory of the ever-increasingly constrained path to the choice point at the tip of the spine. This is a major contributor to the failures practical efforts of decision support, predicated on this logic, which were identified by Humphreys and Nappelbaum (1997).

Conceptualising decision making as "learning" requires gaining feed back from the effects of embarking on "chosen" courses of action (pricking the *real* to gain information) that is not treated in isolation, like a diagnosis, but which extends the rhizome that constitutes the body-without-organs of the decision-hedgehog in which the roots of the decision spines are located, enriching the contextual knowledge for subsequent decision making along a plethora of other spines rooted in this rhizome (figure 4).

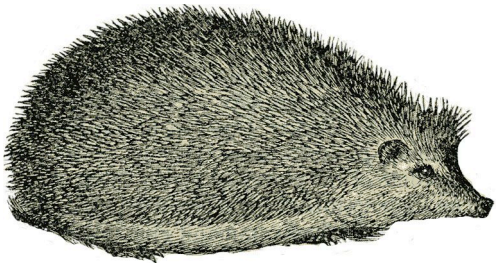


Figure 4: Decision-hedgehog: Body-without-organs, covered in decision-spines, open for exploration and nurturance in the plane of the symbolic/imaginary

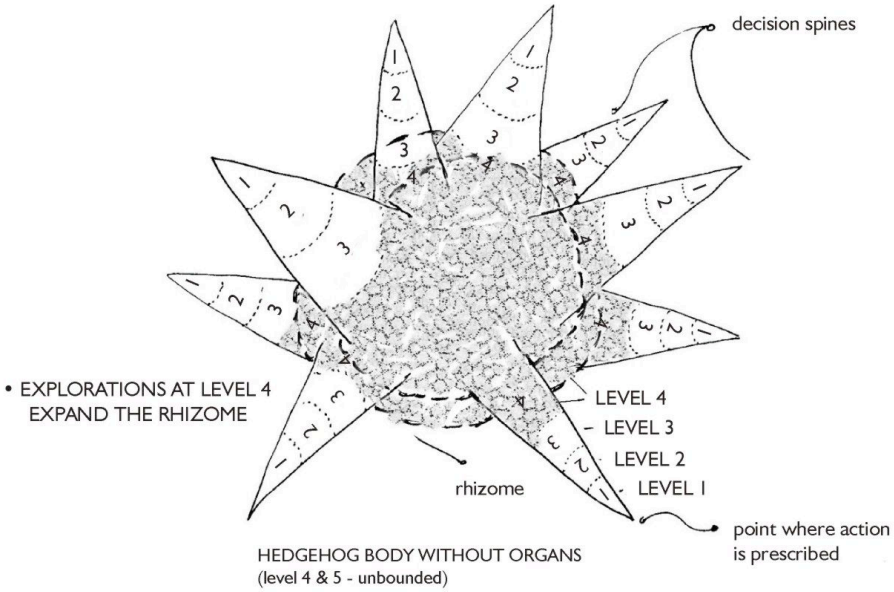
The decision-hedgehog rhizome is not a reference structure or high-level frame informing the selection of decision spines, Deleuze and Guattari, (1987) point out:

"The rhizome is altogether different. Make a map, not a tracing…. What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real…It is itself part of the rhizome. The map is open and connectable in all of its dimensions; it is detachable, reversible, and susceptible to constant modifications. It can be torn, reversed, adapted to any kind of mounting, reworked by an individual, group or social formation" (p. 12).

How can the decision-hedgehog best be nurtured? Humphreys and Brezillon 2002 explain how this can be achieved through

"[The] generation, exchange and interpretation of communications that enriches the context for distributed decision making within an open and extensible arena. Such communications would need to be in multimedia: comprising audio-visual strata founded in rich, open, language which can support innovative conceptualisation and generate new possibilities for exploration of the rhizome. However in order to prevent the interpretation of these communications by their receivers into what Eco (1985) called "infinite semiosis", it is desirable that such communications comprise also strata in multimedia employing restricted language to provide directions on the pathways appropriate in assessment and monitoring these possibilities and in making tradeoffs in deciding between alternatives – a necessary precondition for turning fantasy into real action"

Plateaus[1] linking strata comprising restricted and rich language roots the decision-spines in the rhizome that constitutes the decision hedgehog's body-without-organs (figure 5).



[1] Deleuze and Guattari (1988,p 22) describe a "plateau" as "any multiplicity connected to other multiplicities by superficial underground stems is such a way as to form or extend a rhizome"

Figure 5: Decision-hedgehog cross-section: Decision-spines rooted in the rhizome constituting the body-without organs

Enabling Collaborative Authoring of Outcomes

Through an understanding of the changes in decision support models from the hegemony of the single decision-spine model to the decision-hedgehog, this paper positions decision making within the planes of the *symbolic/imaginary,* with the fundamental aim of enriching understanding of the contexts of decision making authoring of narrative within the rhizome, linked with localised processes involved constructing and exploring a variety of decision spines each of which has the capability to "prick the *real"* at its point, through implementing he course of action prescribed there.

The process of group decision-making is doubled in the parallel planes of the imaginary/symbolic and the real. Group participants engage in real activities in attempting to move through the decision process, working with imaginary ideas and developing a variety of open symbolic representations within a rhizome rather than a frame (Deleuze and Guattari, 1988). When we communicate these, we engage in real authoring activities using our imagination to create symbolic content and our production skills to communicate this content as mediated narrative.

We propose that the construction of mediated authored narrative is not only a means of more powerfully enabling attention within an organisation, but also a means of narrating pathways, as collaborating groups construct and explore maps of possibilities and opportunities, within the doubling structure of a rhizome taking form on a variety of levels (Kaufman, 1998).

At the personal level, the rhizome is experienced as a map formed through exploring potential pathways, rather than as a tracing of "reality". Resources for conceptualisation of collaborative outcomes may be innovatively accessed and their transformation imagined through voyages along these pathways, doubled in imagination and in reality. At the social level, the rhizome is activated, extended and revised by the participants in the group making and exchanging stories about discovery and innovation in the conceptualisation, utilisation and transformation of resources for living. When they are authored in multimedia, these stories involve *showing* as well as *telling* what is, and what *could* be, rather than *being told* what *should* be (Humphreys, Lorac and Ramella, 2001; Humphreys and Brezillon, 2002).

Enabling Contexts

The ubiquity of multimedia platforms, peer-to-peer information authoring tools, design led approaches and contemporary forms of collaborative environments are enabling new ways for us to organise ourselves, and launch our collaborative ideas, products, projects and programmes into the world.

