

A Management Flight Simulator for Virtual Enterprise Network Incubation

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Abstract

In the early stages of development of Virtual Enterprise Networks some of the key leadership decisions may be counter-intuitive. This paper describes a software “management flight simulator” which allow monthly resource allocation decisions in the areas of business development, member development and network development, to be experimented with in a risk-free environment. It offers the user immediate feedback on the impact of their decisions on key results outcomes – bid opportunities, contracts won, new members, membership base and network capital.

Keywords

Virtual Enterprise Network, simulator, mental model

1 Introduction

Founding leaders of Virtual Enterprise Networks (VENs) need to use their resources very carefully particularly in their “incubation” phases (typically the first 12-18 months) to ensure they deliver new revenue for their members.

Such leaders typically have three types of resources at their disposal:

- *Business Development* – responsible for identifying and developing sales opportunities for the network
- *Member Recruitment* – responsible for recruiting and inducting (the right kind of) new members and companies
- *Network Development* – responsible for building shared ambitions, values, network governance and business infrastructures.

This paper describes a “Management Flight Simulator” (aka “Microworld”) for Virtual Enterprise Network incubation implemented using the *Ithink*TM PC-based graphical simulation environment. The simulator allows budding Virtual Enterprise leaders to run a network “in silica” over a 36 month period whilst making monthly resource allocation decisions. The consequences which develop from these decisions are immediately seen over the entire simulation period in real time.

The main purpose of the simulator is in the management development of founding Virtual Enterprise Network leaders by challenging some “common-sense (but wrong) mental models” on optimum resource deployment. We would hope to be able to demonstrate the simulator in a structured scenario exploration session with conference participants at ICE2004.

2 Existing Theories and Work

2.1 Mental Models

People act according to their “mental models” or “meaning structures”. In the classic book, which promotes the concept of the learning organisation, “The Fifth Discipline” [Senge 1990] mental models are described as:

“ deeply ingrained assumptions, generalisations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior.... Mental models of what can or cannot be done in different management settings are no less deeply entrenched.... The discipline of working with mental models starts with turning the mirror inward; learning to unearth our internal pictures of the world, to bring them to the surface and hold them rigorously to scrutiny.”

2.2 “Espoused” versus “In-Use” Models

This, and other texts on individual and organisational learning [Dixon 1994], make the distinction between “Espoused” models and “In-Use” Models. In simple terms espoused models are what we think we believe or how we might explain our beliefs to others. In-use models are what an analysis of our real-world actions by an independent observer would suggest we actually believe. Espoused models and in-use models are often in sharp contradiction. These contradictions can only generally be exposed through some kind of action – real or simulated.

For example, I used to think that my in-use model for reacting as a competent car driver on unexpectedly hitting an icy patch would be to regain control by not deploying my brakes and turning into the skid (as recommended). However my only practical experience thus far of this situation resulted in me doing exactly the opposite. This showed me clearly (and shockingly) that my espoused model was different from my in-use model for this situation. Now armed with this knowledge I am better equipped to handle the situation next time – I know what my natural automatic reaction will be. I would be even better equipped if I were now to go to a car skid track, or driving simulator, and practice such manoeuvres in a risk free environment.

2.3 The value of computer-based simulation models

[Senge 1990] describes the advantages of having a tool for accelerating learning which he calls a “microworld”: “One of the most important new tools for accelerating learning and fostering shared mental models of the large system among local decision makers is ‘microworlds’. These are microcosms of real business settings where teams of managers together learn by conducting experiments that are difficult or impossible to conduct in real business”.. The research and design of microworlds will, I believe, come to be the primary task of central management in learning organisations of the future”

[Dörner 1996] in his excellent book “The Logic of Failure” amplifies on this and suggests how such a tool should be best used: ”Thus, simulated scenarios are an excellent teaching device. But it probably profits no one if we simply turn our pupils loose on these scenarios. Action alone is of little value. What makes more sense is to assemble a battery of different scenarios that expose our participants to a “symphony of demands” posed by various systems. We should also have experts observe participants as they plan and act”

2.4 The Process of Individual Learning

There are a number of theoretical frameworks for individual learning [e.g. Dreyfus, 1988]. One which we have found useful in this context is Kolb’s experiential learning cycle, based on the work of Reg Revans on “Action-Learning”. This is described in “The Organisational Learning

