

## On Duality and Dynamics in Systems: In Support of a Formal Approach to Facilitation

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### **Abstract**

A summary is offered of our attempts to find a formal underpinning to facilitation in which stakeholders to a set of concerns are helped to come to consensus views. The full terse treatment follows an approach based on definitions. Here we present an overview of this formality and an interpretation of facilitation as an outline procedure. As a consequence this paper summarises our approach to systems as objective realities and their interpretation as subjective, dynamically dualistic, inferential and layered, weighted influences.

### **A Summary Introduction**

As a direct outcome of our system engineering practice [Boarder, 2001], this paper explores the possibility of a theory of facilitation where facilitation is being used as a prelude and a sequel to system requirement specification. Were it not for the fact that our methods have worked, even in the earliest possible stage of system engineering, a theory of facilitation would not be worth pursuing.

With regard to facilitation, the system engineering community is always faced with the need to address systems as if they exist or can be brought into existence objectively. This is the case even though our written and spoken languages always address systems subjectively, colloquially, and with consequent conflicts and confusion; systems are not always what we might think them to be, would like them to be and say they are. As a consequence, engineers have long sought formal languages to support their need to prove their specifications and designs. However, formal methods only provide a partial means for discussing the system life cycle.

Our approach to formalising facilitation is therefore one that attempts to address the problems of subjectivity. We want to be able to assist a wide variety of those involved to express and rationalise their concerns and interests. In pre-requirement contexts, we are attempting to offer a formal framework that makes organised sense of the expressed and often conflicting and confused concerns for day-to-day, medium and long term issues. Since facilitation can lead to increased system knowledge, we are trying to provide a formal basis to the learning organisation.

With these aims in mind, in extracting consensus views from expressed concerns, we found it useful to consider systems as dynamic dualities. For our purposes a system is

a collection of dynamically interrelated resources and processes. However, in order to convey to others what we were doing we found it necessary to formalise this concept. While the full development of the formal concept is presented elsewhere, here we only wish to highlight the salient points.

## ***Organising Subjectivity***

Principally, formalising our approach requires us to organise subjectivity. We need to take the subjective views of system stakeholders and organise them in terms of some objective, formal, generic system model. This model helps us to unravel convoluted inferences and layers of terminology inherent in descriptions.

Hence, in listening to and processing descriptions of systems and the issues they raise, we found it beneficial not to treat systems holistically. At all stages of the system life cycle, systems are not dynamic wholes to those who are embedded in day-to day operations. To their embedded stakeholders, systems are at best coherent, partial interrelated structures and behaviours forming links in supply chains between their suppliers and consumers. While systems are certainly dynamic they are at best dualistic, as we have suggested.

In developing the theory of facilitation then we assume the two sides of the duality, the structures and behaviours, are separated mutually-exclusively in space and time and functionally, indeed mutually-recursively, related in space-time and time-space. Indeed, we consider that, while it may be known what a system is in terms of its structures, its behaviour, what it is doing, may not be known with any immediacy. Similarly, while it may be known what a system is doing in terms of its behaviour, its structure, what a system is, may not be known with any immediacy. This because what a system becomes changes what it is and what it is changes what it becomes. As we have stated, systems and their dualities are dynamic. Any reflection by a stakeholder on a system of their concern can only be an inference of behaviour out of structure or vice versa.

To illustrate, system structures are composed of resources which have properties of spatial extension and location, system processes have properties of temporal duration and era. In space-time, the states of resource properties influence process properties. In time-space the states of process properties influence resource properties. But we cannot objectively determine what resources a system is using and which process a system is following at any specific instant of time and in any specific location of space. We can only infer the one from the other when reporting on past experience.

This tells us there can be two views of subjectivity. We can discuss systems subjectively in terms of their spatial structures or in terms of their temporal behaviours. But we also need to discuss the dimensionalities and functionalities that exist in and persist over space-time and time-space which create the dynamics. We need to discuss how resources influence processes over space-time and how processes influence resources over time-space. Which ever mode of subjectivity we choose, we always need to infer its dimensional and functional implications for the other mode.

In other words, subjectivity is not only dualistic and inferential, it is layered. By discussing systems in terms of their resources, one side of the duality, we infer the processes, on the other side of the duality, the resources support over all the logical

paths the processes may follow. Such processes are a layer removed from the subjective discussion of the resources they employ.

Conversely, if we discuss systems in terms of their processes, we infer the resources needed to support them, all the resources they use and on which they operate. Such resources and their material sources and products are at a layer removed from the subjective discussion of the processes they support.