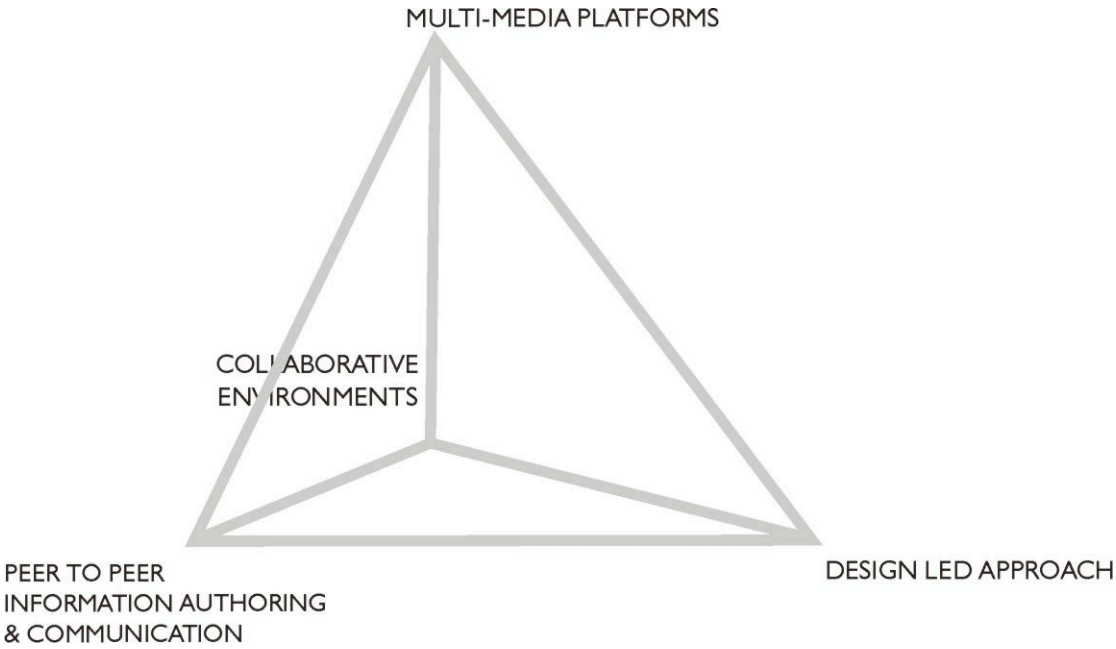


Figure 6: Enabling contexts for collaborative authoring outcomes

The synergy of processes within the tetrahedron shown in figure 6 unleashes a plethora of options for getting things done. Awareness of choices available motivates the creation of the rhizome through which collaborating groups attempt to map their way toward outcomes. The choices by which routes through the rhizome are mapped, explored, tested, rejected or pursued have strategic implications for groups:

- How can we as organising groups chart the landscapes of options available to us?
- How can we know which strategies of engagement will lead to success?
- How can we collaborate with the multitudes of interest groups or engage in ways that enable multiple agendas to be satisfied simultaneously?
- How can we move to an understanding of context from where we gain resources to help us decide how to proceed?

Consider, for the moment, Hansel and Gretel whose journey of capture and redemption through their own initiative began with their step-mother's decision that the only possible single solution to the family's lack of food was to abandon the children deep in the forest. [2]

Convergence of Processes Supporting Collaborative Authoring of Outcomes

Group decision authoring and communication support (GDACS) supports creative authoring at levels 5 and 4 – writing the rhizome where decision-spines are rooted and incorporating artefacts crafted at levels 3 and below in spiralling through individual decision spines. It works through continuous cycles of conjecturality, contingency and encounter with artefacts to yield collaboratively authored outcomes, informed qualitatively by the convergence of processes that lead us from feeling to action.

These converging processes identified here are *a facilitating environment, authoring in rich language, participatory multimedia, exploration of context within the rhizome, decision-spine construction, and utilization, group processes and design processes*

[2] The excerpts from Hansel and Gretel are to be found at http://www.mordent.com/folktales/grimms/hng/hng.html

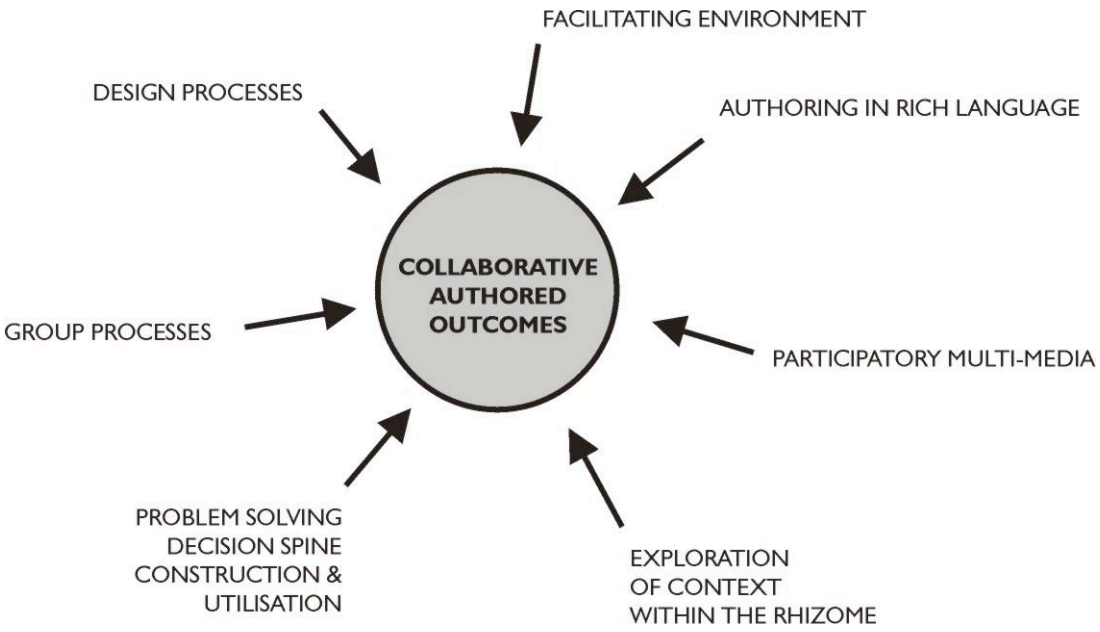


Figure 7: Converging Processes in Collaborative Authoring of Outcomes.

Facilitating Environments range from purpose built decision conferencing rooms and "Pods" (Phillips, 1989), Accelerated Solutions Environments (Jones and Lyden-Cowan, 2002) and Flexible Learning Environments (Jones, 2005) to street furniture, wireless hotspots and public infrastructure designed by architects to enable group work in the internet-enabled laptop age. Facilitating environments for GDACS typically create knowledge rich arenas, interactive technology, feedback systems (visual and data), production support, and spatial facilitation of group, private and interpersonal work. In most cases the idea of the *proscenium* exists: incorporating a back stage and a front stage, where participants are enabled, and the work mediated, by facilitators and support teams. Multi-media, however, enables us to create a stage on which the players, actors, authors, stagehands and audience are all present and where the proscenium shifts to the interface with the screen.

The principles operating within facilitating environments for GDACS are that "help is focused at the point within the problem structuring and decision-making process where the problem owner / decision maker is experiencing difficulty in proceeding" (Humphreys and McFadden, 1980). Such environments provide a means of enabling rapid and creative progress, unencumbered by structural, logistical and information deficits. Facilitation in this context means "to make it easy".

Sense making and Communication within the Labyrinth

"Hansel, what are you looking at there and staying behind for? Pay attention, and do not forget how to use your legs." "Ah, father," said Hansel, "I am looking at my little white cat, which is sitting up on the roof, and wants to say good-bye to me." The wife said: "Fool, that is not your little cat, that is the morning sun which is shining on the chimneys." Hansel, however, had not been looking back at the cat, but had been constantly throwing one of the white pebble-stones out of his pocket on the road.