Cycle [Dixon 1994]. Kolb proposes a cycle (see figure below) through which individual learning progresses involving four stages (cf. Figure 1):

1. Concrete Experience – we experience the world through our senses
2. Reflective Observation - we consciously reflect on what has occurred
3. Abstract Conceptualisation – we make sense of what we have experienced by relating the new information to existing meaning structures (mental models) and out of that relationship we create new meaning
4. Active Experimentation – we test out the meaning that we have constructed by taking action in the world, which then leads to new experience (then back to stage 1 again).

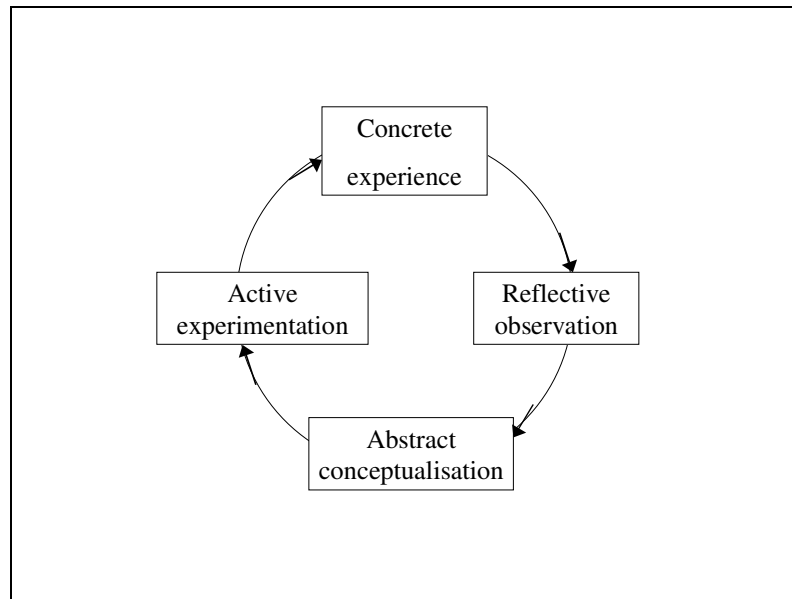


Figure 1: Kolb's experiential learning cycle

2.5 Difficulty in anticipating the (time delayed) consequences of actions

[Dörner 1996] reflects on common themes in human-induced catastrophes such as the Chernobyl disaster and development agency induced drought in developing countries. He observes

“One basic error accounts for all the catastrophes: none of the participants realized that they were dealing with a system in which, though not every element interacted with every other, many elements interacted with many others. *They conceived of their task as dealing with a sequence of problems that had to be solved one at a time.* .They dealt with the entire system not as a ‘system’ but as a bundle of independent mini-systems.”

One of the ways we try to deal with complex systems is to work from “general principles” which we apply in different situations. However Dörner also points out the obvious major flaw in this approach: “In complex systems with many interlocking elements, deconditionalizing abstractions are dangerous. The effectiveness of a measure almost always depends on the context within the measure is pursued. A measure that produces good effects in one situation may do damage in another, and contextual dependencies mean there are few general rules.”

Professor Edward Wilson of Harvard, and probably the world's leading biologist and environmentalist, muses on the problems we seem to have as human beings in anticipating the long-term consequences of our behaviours [Wilson 2003]: “Why do they (we) think in this short-sighted way? The reason is simple: it is a hardwired part of our Palaeolithic heritage. For hundreds of millennia, those who worked for short-term gain within a small circle of relatives

and friends lived longer and left more offspring...The long view that might have saved their distant descendants required a vision and extended altruism instinctively difficult to marshal.”

2.6 The Limits of the predictive ability of Simulation Models

The quote “All models are wrong but some are useful” has been attributed to Albert Einstein. We should never deceive ourselves that we are dealing with correctness in any model-building activity. The only value of a model is its utility or usefulness never its correctness or accuracy.

The builders of simulators recognise that a good test of a model is for it to be able to retrospectively reproduce some previous historical behaviour pattern. Whilst this is, of course, true it may only be partly achievable. However even if it were fully achievable it would not make the particular model any more “correct” - only more “useful”. Thus retrospective behaviour reproduction is more a necessity than a sufficiency for models and simulators.