In either case, systems do not exist and persist in isolation. If they exist and persist objectively or subjectively at all it is necessary to infer the dynamically dualistic effect of their resources and processes on other interrelated systems. In this sense, the layering of subjectivity is not just local to the system itself with immediate interrelations among its resources and processes. The layering may be distributed over multidimensional chains of interrelated supplier and consumer systems, supply chains. These other systems interconnect and interact as dynamic dualities with a dynamic duality of interest, directly, indirectly and remotely. Of course the more indirect and remote such dynamic dualities are the more uncertain, the more subjective the explanations of their involvement.

As a consequence, when acting as facilitators, we are trying to create an awareness of these dynamically dualistic, layered, inferences so that they can be interpreted by their stakeholders. We need to extract the structures, resources, behaviours, processes and their interrelations from the expressed to cover all the immediate, direct, indirect and remote dynamic dualities with which they appear to be involved. The relations discovered will not in any sense be complete.

Out of this, we need to bring into focus the dynamic dualities of consensus concerns, those interrelated structures, behaviours, resources and processes, supplies and products, about which something needs to be changed. Subsequently, we need to establish that concerns for the dynamic dualities brought into focus have been alleviated and that, in a sense, they no longer exist and persist as concerns in the minds of those involved. The subjective systems raised in facilitation have been relieved, the quality of the dynamic dualities have been improved.

Our extended practice of facilitation and its underlying principles have been presented elsewhere. The development of the theory underpinning it is also presented elsewhere. That development uses conceptual operations to 'unfold' 'generic' dynamic dualities in the reverse order to the above description. Thus, above we have tended to proceed from the concept of subjective, inferential, layered, dynamically dualistic systems to the general concept of a reality as a dynamic duality. In the formal development, an abridged version of which follows, we proceed from the generic definition of a reality as dynamic duality to its representation as a subjective, inferential, layered dynamically dualistic system in focus.

## ***An Informal Development***

Briefly, the formal development uses concepts which separates, unfolds, reality, that which is thought to exist in space and time and to persist over space-time and time-space, into two mutually-exclusive and mutually-recursive sets so that each set is a definition of the other. Figure 1 illustrates the unfolding while figure 2 illustrates the dimensions and functions among elements of an unfolded generic dynamic duality.

## A First Unfolding

The first unfolding is a response to the mutually-exclusive questions implied above:

1. What is a reality?
2. What is a reality doing?

It seems reasonable to assume these related questions to have related answers so that what a reality is, its Being, its space, defines what it is doing, its Becoming, its time, and, dualistically, a reality's becoming, its time, defines its being, its space. In short, a reality is at least a dynamic duality of mutually exclusive space and time (being and becoming) interrelated by mutually-recursive definitions over space-time and time-space. If these interrelations are complete then becoming is the dual of being and being the dual of becoming. Looking ahead, the terms 'reality' and 'system' become a 'shorthand' for 'dynamic duality'; subjective 'holistic' terms for an objective dynamic duality.

Unfolding a dynamic duality implies that its being, its becoming and their interrelations can be expressed in a single domain, a domain in which space, time, space-time and time-space can coexist and co-persist. This is possible if, in the unfolding, this domain captures both spatial and temporal being together with their interrelations. A new layer, a new domain, of becoming is then required to maintain the dynamic relationships. This domain is one in which the states of spatial being are differentiated over space-time and integrated to determine the states of temporal being. Similarly, in this new layer the states of temporal being are differentiated over time-space to determine the states of spatial being. The differentiating and integrating functions of this new layer determine the weights of the interrelations. As such these functions exist in space-time and time-space with interrelations over space and time. Spatial and temporal states determine conditions over space-time and time-space so that this unfolded dynamic duality is in continuous change.

A direct answer to our two questions is then

1. What is a reality?

A reality is a becoming, but an unfolded reality is a mutually-exclusive space and time with weighted mutually-recursive interrelations over space-time and time-space.

2. What is a reality doing?

A reality is being, but an unfolded reality is a mutually-exclusive space-time and time-space with weighted mutually-recursive interrelations over space and time.

For an unfolded reality, the state of spatial being determines the condition of temporal becoming which differentiates and integrates spatial states to determine temporal being. The state of temporal being determines the condition of spatial becoming which differentiates and integrates temporal states to determine spatial being.