In GDACS, collaborative authoring of outcomes is founded in investigation and conjecturality. Umberto Eco (1986) reminds us that a useful model of conjecturality is the labyrinth. But what kind of labyrinth? Eco identifies three kinds of labyrinth. The first kind is the classical labyrinth, the labyrinth of Theseus:

"This kind does not allow anyone [reading the tale] to get lost you go in, arrive at the centre and then from the centre you reach the exit. This is why in the centre there is the Minotaur [or in the case of Hansel and Gretel, the witch in the sweet house in the centre of the forest]. If [s]he were not there, the story would have no zest; it would be a mere stroll. Terror is born, if it is born, from the fact that you did not know where you will arrive or what the Minotaur will do. But if you unravel the classical labyrinth, you find a thread in your hand, the thread of Ariadne."(Eco, 1986, p57)

The entire narrative of the tale of 'Hansel and Gretel,' as presented to the reader, is such a labyrinth. The reader, like the author of the tale, resides outside 'Hansel and Gretel'. But what kind of labyrinth does, Hansel, who has to make decisions inside the world of the tale, find himself in?

Hansel initially assumes that he in being led into the second kind of labyrinth: a mannerist maze:

"If you unravel it, you find in your hands a kind of tree, a structure with many blind alleys. There is only one exit but you can get it wrong. You need an Ariadne's thread to keep from getting lost. This labyrinth is a model of the trial and error process" (Eco, 1986, P57).

Hansel decided to lay a pebble trail as the thread. Once faced with the problem of how to get out of the forest-labyrinth, Hansel chose the prescribed course of action: he followed the pebble trail in reverse and found the exit without any errors. He supposed that the situation that he and Gretel had been led into by their parents was located in what Brezillon and Pomerol, (2001) called the "engineering view of context", which assumes that context is useful for making a frame in which a problem can be solved.

In terms of our decision hedgehog model (figures 3-5), Hansel concentrated on constructing and utilising a single decision-spine. In this process, knowledge at levels 5 and 4 had already been considered and acted upon by others (his parents, and the author of the tale *in loco parentis*) to set the constraints on the problem frame at level 3 in the spine (which also relies upon Hansel's knowledge of presumed stable structural constraints in the physical world: paths through the forest do not change overnight; pebbles do not change overnight except to glow in the moonlight). The problem requires some active consideration at level 2 (what if we wait till night as then the pebbles will glow so we can see them?), but that is all that is needed for the point of the spine to be reached and utilised in pricking localised reality to solve the problem of finding the exit.

One of the biggest problems facing practitioners, and systems, attempting to support decision-making in unstructured situations with conventional problem solving methodology, is how to match problem frames to situational cues within a single decision-spine before trying to solve the problem within the spine (Brown and Ulvila, 1977; Humphreys and Berkeley, 1983; Phillips, 1989; Landry, 1995). Pattern matching within a single spine may be the norm, but can it suffice?

Within the tale, Hansel soon finds a similar pattern arising, within the single decision-spine he was employing to make sense of his and Gretel's situation (overhearing his mother telling his father that the children must be abandoned in the forest). He matches it as a recurrence of the previous problem - with the same solution (Ariadne's thread), but cannot scavenge pebbles (his mother has locked him in the house). So Hansel, on the voyage into the forest, lays a trail with a substitute resource, crumbs of bread from the piece given to him for his supper) as he and Gretel are taken deep into the forest and left there.

Hansel comforted his little sister and said "Just wait Gretel until the moon rises and then we shall see the crumbs of bread that I have strewn about, they will show us our way home again." When the moon came they set out but they found no crumbs. For the many thousands of birds, which fly about in the woods and fields, had picked them all up. Hansel said to Gretel "We shall soon find the way", but they did not find it. They walked the whole night and all the next day too from morning till evening, but they did not get out of the forest.

So the "problem" could not be solved: the mannerist maze had too many pathways, all ending in error. Instead Hansel and Gretel meet the witch and realise that they are in an altogether different labyrinth – a labyrinth where successful decision-making will depend on

the development of collaborative outcomes. Umberto Eco (1986, pp 57-8) describes this as the third kind of labyrinth – a space of conjecture like a rhizome which

"Has no centre, no periphery, no exit because it is potentially infinite … it can be structured, but never definitively" (Eco, 1986, pp 57-8).

Hansel, and particularly Gretel, henceforth collectively realise that the decision-making context in which they are now immersed matches what Brezillon and Pomerol (2001) call the "cognitive science view" of context, where:

"Context is used to model interactions and situations in a world of infinite breadth and that the human dimension is the key to extracting a model…. Context is considered as a shared knowledge space that is explored and exploited by participants during the interaction. Contextual knowledge acts as a filter that defines, at a given time what knowledge pieces must be taken into account (explicit knowledge) from those that are not necessary or already shared (implicit knowledge)." (Brezillon and Pomerol, 2001, p 268).

Later in the tale, Gretel employs this kind of contextual knowledge very effectively in "coming to know" how to dispose of the witch, and how to author the outcome where a [mythical] duck's offer of help effectively enables Hansel and Gretel to escape from the forest-labyrinth. As we shall see, pointing out the course of action that will "solve" this problem will require the construction of new spines rooted in the body-rhizome of the decision-hedgehog.

In a literary view of the organisational decision making, as in Hansel and Gretel's successful decision making in escaping from the witch-labyrinth, the processes linked with decision making are complex and interdependent and construed as a process of collaborative authorship. The collaborative interactions that elicit conditions of "coming to know" within the framework of the proscenium, the interaction with the physical environment in constructing the rhizome that provides the pathways leading through the proscenium background (the "scene" of mise-en-scene), the interaction between the actors (or co-authors) and the crafts associated with production of signifying artefacts in the proscenium foreground (or arena; theatre-in the-round), combine to enable sense-making and contingent encounters with the real.

The language of the design process has emerged as a means by which groups socially construct outcomes at every level of GDACS. Such language is used to enable the design of procedures for decision-making as well as providing frames within which the decisions may be manifest – supporting rapid iterative cycles of decision-making, anchored within artefacts leading in turn to rapid cycles of reflection and reaction.

The convergence of these technologies in GDACS raises challenges for how we organise our work in groups, the physical environments we construct for ourselves to work in, the organisation of our knowledge systems, and how we organise ourselves to achieve desired outcomes. We propose that the language of authorship and production in multimedia provides a richer set of constructs with which we are better equipped to co-author collaborative outcomes, showing as well as telling *what is* and *what could* be (Humphreys and Brezillon, 2002).

Evolution of Group Decision Support Models

Currently, GDSS range from rationalist driven processes, to those encompassing the behavioural and narrative contexts that are embedded within content and sense making. This range may be found reflected in the different approaches to the construction of Group Decision Support environments such as the "Pod" (Philips, 1989), Accelerated Solutions Environments Jones and Lyden Cowan, 2002) and "Box" (Boutari, 2004).

These developments in Group Decision Support environments also reflect the evolution in the processes that support decision-making. Decision Conferencing typically works backwards along a single decision-spine from an understanding of collaborative models to define the tasks leading to construct the reality (Phillips, 1988). The decision analysis technologies that support it require the interface of a facilitator to enable the programming of models structuring the decision-spine and to gain commitment of participants in the group to the course of action thus pointed out.

Accelerated Solutions Environments (Jones and Lyden-Cowan, 2002) are located within ideas of the learning organisation. The environments are configured as flexible learning environments (Jones, 2005) providing the structural and procedural conditions for large groups to frame their decisions making. Groups move through phases of scanning the landscape of information and defining the problem, to focussing on finding ideas, the generation of alternatives, and learning to act on prescriptions through processes of acceptance-finding and group-sign-up-to-activities. Scale, mobility, flexibility and rich context are means by which the experience of the Attempts are made to bridge the gap between decision-making and ongoing implementation through the creation of web based interfaces and "knowledge repositories". Accelerated Solutions Environments have required large consulting engagement teams to ensure their implementation within organisations.