3 Specific Foundations to the Simulator

3.1 Basic Rules

The five basic rules of the Virtual Enterprise Network simulator are outlined below:

1. “Opportunities to Bid” for the Virtual Enterprise Network are generated by deploying effort in Business Development. In addition, it takes time to attract and warm-up prospective customers.
2. “Opportunities to Bid” are converted into “Contracts Won” at a rate which depends on the “Breadth of the Virtual Enterprise Network (i.e. the number of members in the network) and the “Depth of the network” (i.e. the social capital/relationships, collaboration skills and infrastructure capital developed by the network). In other words ability to close contracts depends on the perceived capability of the network to deliver.
3. There are thresholds for minimum levels of Network Breadth and Depth – i.e. no matter how many opportunities are generated to bid the network will win none without a minimum number of committed members and level of network capital.
4. Virtual Enterprise Network Breadth and Depth both undergo a “natural decay” over time if not tended – without a certain level of effort members will leave and relationships will dissolve. So a level of effort must be expended just to stand still. In addition it takes time to attract and induct new members
5. Finally the more the Virtual Enterprise Network wins contracts the easier it becomes to win more contracts and attract new members (“success breeds success”)

The Ithink™ notation [Richmond 1998] is based loosely on the “plumbing metaphor” and involves interconnection of the following objects into complex models:

- **Stocks** – Shown as *Rectangles* and behaving like bathtubs. There are different types of stocks such as “conveyors”, which act on a first-in first-out basis and “ovens”, which cook a specific capacity of inputs for a predefined time period and then open up to let the next batch in.
- **Flows** - (Inflows and Outflows) - shown as *Dials* and behaving like taps (inflows) or plugholes (outflows).
- **Regulators** – Shown as *Circles and Arrows*, which point at the flows, which they regulate (via arrows) and can be linked through arithmetical operators into composite

regulators (e.g. $\text{Composite_closure_Factor} = \text{Member_Closure_Factor} (*)$
 $\text{Capital_Closure_Factor}$).

Feedback loops occur when the output of a flow is connected directly or indirectly to the input of the same flow. These feedback loops can be both negative (self-regulating) and positive (amplifying) and can include various delays (cf. Figure 2)