The states of space and time are the weights of interrelations between space-time and time-space. The conditions of space-time and time-space are the weights of relations between space and time.

## **A Second Unfolding**

A second unfolding recognises that the space and time of an unfolded reality may be a structure and behaviour with beings of lesser spaces and times interrelated over lesser space-times and time-spaces.

In this second unfolding, we assume that what is unfolded are interrelated structures and behaviours of which the space and time of a folded reality are composed. Space and time have been expanded to a new level of definition as have the differentiating and integrating functions that establish and maintain the dynamic. One domain again expresses the being of the twice unfolded duality, the other domain the becoming.

## **A Third Unfolding**

For our purposes as facilitators we associate a set of attributes with structure and behaviour. Our attributes are the dimensions of spatial structures and temporal behaviours in the domain of being. In the domain of becoming, we associate a set of features with the differentiating and integrating functions. Our features are, in effect, the dimensions of the functions.

Therefore in this third unfolding, we are assuming that the being of a reality is formed of the interrelated attributes of spatial and temporal being while the becoming of a reality is formed of the interrelated features of the functions.

## **A Fourth Unfolding**

Our fourth unfolding assumes that our structures and behaviours, our differentiating and integrating functions are composites. Structures are composed of resources, behaviours of processes, functions of arithmetic operations. However, in this unfolding, structural and behavioural attributes unfold into resource and process properties whereas functional features unfold into operational characteristics.

The states of spatial and temporal properties in the being domain are therefore related to the condition of spatial and temporal characteristics in the becoming domain. Space as a structure is a collection of closely bound resource properties, time as a behaviour is a set of closely bound process properties. In the space-time and time-space functional domain of becoming spatial and temporal operations are a collection of closely bound characteristics.

In this unfolding, spatial property states are differentiated in space-time with respect to temporal states so that temporal property states are integrations over space-time of differentiated spatial property states. Also, temporal property states are differentiated in time-space with respect to spatial states so that spatial property states become integrations over time-space of differentiated temporal property states.

In both cases, it is the functionality of space-time and time-space which performs the differentiation and integration. Hence, spatial and temporal states determine the condition of the space-time and time-space functions which in turn determine spatial and temporal states.

## **A Fifth Unfolding**

A fifth and final unfolding arises because we recognise that in formulating objective realities, objective systems we get it wrong. The realities we conceive, the systems we

build become the realities and the systems we didn't want or no longer want. This introduces the notion of a presented reality, a subjective reality, a reality as might be described by a representative observer; an operator, manager, supporter, developer, administrator, a user, system in which there are probabilities associated with relations. Such representatives are using the term system in the subjective form and their descriptions are merely interpretations of the term in a given context.

However, subjective systems are related to objective realities. The subjective is an unfolding of the objective. There are interrelations between subjective spaces and objective times, between subjective times and objective spaces. All that has happened because of the limited nature of the presenter, is that instead of objective spaces and times with objective states in the being domain and functionalities in space-time and time-space with objective conditions, the descriptions are in terms of probable relations between the being and becoming domains.

In the objective reality, while dynamic duality is still a feature of the interrelations, completeness of relations requires all process properties to influence all resource properties, all resource properties to influence all process properties, so that the dual relation is maintained. In the subjective system, derived from the presenters' descriptions, due to the nature of language, the dynamic duality, the layering, the inferences, completeness of description cannot be guaranteed and the dual relation can be doubted. Potential conflict and confusion is introduced by differences in representative's culture and power of description; their viewpoint.

The above describes the unfolding of an objective reality as a dynamic duality with respect to subjective descriptions from conceptual, generic representatives. In that sense, the dynamic, dualistic, layered and inference descriptions are made according to representative viewpoints. Such viewpoints may be any one of a multiplicity of space, time, space-time and time-space viewpoints and in the case of a human representative it may also be a confused and conflicting mix of them all. Their expressions, their partiality and the probability of their veracity, will depend on their contribution to the system. Therefore, while an objective system as an objective reality might really exist, all that a facilitator can do, using the descriptions is to construct a consensus in which confusion is minimised and coherence maximised. Thus, the question arises, 'What is the viewpoint of a facilitator?'