Whereas large-scale sophisticated GDSS go a long way to engaging large groups in constructing the complex decisions that will influence them, it prompts questions concerning the point of closure of frameworks within decision-spines that lead to pre-defined outcomes. Its reliance on the development of collective fantasy to generate intent, as well as the role of outsiders in the pre-definition of knowledge bases and implementation is problematic within an open, associative, decision-maker driven, social construction approach.

Decision making systems may be seen as enabling action within the plane of the real through symbolic engagement with desired outcomes through processes spiralling within decision-spines. However, the sophistication of the approach to achieving such decision-making is not necessarily indicative of its effectiveness in enabling implementation. Group Decision Support Systems in the age of ubiquitous access to information and within the support infrastructures of the socially constructed environment need to be able to support processes growing the rhizome which constitutes the body-without-organs of the decision hedgehog, These include mediated communication, social construction of information, multi-disciplinary frameworks for organising information, open associative discourse, creative awareness, conceptual layers of organisation and the understanding and exploration of different types of knowledge.

Thus GDACS evolved as a multi-dimensional approach requiring groups not only to author content, but also to know where they are in the authoring process, or the conceptual construction of the outcome at the level of "the book" as well as at the level of "the chapter". It is a multi-authored approach which asks who has the voices that are best able to craft the multiple decision spines as artefacts rooted as plateaux in the rhizome endings for the book. Who is the "the book" for and what it will take to resonate with the extended communities of "co-authors" in the library? Umberto Eco in *Reflections on the Name of the Rose*, points out that

> "The labyrinth of my library [of already-published books] is still a mannerist labyrinth, but the world in which William [like Hansel and Gretel and the participants in GDACS environments] realises he is living, already has a rhizome structure" (Eco, 1986, p 58).

The Change Challenge: Escape from Coercion

Witches have red eyes, and cannot see far, but they have a keen scent like the beasts, and are aware when human beings draw near. When Hansel and Gretel came into her neighbourhood, she laughed with malice, and said mockingly: "I have them, they shall not escape me again!" Early in the morning before the children were awake, she was already up, and when she saw both of them sleeping and looking so pretty, with their plump and rosy cheeks, she muttered to herself: "That will be a dainty mouthful" Then she seized Hansel with her shrivelled hand, carried him into a little stable, and locked him in behind a grated door. Scream as he might, it would not help him. Then she went to Gretel, shook her till she awoke, and cried: "Get up, lazy thing, fetch some water, and cook something good for your brother, he is in the iron cage outside, and is to be made fat. When he is fat, I will eat him." Gretel began to weep bitterly, but it was all in vain, for she was forced to do what the wicked witch commanded.

Powell and DiMaggio (1991) describe institutional isomorphism (change) and collective rationality in organisational fields in terms of an iron cage. They propose a distinction between coercive, mimetic and normative forms of isomorphism. Coercive isomorphism creates pressures for change by formal, informal or culturally conditioned means. Decision-making systems are impacted by the rules of conformity that pervade the culture. Mimetic isomorphism relates to structural changes that occur through organisations imitating the structures and processes of other perceived successful organisations in the hope of achieving efficient solutions. For example, organisations which have "decided" to implement pre-existing processes, systems and organisational structures through the implementation of apparently "best practice" electronic retail systems (Sammon and Adam, 2002). Normative isomorphism seeks to establish norms, modes, conditions and techniques which lead to a shared cognitive base for behaviour in a given field, professionalism or qualification being the determinant of structural rationale.

Group Decision Support Systems (GDSS) are not in themselves value free. Systems exist that could be considered normative, mimetic or coercive and divisive (Humphreys, 1989). For example, a normative GDSS will coerce users to spiral through a particular pre-selected decision spine by, for example, utilising a professional knowledge base and/or pre-set decision representation frameset as determinants. Mimetic GDSS could be defined as those that seek to employ so-called best practices and subject matter specialists as the pattern-matching knowledge base whereby "appropriate" decision-spines are identified. GDSS that are configured as learning systems, bringing subject matter specialists together with specialist research, in accelerated solutions environments, are mimetic.

However, the question of *when could a GDSS be considered coercive* is more complex. It may be useful to consider whether the decision-making procedure involved impacts the structure or the content of the outcomes and whether it restricts, rather than enhances, resources for innovative and creative decision making. An example of a coercive GDSS would be where pre-configured outcomes are implicit within the structural framesets, and all that we are asked to do is to populate templates with content in order to move to the point of the pre-selected decision-spine where action is prescribed. As we have discussed above, this is the model for the second type of labyrinth (Eco, 1986) and the "engineering" view of the context of decision-making (Brezillon and Pomerol, 2001).

The degree of power that we have to create or select a particular decision-spine, to develop structural framesets for ourselves, come to closure, explore content, and choose where to direct our energies beyond the event, impacts whether the system providing us with "group decision support" can be considered coercive or not. In our view, the degree to which we are able to choose how and where we will apply ourselves is conceptualised within the rhizome of the decision-hedgehog.

GDACS provide infrastructure, procedure and information through which groups may actively engage with creative processes by enabling creative engagement at levels 5 and 4 within the body-without-organs of the hedgehog in which the decision-spines are rooted. GDACS facilitates not only structural flexibility but also the willing engagement of the broader population. Deleuze and Guattari 91988) present the emergence of the contemporary cultural condition as an ongoing creation of limitless coexisting worlds.

How then can we enable critical engagement of broad constituencies within open frameworks for decision-making? Within a Lacanian perspective, the engagement of the broader population with the decision-making process can be read as the changing relations of identity formation of organisations within networks that derive from the *symbolic* and the *imaginary* (Lacan, 1977a). The expansion to the *real* is driven by perceived lack and motivating desire which creates meaning as well as steers action.

The challenges for GDACS are those of expanding inclusion, enriching context and exploring beyond the symbolic and imaginary into the real. These are challenges of scale, attention and the interpenetration of systems. We believe that media within GDACS is one of

the means by which these challenges can be met through an approach based on co-authoring of outcomes.

Collaborative Media and Visual Authoring are the means by which groups are able to develop digitally based narrative. For example scenario creation, contingent outcomes and the world as we narrate it from our perspectives may be storyboarded, crafted, produced and disseminated. The growth in availability of production equipment, the ubiquity of digital media equipment and increases in visual literacy provide powerful set of tools to do so. Video equipment, and visual authoring skills, in the hands of groups who are co-authoring their perspectives and options has powerful effects on the groups who are engaged in such activities (Humphreys, Lorac and Ramella, 2001).

Authoring multi-media artefacts enables the inclusion of large constituencies, which may be dispersed in space and time, through engagement with the construction of narrative. The challenge of enriching context is tackled through a multi-perspective approach exploring and communicating in rich as well as restricted language (Humphreys and Brezillon, 2002). Multiple cycles of multi-media development enables the continuous oscillation between exploring in the symbolic and the real. The social construction and communication of media artefacts linked by narrative attracts and holds the attention of the decision-making constituency. The collaborative authoring process also acts as a means by which the broader communities are engaged and complicit in the outcomes. The multi-media infrastructures available provide opportunities for mass collaboration and many-to-many authorship on a scale hitherto impossible.

Text based and restricted languages are considered limited for describing all the dimensions associated with our perceptions of the real and of what is missing. Rich language informing authoring in Audiovisual media (Lorac, 2002), extended language subsystems facilitating navigation through the rhizome and the processes of co-authoring media objects, goes some way to providing richer means of understanding each other and the worlds we wish to live in.