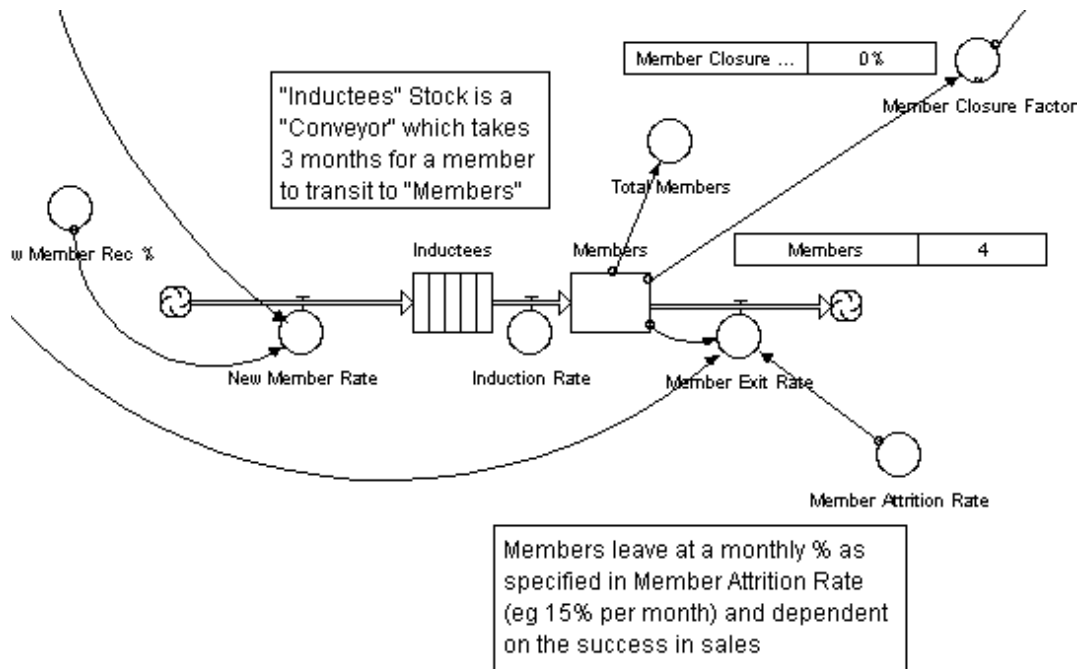


Figure 2: Fragment of VEN Simulator in Ithink notation

The model has 3 main chains – Contracts, Members and Network Capital. For example, Figure 2 shows the stock INDUCTEES being in-filled by a flow NEW MEMBER REC. After a defined number of months the INDUCTEE stock is then emptied as an inflow into the MEMBERS stock. The MEMBERS stock then decays at a rate, which is moderated by a SUCCESS_BREEDS_SUCCESS_FACTOR.

3.2 Start-up Scenarios

The model can be set in different start-up scenarios by adjusting 4 start-up variables (cf. Table 1):

- “Opportunities to Bid” represents the number of opportunities on the table.
- “Contracts Won” represents the starting position with respect to signed customer contracts. For example, in a VEN initiated around a specific contract this could start at 1 or more, otherwise it would be zero.
- “Members” represents the number of initial founding members. For example, if the VEN is a conversion of an existing supply chain then it might have more members than a VEN built from scratch.
- “Network Capital” represents the pre-existing relationships, procedures, infrastructure and agreements which are in place at the start of the VEN. For example if we are modelling an existing collaborative network this would be higher than a “direct referrals” (non-collaborative) network which, in turn, might be higher than a “from-scratch” network.

Starting Scenario	Outline Description	Opportunities to Bid	Contracts Won	Members	Network Capital (%)
1 - Green Field	RDA Initiates	0	0	6	0%
2 - Contract Initiation	A specific Contract is put on the table	0	1	6	0%
3 - Customer Initiation	Major Customer requests a supplier network is formed and commits to provide bid opportunities	10	0	6	0%
4 - Supply Chain Conversion	An existing supply chain or a major fragment decide they wish to operate a network (as well as or instead of)	0	0	12	25%
5 - Business Network Formalisation	An existing informal business to business network aimed at winning business (for individual members or collectively) decides they wish to formalise the way they operate	0	0	12	25-50% Individual or Collective Focus
6 - Combo of 3 & 4		10	0	12	25%
etc					

Table 1: Different start-up scenarios for VEN Simulator

4. Research Approach

The development of the simulator has progressed through a number of stages:

- Stage 1 – Development of the basic simulator
- Stage 2 – Sanity Checking of the simulator and testing of the boundary conditions
- Stage 3 – Testing of the simulator with an experienced group of virtual enterprise practitioners using specific problems and challenges
- Stage 4 – Using the simulator with prospective VEN leaders as part of their management development

We are currently at Stage 3 of the simulator development.

Figure 3 shows the basic user interface:

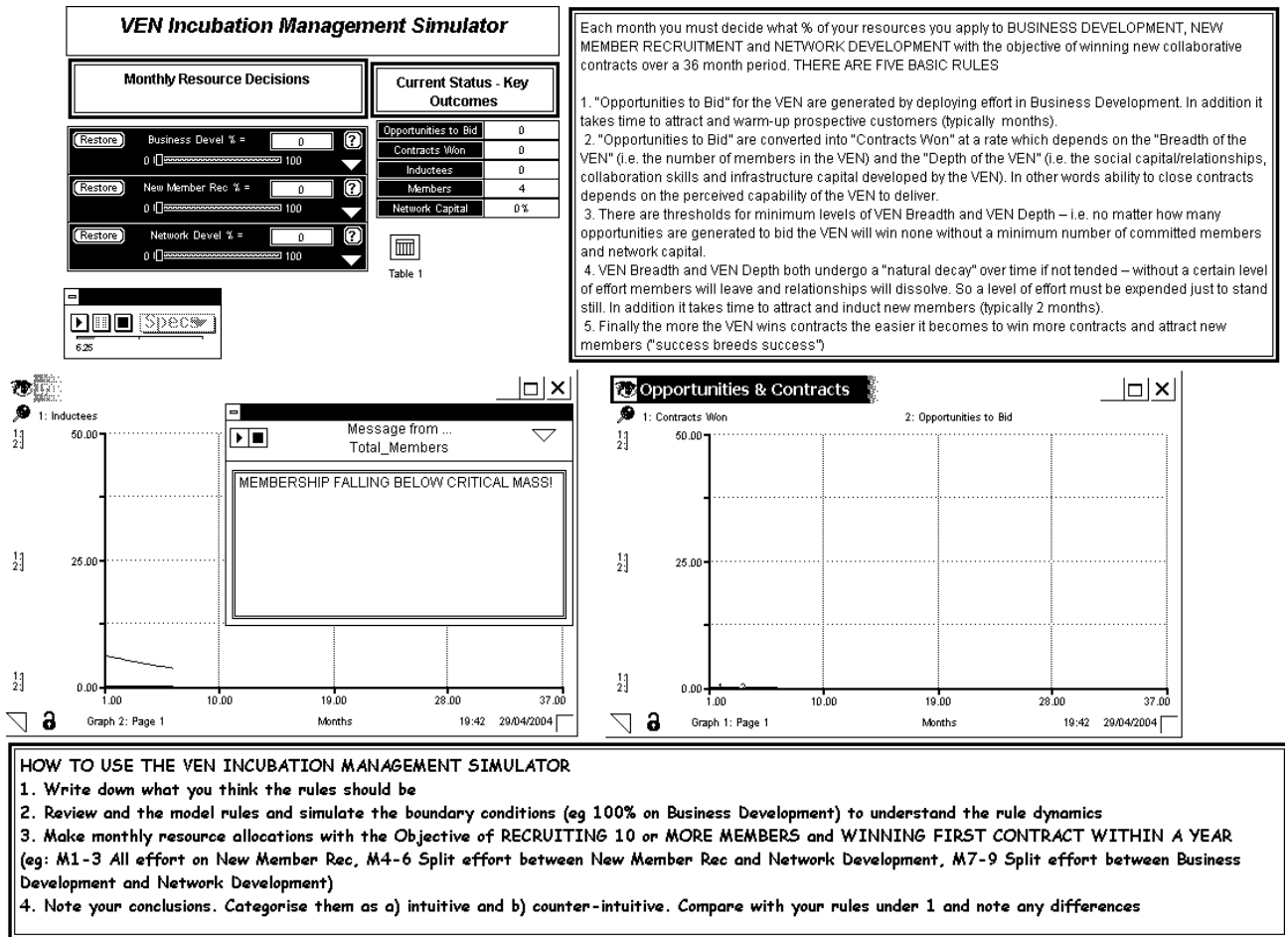


Figure 3: User interface for VEN Simulator

In the Top-Left we have the Data Input and Key Outcomes Area. Note the use of “sliders” as a data input instrument. In the Top-Right we see a reminder for the user of the Basic Model Rules. The Centre of the screen is the area where the key results can be viewed graphically, on a month-by-month basis for the entire simulation period. Finally, in the Bottom of the screen, a simple 4-step approach, for how to usefully engage with the model, in line with best practice, [Dörner 1996], is suggested.

5. Provisional Findings

We have developed the VEN simulation model to explore and investigate two critical propositions. Firstly, that some of the key decisions needed in successfully incubating a Virtual Enterprise are counter-intuitive. For example, too much effort on early Business Development without sufficient effort in Network Development results in the early contract opportunities being squandered, prospective customer relationships damaged and members being discouraged. Secondly, that prospective virtual enterprise leaders can expose the consequences of their “in-use” mental models in a less risky and more effective manner using a management simulator than traditional training, knowledge sharing or even coaching/mentoring.

6. Tentative Conclusions

We believe that the management flight simulator will prove to be a highly effective tool in developing Virtual Enterprise Network leadership skills and the approach is applicable to other systemic/resource trade-off problems in the domain.

The purpose of the VEN simulator is not to develop general principles for incubating VENs but rather to help VEN leaders to think more deeply about the decisions they make in this domain. It is also intended to provide critical challenges to deeply held mental models and assumptions that these leaders bring from other fields such as supply chain management.

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