Be that as it may, this development could appear to be on the verge of descending into infinite regression by unfolding spaces, times etc., of the generic model indefinitely but this is not the case. Unfolding a system, as a matter of viewpoint, means the original system no longer exists. An objective system only exists relative to one or more subjective viewpoints; it is a dualistic, layered and inferred system described with respect to its stakeholders. Indeed, even the existence of an objective system may be doubted because viewpoints are biased and related duals lost. Therefore, for a facilitator, all that exists with respect to some hypothetical objective system are the probabilistic, differentiated and integrated, layered, inferred subjective views of representatives as complex sets of interrelations among the myriad properties and characteristics of system spaces, times, space-times and time-spaces translated in terms of a conceptual, generic system.

The original system which is the subject of representatives' concerns, cannot be recovered by reversing the unfolding, even if a strict order of unfolding and folding the subjective views were to be kept and the relations were complete, because the folding would require the viewpoint to be folded; the subjective view, indeed the representative, would be folded out of existence and the viewpoint lost. The stakeholders to our systems of concern are embedded in their systems.

In addition, any change in the relations, due to system's dynamics would mean the resultant system was not the original. Also, since facilitation is the result of many subjective viewpoints, any one subjective folding is likely to be different from, though equally valid to, any other.

All that can be achieved by folding a mix of inferred subjective viewpoints is the identification, recognition, naming, of layered, interrelated subjective systems, hence supply chains. These systems, as common features of representative viewpoints, are complex sets of folded beings and becomings. In this way, interrelated systems, as dynamic dualities, are subjective, other-order, interrelated and inter-functioning spaces and times. Thus, for the facilitator, viewpoints from the myriad spaces, times, etc. are bounded 'above' by subjective system structures and behaviours, etc., to which the representatives contribute, while viewpoints from the subjective system structures, behaviours, etc. are bounded 'below' by the subjective spaces, times, etc. of which they are composed. But since this simply introduces other subjective viewpoints, it may not be possible to decide which is 'above' and which is 'below', what is contributing to what, what is composed of which. All that results is a view of interrelated dynamic beings and becomings held in common by groups of representatives and derived from the mix of viewpoints and bringing their system of concerns into focus. That, of course is the answer to the question 'What is the viewpoint of a facilitator?', it is a formal, consensus, subjective, view derived from representatives' descriptions with confusion minimised and coherence maximised unfolded over a model of generic systems and supply chains.

In our paper, of which this is a partial summary, Part I lays down a formal model of dynamic duality leading to a presentation of possible subjective views, in terms of which Part II develops a theory of generic, organised systems and supply chains for interpreting the descriptions of representatives in the task of facilitation.

## **Facilitation**

A facilitator is one who differentiates the subjective views of stakeholders with respect to the dynamic dualities of their concerns. These differentiated views are then integrated as webs of weighted influences to bring the dynamic dualities into focus and to highlight their significance. Subsequently, a facilitator monitors and revises the webs of weighted influences, in response to stakeholders' attempts to bring about mutually beneficial change, by demonstrating the reduction, or otherwise, of the webs' significance.

In effect, a facilitator begins facilitation with an apparently unbounded and empty reality; free of preconceptions. This reality, when first unfolded, reveals two classes with two complete sets of relations between them. The two classes are mutually-exclusive and the relations are mutually-recursive definitions of each class in terms of the other.

In the mutually recursive definitions, the spatial existence of the reality is defined by its persistence over time. Similarly, the temporal existence of the reality is defined by its persistence over space. The definition of space with respect to time is a definition in space-time. The definition of time with respect to space is a definition in time-space. Since the duality is dynamic, the definitions are functions of space and time. Since the definitions are, at this stage only hypothetical, the weights of all such definitions, the values of the functions' inputs and outputs, is zero; relations between these two sets are un-weighted. In such a manner, this first unfolding is a representation of all unobserved, realities and represents, for the facilitator, the initially undeveloped state of stakeholders concerns.

The facilitator next collects the informally expressed concerns of stakeholders with respect to the organisation, the structure and behaviour, of some particular or set of conjectured objective realities. The expressions capture stakeholders' subjective views from a mix of organisation space and time viewpoints. From these subjective views, the facilitator unfolds the subjective realities and establishes their probable relations to the objective reality. In practice, using a hypothesis that there is some common objective reality to which the subjective views are related, the facilitator populates a copy of the first unfolding.

In this second unfolding, in the domain of being, the class space is populated with the states of organisation resource-properties; their quantity, size, location, etc. The class time is similarly populated with the conditions of organisation process-characteristics; their duration, complexity, era, etc. The relations, or definitions, in space-time and time-space are populated as subjective, layered and inferred definitions of dynamic dualities among the resource-properties and process-characteristics of the organisation. These relations are a representation of the inaccessible becoming domain. Repeated definitions captured from one or more stakeholders determine the definition's weight; its strength. Unreferenced definitions are weighted zero. It is then assumed, for the purposes of discussion and subsequent confirmation that the resultant subjective reality is a reflection of some assumed objective reality.