Authoring Outcomes Between the Planes of the Real and the Symbolic

Group Decision Support Systems (GDSS) have been challenged for their reliance on the construction of collective fantasy as a driver of intent. Whether they successfully enable groups to deal with continuous shifts in context and information landscapes is also in question (Humphreys 1989). Decisions made in isolation from their context are immediately redundant as those contexts shift. How then is it possible for us to work together in ways that enable the trajectories of our decision making to have the greatest possible chance of achieving acceptance of these decisions in the broader communities into which we launch our desires?

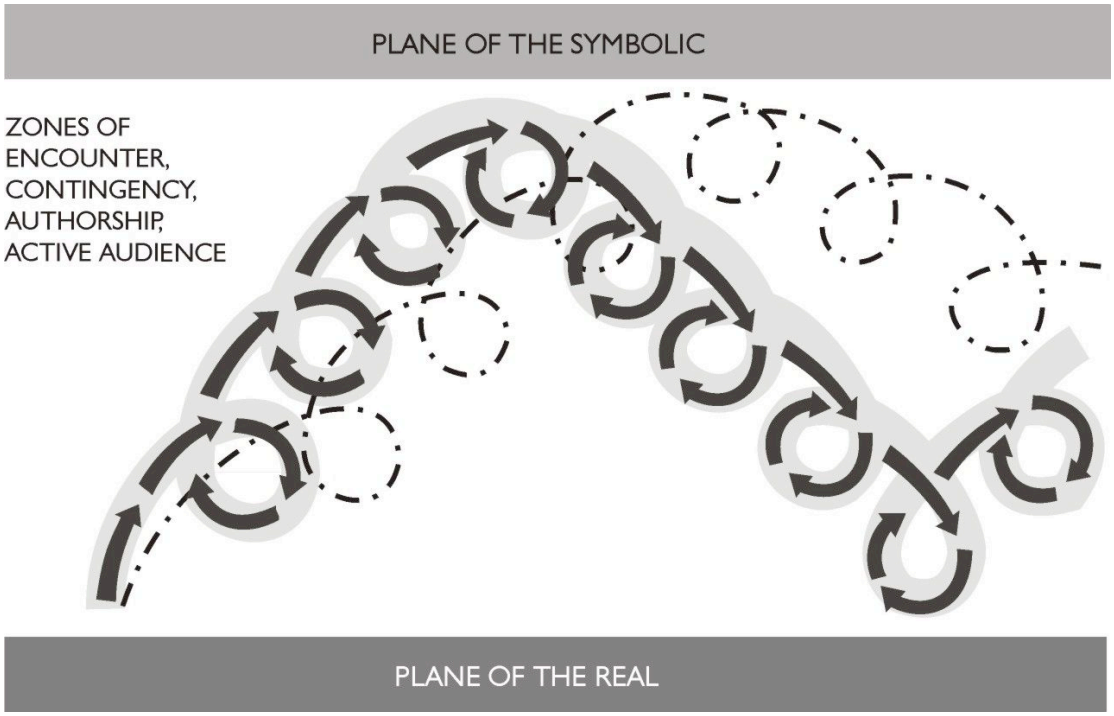


Figure 8: Zones of Authorship and Encounter in Collaborative Authoring of Outcomes

The shift to the knowledge economy and the rise in real-time information systems provide opportunities for the crafting of complex narratives from the vast amounts of information available. In such a condition the collaborative construction of rhizomes, visualisation of desired outcomes, and the design of pathways to and through decision-spines, enables groups to navigate and author the decisions that lead to desired consequences.

Hansel held out the bone through the bars of the cage for the witch to feel. The witch, who could not see that well, was puzzled. She had been fattening him up for the pot. Why was he not putting on any weight?

However, the challenges of constructing and navigating though decision spines into the real still face us. How do we ensure our decision-making isn't taking place in isolation? How do we ensure that we aren't the developers of redundant and expensive collective fantasy? How do we engage the attention of the communities affected by our decision making to ensure acceptance and activities of implementation? When the witch tests her reality by prodding Hansel – and she accepts the bone he offers – it is clear to us the reader that the sense-making technology supporting the witch's decision-making is seriously flawed.

In psycho-analytic terms, when making decisions, groups of decision makers oscillate between the plane of the symbolic and the plane of the real, through the imaginary, guided by the "gap" (Lacan, 1977b) they experience between expectations and exploration of outcomes.Fo r Deleuze & Guattari (1988), the symbolic acts as a constraint on the imaginary. GDACS attempts to provide sufficient encounters between these planes to enable sense making. Collaborative Authoring of Outcomes uses multi-media as the active channel between these planes. The use of media in Collaborative Authoring of Outcomes causes a doubling to take place that enables us to make sense of the real and the symbolic.

For decision-making groups, the philosophical space between these planes can also be considered contingent. Groups who are mapping rhizomatic pathways through the labyrinths of information do well to consider constructing multiple decision-spines in parallel. Rapid processes of generating, alternatives and challenging assumptions, enable the authoring of narratives containing rich representations of socially constructed scenarios. The

collaborative construction of decision-spine frames and the subsequent populating of them with content provide artefacts within which the objects of desire (outcomes) can be trammelled. It is the difference between the representations of desire in these contingent artefacts and its experience in the "real" at the points of decision-spines that makes the difference – that yields the dynamic informing the continuous state of "becoming".

Crafting of Artefacts

For example, in the design world, proto-typing could be said to be a process of creating transitional objects of desire or recoil around which groups cluster. The transitional artefacts, or prototypes, constitute the symptoms of the group's condition (Bion, 1961; Winnicott, 1971; Yalom, 1964). The act of creation of the artefact leads immediately to a mode in which the object has withdrawn from us and we obtain critical distance. The fetishisation of these artefacts occurs as contra-distinct from the symptom where "the fetish is the embodiment of a lie that enables us to endure an unbearable truth" (Zizek: 2000) – that of what we really want.

The process of co-authoring collaborative outcomes, through the creation of media artefacts, enables us to gain rapid, critical distance from our symptoms. By filming our condition, appearing in it and presenting our versions of reality now, and future desired, we become able to have a dialogue with the unspoken and unspeakable. Lacan calls this the lack or the *objet petit a.*

In the book edited by Zizek (2000) on "Everything you always wanted to know about Lacan (but were afraid to ask Hitchcock)" *the lack* and its impact in enabling a reality constructing dynamic is linked to Hitchcock's term the MacGuffin:

"MacGuffin is *objet petit a* pure and simple: the lack, the reminder of the real that sets in motion the symbolic movement of interpretation, a hole at the centre of the symbolic order, the mere appearance of some secret to be explained, interpreted, etc."

The continuing production of signifying artefacts enable the movement away from what we feel toward action. They also serve another purpose – that of easing interdisciplinary collaboration. Each of us using the language we are most familiar with to construct our artefacts. They are the product of interdisciplinary co-construction rather than confrontation, and go beyond what Bourdieau (1973) called "explicit expressions of the assumptions peculiar to each discipline."

Collaborative Authoring of Outcomes is predicated on an understanding that the real is to be endured, embraced and incorporated into the narrative structures of our personal fiction, in order for it to lead to sustainable change in our own behaviours. Rapid co-authoring of contingent, framed artefacts enables the unspeakable to be sufficiently present to inform the proceeding cycles of authorship.

What then are the implications for GDACS? Collaborative outcomes are represented and evolved using visual language systems through engagement with media production processes (Lorac, 2002). We, as a group, are engaged in the authoring of contingent opportunities from within our own context.

Through ongoing and continuous engagement with the real, using multi-media, we are able to engage in an ongoing recalibration of the collective fantasy of outcomes with that of the field of real potential. The engagement with visual authoring and narrative enables such an approach to become a stream of engagement of transforming narrative rather than single events over time.

This applies in many domains. The architects *The Office Of Alternative Urban Planning (TOOAUP)*, based in Rotterdam, define themselves as wanting to engage in "a relation with the city via the apprehension of its infrastructurality, tending towards establishing an analogical relation and the production of material organizations whose effects on the city are 'immanate' in the cause, rather than emanating from it; their effects are in themselves" rather than the modernist production of new symbols whose effect is intended to be emanative within the city (Khourian, 2004). Designers are increasingly building usability testing and front-end design into the very early stages of the design process, to ensure increased take-up and engagement with the systems when they are launched. Film-makers

are creating type 1 labyrinths with multiple beginnings, middles and ends and testing alternative threads of Ariadne as they unravel with test audiences. Software developers establish networks of early adopters, beta testers and celebrity users.

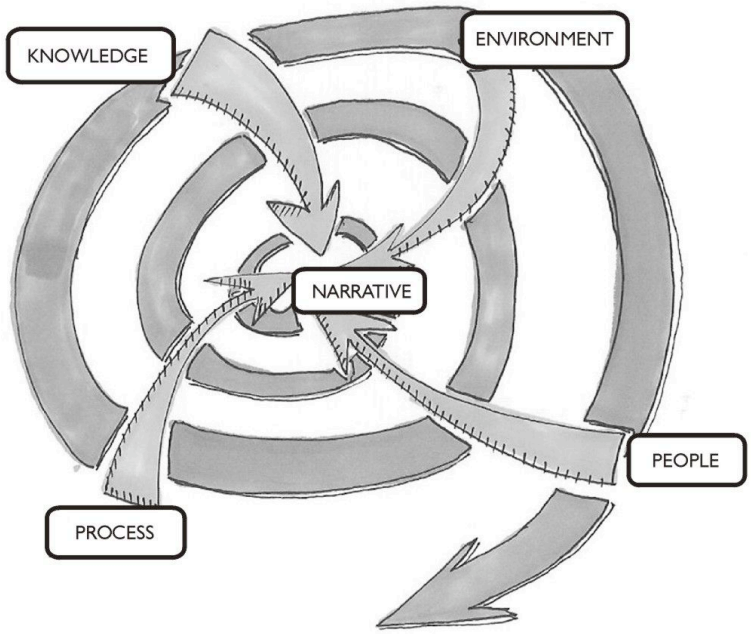


Figure 9: Actors in the spiral of collaborative outcome authoring

The primary actors in such an approach are the people, environment, processes and knowledge working together to enable multi-disciplinary collaborative authoring of outcomes. Action and decision-making are established as a vortex of collaborative testing of contingent artefacts each representing the continuously spiralling collective desire.

Authorship as a Means of Enabling Engaged Attention and Collaboration

Getting the attention of an organising system is crucial if the decision-making processes are to lead to implementation. The need for the expansion of the field of engagement with constituencies, stakeholders and interest groups creates pressures for decision making to take place on ever increasing social scales. Engaging the broader constituencies and decision makers within the authorship of narrative structures, creates the opportunity for personal narrative to become implicated in the bigger story (Imas, 2004).

Authorship is a craft. The construction of narrative, the processes by which narratives are reflected and signified through artefacts (e.g. book, video, object) is a craft. Mihaly Csikszentmihalyi (2002) creates the utopian ideal of the autotelic worker. As a worker we achieve a state of psychological engagement with our work to the point where we are flowing - a state that Hip-Hop musicians identify as vital for their success. "Flow" is a condition enabled by the balance between challenge and technical skill. Too much challenge and insufficient skill leads to stress; too little challenge and over skill leads to boredom (Karasek, 1979). Environments that are constructed to provide both challenge and access to requisite skills enable us to achieve "flow". An excellent example of this is the reality television programme "Faking It" where individuals volunteer to learn a completely new job or activity in an incredibly short time, tutored by experts in multiple disciplines. They are then blind tested by another group of experts who have to guess the fake. The pierced bicycle

courier, who fooled some of the worlds best polo players that he was one too, stands out. As was the utter joy he expressed when having done so.

Collaborative authoring of outcomes provides us with the opportunities to craft narrative structures through the collaborative creation of multi-media artefacts. We engage our broader communities and environments in complicit and critical activities in co-authoring the broader narrative. Narrative, like decision-making, is constructed on multiple levels.

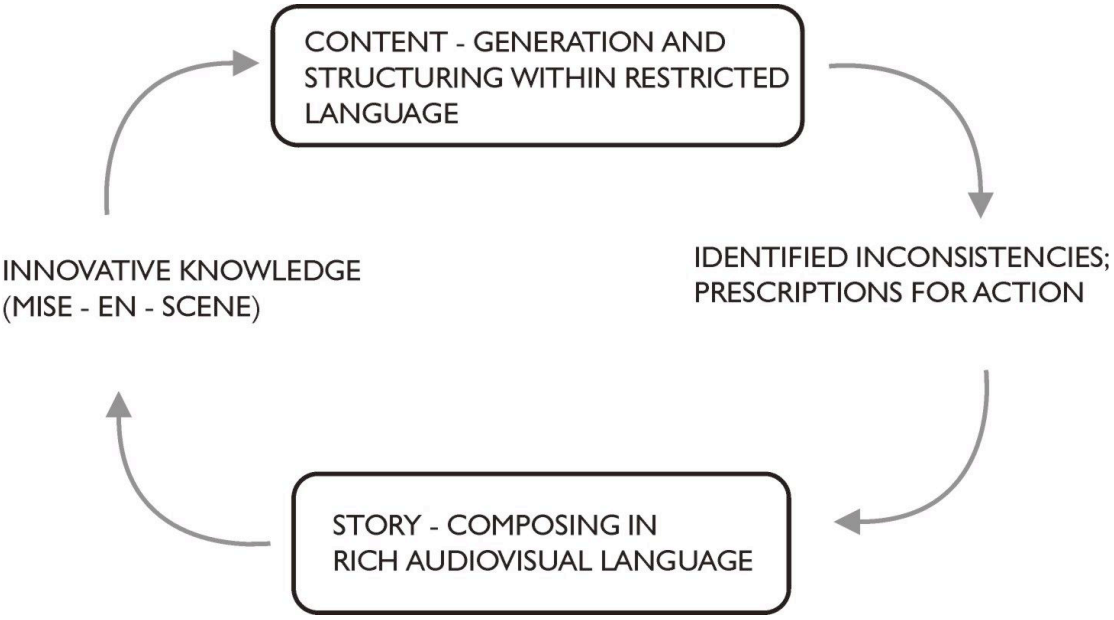


Figure 10: The cycle between rich and restricted language in collaborative authoring of outcomes

In the collaborative outcome authoring process, the cycle shown in figure 9 spirals through time as story composing in rich, audio-visual language provides innovative knowledge, (as *mise-en-scene*) for content-generation and structuring in restricted language. Conversely, inconsistencies (gaps, contradictions, vicious circles), as well as prescriptions for action, identified through content structuring in restricted language, can provide entry points for pathways through the rhizome which could profitably be explored further in composing narratives in rich language (Humphreys and Brezillon 2002).