It is in this sense that the facilitator acts in the becoming domain, for it is the facilitator that differentiates the state of each resource-property with respect to all referenced process-properties. The more frequent the references to resource-property, process-property relations the greater the weight of the definition. The weights of each definition with respect to each referenced process-property are then integrated to determine the states of the process-properties.

Similarly, the facilitator differentiates the state of each process-property with respect to all referenced resource-properties. The more frequent the references to process-properties, resource-property relations the greater the weight of the definition. The weights of each definition with respect to each referenced resource-property are then integrated to determine the states of the resource-properties.

As described the outcome of this stage of facilitation is a representation of the stakeholders' subjective organisation or interrelated organisations. The chains of mutually-recursive definitions between sets of resource and process-properties, as nodes, are interpreted as weighted webs of directed influences. In these weighted

webs, nodes with only out-going edges are inferred to be root sources to the webs. Nodes with only in-going edges can be inferred to be root sinks. Within the webs, nodes with converging and diverging edges may be inferred as nexus nodes. Edges with the greatest weights are the edges bearing the most significant consequences for the internal configuration of the webs and the organisation it represents.

Using the webs of directed influences, stakeholders are able to make judgements as to their intentions.

If the webs are sparse, random collections of relations with low weights, the stakeholders may be inclined to view them as indicators of relations with low significance and in temporary passing states and conditions of stresses and strains so that their subjective views can be accepted as a relatively true and stable representation of their objective organisation.

If the webs are dense, with self reinforcing virtuous and vicious cycles of relations with large weights, the stakeholders may be inclined to view them as indicators of relations with high significance and in relatively permanent states and conditions of considerable stresses and strains. Such indicators may be representative of real stresses and strains in their unstable objective organisations such that these organisations may need to be rejected and replaced by other less stressful ones.

If the webs are confused with some relatively sparse, some relatively dense and some small isolated internal arrangements with moderate weights, the stakeholders may be inclined to view them as indicators of potentially adverse but unresolved relations with undetermined states and conditions of stresses and strains. In this situation, the stakeholders may feel inclined to organise a series of tests to assess in more detail the significance of the relations. Such tests may confirm, deny or modify the webs so as to clarify stakeholders' views.

In these three cases, facilitation can be repeated either at regular intervals or on the completion of tests, modifications or replacements to the original organisation. These new facilitations will substantiate, or otherwise, the reduction in weight, if not the complete removal of significant edges in the webs, as a measure of the stakeholders' success in reducing the stresses and strains in their organisations.

## **Conclusions**

In our systems practice and in our use of methods for system analysis and synthesis we were concerned, because of our background in formal methods, about the lack of formality particularly when attempting to organise the concerns of system operators, managers, etc. Of special significance, our work on embedded systems led us to question the application of holism in such situations.

From an analysis of our reports on system concerns it appeared that in order to structure the issues in form that was easy to understand we needed to recognise the dualism between resources and processes. We also needed to offer an explanation of hierarchy and emergence that was effective in non-holistic, supply chain oriented views of interrelated systems.

This led us to a difficulty in that there is no commonly accepted definition of a process operating in real time other than that of its being a procedure in execution. We cannot capture the essential dynamic nature of systems particularly when we are faced in facilitation with only the subjective of system stakeholders. This led us to question the nature of resources and processes, their interrelation, the properties by which they are distinguished and the influential structures and behaviours that underpin system concepts. But over and above these issues we were led to question the relation between objectivity and subjectivity in the descriptions of system problems by their stakeholders.

The outcome of our questioning is this embryo formalisation of systems, of realities, as dynamic dualities of being and becoming. However, because of the problem of process definition, facilitators can only treat with the being domain of systems, the spatial and temporal dimensions of systems characterised by the states of resource and process properties with weighted interrelations over space-time and time-space. The becoming domain remains largely unknown in the objective sense. However, we do know the becoming domain in the subjective sense, because it is the facilitation process of differentiating and integrating the views of stakeholders with regard to the states of their system resource and process properties to present them with a representation of issues that minimises confusion and maximises coherence. The features of this domain can be known or at least inferred by a measure of the quality achieved by stakeholders in resolving the dynamic and dualistic issues of their concern.

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