Such social, collaborative construction of knowledge suggests that we are engaged with the stories we are telling about what we are building together. We pay attention to the collective narratives we identify with our own fictionalised narrative, and in particular those we are complicit in co-authoring. Human forces are not sufficient on their own, we have to collaborate, gain the attention of, and become linked to other forces to establish a dominant form in which we can install ourselves. Authorship is in this sense a strategy for obtaining the attention and collaboration of other forces. GDACS become enablers for radical reterritorializations, and new social groupings, through the poetry of our narrative.

"But now we must be off," said Hansel, "that we may get out of the witch's forest." When they had walked for two hours, they came to a great stretch of water. "We cannot cross," said Hansel, "I see no foot-plank, and no bridge." "And there is also no ferry," answered Gretel, "but a white duck is swimming there; if I ask her, she will help us over." Then she cried:

"Little duck, little duck, dost thou see,
Hansel and Gretel are waiting for thee?
There's never a plank, or bridge in sight,
Take us across on thy back so white.

The duck came to them, and Hansel seated himself on its back, and told his sister to sit by him. "No," replied Gretel, "that will be too heavy for the little duck; she shall take us across, one after the other." The good little duck did so.

Enabling Platforms for Collaborative Authoring of Outcomes

Clearly, we are calling for a different way of going about the organisation of decision-making. As De Certeau says in "The Practice of Everyday Life" (1984, p 81) "the story does not express a practice. It does not limit itself to telling about a movement. It *makes* it." The underlying principles require testing and contingent encounters with its own constituencies in the development of these ideas in practise. We ask what platforms, or machines, are required to enable decision-makers to work as collaborative authors? We are concerned not only with the theory, but also with how we *make* it in practice so that it may become useful to us.

The set of systems providing the converging processes in GDACS, that we identified in figure 7, collectively constitute an enabling platform for collaborative authoring of outcomes. Knowledge subsystems concern the ordering of information. These include procedural knowledge, context knowledge and content knowledge. Collaborative environments, multi-media platforms, peer-to-peer authoring and communication and design led approaches inform the construction of physical environments to enable synthesis and production of materials, group work and visual displays of information. The physical environment forms an intersection with the virtual environment, the online tools and the technical systems that support dynamic knowledge repositories.

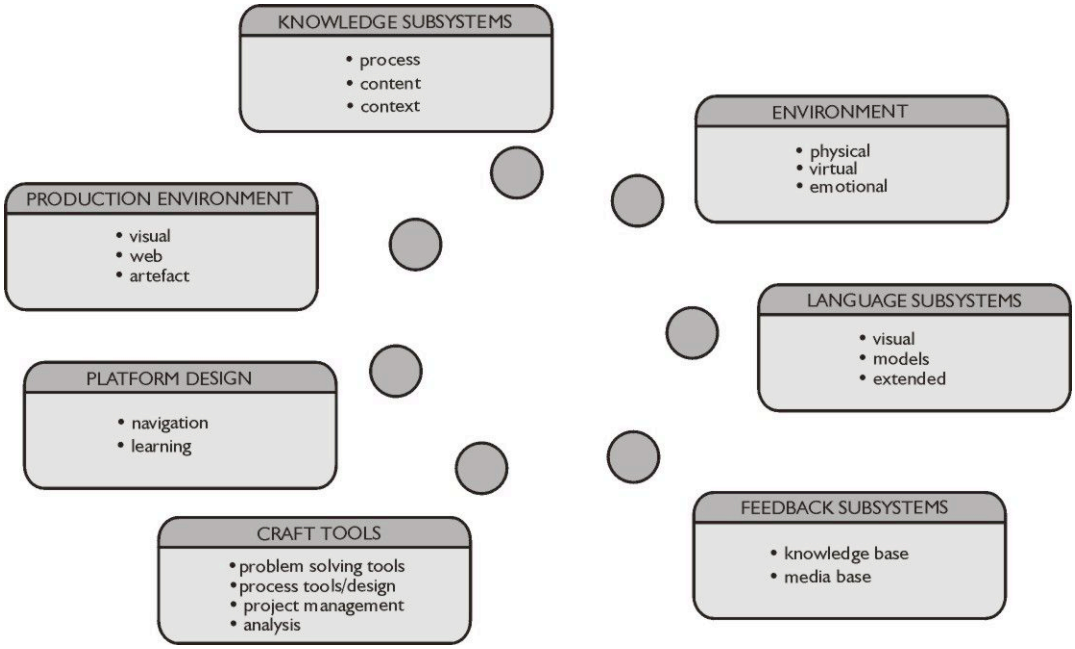


Figure 11: Environmental infrastructure supporting collaborative authoring of outcomes

Language subsystems refer to the rich language underpinning audiovisual authoring, designs of models and other information visualisation skills. Included are tools providing easy access to these subsystems enabling rapid editing and production in multimedia, without the steep learning curve that has often been the entry barrier to provision of support through the use of these tools. Feedback subsystems include knowledge bases as well as media-bases, using digital asset management and powerful multiple search algorithms to provide platforms for dynamic authoring and collaborative decision-making.

Craft tools are the frame sets that enable problem solving, process design understanding, project management, analysis, visual representation and other functionally specific technical tools. Platform design enables groups to construct the criteria for our

working together, as well as the means by which we will do so over time. The production environment provides the means by which visual authoring, and communication artefacts can be created, constructed and disseminated.

Craft at Every Level

Engagement by groups in the production of collaboratively authored outcomes is not a passive process, taking place in isolation, but is a craft based, artefact authoring activity. It enables social construction of outcomes through continuous engagement with its constituencies using layers of multi-media. It harnesses what Deleuze and Guattari (1988) call "productive desire" and what de Certeau (1984) calls the "procedures of everyday creativity".

We are able to obtain critical distance from the information we are dealing with, while at the same time being engaged in authoring contingent outcomes. We are engaged with content, while simultaneously authoring perspectives, and reflecting them back. Craft is in dynamic relationship with communication and contingency. To put it another way through processes of collaborative authoring, large constituencies are actively engaged in the craft of co-authoring contingent outcomes.

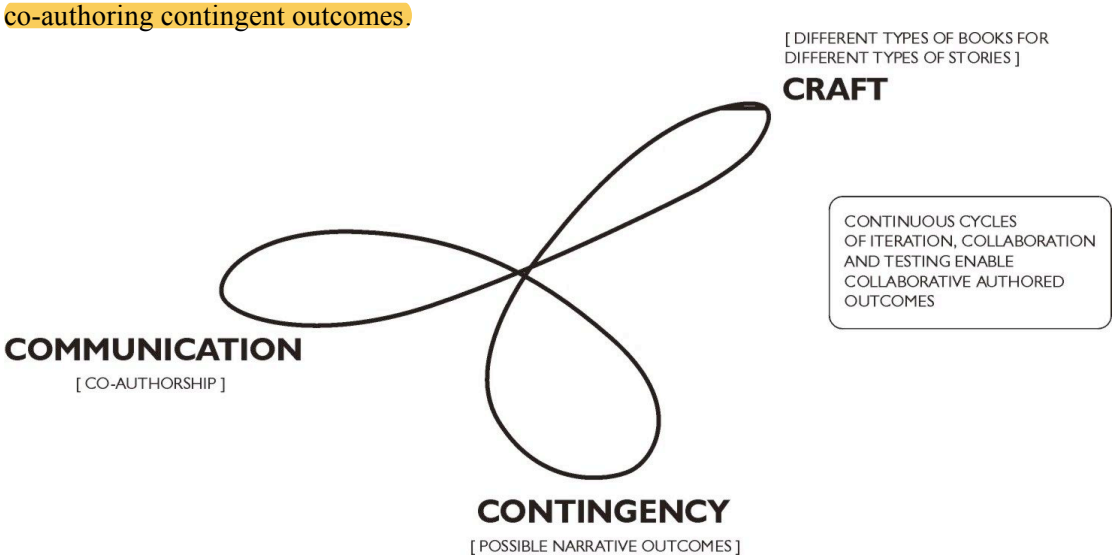


Figure 12: Continuous Cycles in Collaborative Authoring of Outcomes

The decision-making process builds on the dialogue between the experiences of different domains. For example the languages of architecture, design, production and business each possess their own constantly evolving frame sets which enable sense-making and lead to specific desired outcomes such as the construction of a building, the introduction of a new product, the premiere of a film, the profitability of a business. We invoke craft as a means of supplying languages for identifying and navigating decision-spines, creating frame sets and artefacts. Craft serves to create rich context through providing numerous perspectives on how things are considered in other domains. The stories crafted in such contexts are themselves enriched and the creation narrative is itself driven by the revealed differences in perspective.

A fundamental difficulty of the work of multi-disciplinary teams is that of language. Each discipline or group speaks its own restrictive language, and constructs decision spines employing its own frame sets. Creating an opportunity for encounter is not sufficient; it immediately leads to the need for the decoding of language. Some disciplines are better at providing the means of negotiating the interstitial space than others – contemporary art practice provides documentation and essays as a means of leading the external observer in. Architecture crafts multiple representations of perspectives as a means of generating discourse and engagement with the evolution of ideas as well as a means of communicating the concepts and ideas. The most successful practices have shifted from coercively

presenting contingent models, couched in restricted language, for committees for decision making, to creative and participatory activities, engaging the communities within which the proposals are situated, in the conceptualisation and development of the plans, at every stage of realisation (Humphreys and Brezillon, 2002).

Toward Architecture that supports large-scale collaborative outcome authoring

Theories are useful only in so much as what they enable us to do. In a Deleuzian sense they are immanent through their creation of movement and consequences. We are concerned therefore with creating an infrastructure for enabling large scale collaborative outcome authoring. The question here is concerned with how the technology is used and which processes are designed to create pathways across the technology platforms. A technical architecture is proposed below.

Technology exists which can be employed within GDACS to enable the scaling up of conjecturality in rhizomes to far broader constituencies than hitherto possible. In the following we indicate a way this may be achieved by focusing on technical systems supporting large scale collaborative outcome authoring. In the envisaged environment, the authorship of visual media and information is maintained in a live, streaming media-base whose purpose is to collect, collate and log incoming media. It also provides the tools by which large groups are rapidly able to assimilate, narrate and author contingent stories for communication to the broader constituencies.

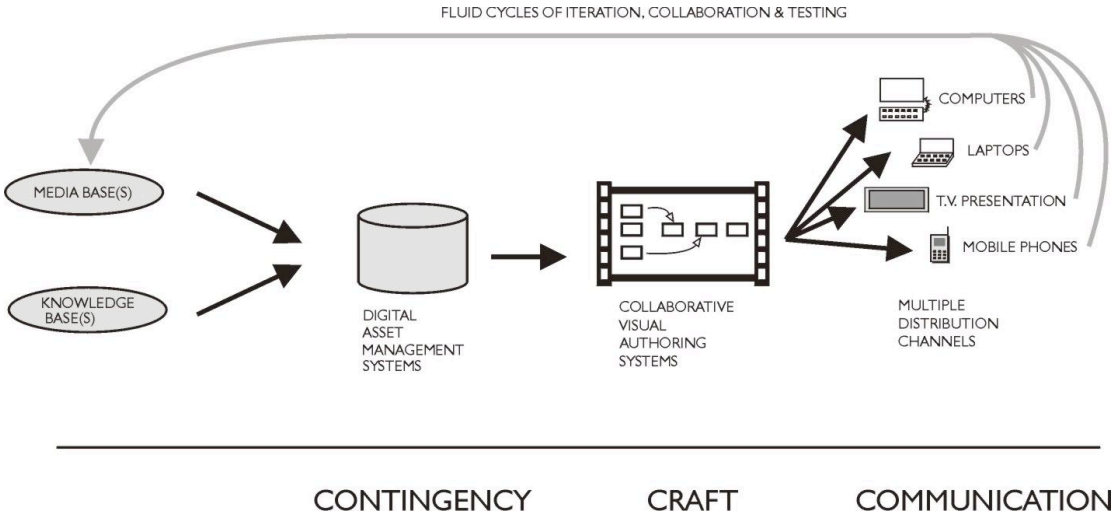


Figure 13 Proposed Architecture for dynamic streaming of Collaboratively Authored Outcomes - first iteration

A comprehensive environment that supports collaborative authoring of outcomes is constituted by

- A physical learning environment, with surfaces for contingent exploration, documentation, and feedback;
- Language subsystems such as visual languages, production, authoring and design;
- Feedback subsystems such as knowledge-bases, media-bases and digital asset management systems;
- Craft tools and skills, which provide craft frame sets that represent information, provide process tools, project management tool, analysis tools, facilitation tools, production tools, design tools and framing tools;
- Platform design capabilities, which provide navigation tools over time;
- Learning platforms and programme management;
- Production environment supporting visual authoring, web authoring and artefact production;

- Knowledge subsystems, which enable process design, content knowledge and contextual exploration.

These subsystems are supported across an architecture that locates multi-media artefacts within a *compendium*. The interface with a collaborative visual authoring system enables rapid authoring of artefacts to be distributed across a wide variety of platforms. Cycles of contingency, craft and communication of artefacts are able to take place continuously across all platforms.

Conclusion

We are interested in the evolution of Group Decision Authoring and Communication Systems. We propose that existing problems with the creation of collective fantasy, coercion along a decision-spine, implementation, scale and rapid changes in information landscapes may be addressed through the interpenetration of a number of systems. Our account of collaborative authoring of outcomes places the broad based construction of narrative at the centre of GDACS. Multi-media are used as the means by which we actively engage with the continuous authoring of desires in reality, through the construction of artefacts and narrative. We tell stories and we build in order to both create and navigate the rhizome that constitutes the body-without-organs of the decision-hedgehog.

Technical skill and craft serve the functions at every level and every outcome is perceived as the collective vortex of multitudes of smaller outcomes. Contingent outcomes and conjecture are tested and simulated through transitional artefacts to the point where what is launched into the real is already known by the real. The field of collaboration is expanded in every direction, as broad constituencies are complicit throughout the lifecycles of production and authorship. It enables the intersection of philosophy, art and science that Deleuze and Guattari (1988) posit in *A Thousand Plateaus*.

Decision-making is evolving from spiralling within the structure of a single decision-spine to become a continuous process of collaborative authoring – growing the decision-hedgehog. Transitional multi-media artefacts are linked through narrative in response to the continuous challenges posed by the broader constituencies. The future of GDACS lies in the tools being used across the emerging technology infrastructures. Dynamic visual authoring tools will become distributed and will, in turn, enable collaboration with the authoring of narrative on a vast and ubiquitous scale.

And so Hansel and Gretel may continue with the never-ending process of implicating all the forces they are able to muster as they author their way home (home, of course, is where the heart is).

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