Does system-dynamics limit the growth of system-dynamics?

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demand for system-dynamics

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documentation of experience

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$\mathcal{B}$

modelling

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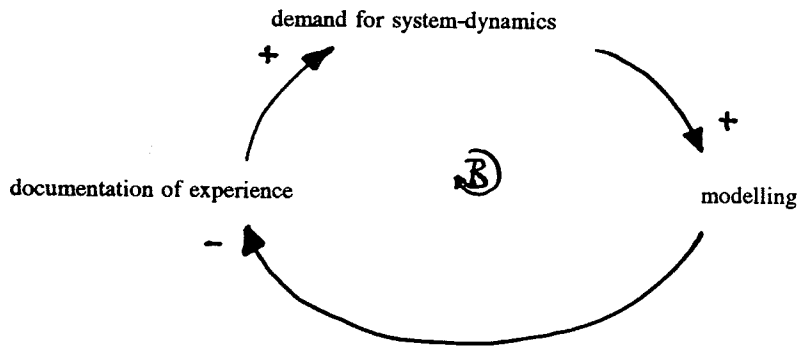
Abstract

The paper describes from a client point of view some experiences with system-dynamics during the first year of Nostradamus. Nostradamus is a project which aims at stimulating the senior management of a large Dutch governmental organization with an one action orientated engeneers approach to adopt a more outwardly-oriented, creative and flexible attitude. In the beginning of the project the use of system-dynamics was intended as a central guiding aid in the proces of organizational growth. The intended use proved considerably more extensive than the actual use. Insofar this regression is attributable to system-dynamics we, as a client of system-dynamics, see in this regression a possible challenge for system-dynamics.
We think system-dynamics could have been a more central supporting aid in Nostradamus if we would have found well-documented experience with system-dynamics in comparable situations. We suggest the system-dynamics-society to develop certain activities in order to stimulate demand and to better link up demand and supply in the area of systems-thinking.
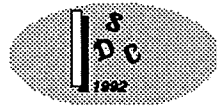
1. Introduction

The Department of Public Works has an almost two hundred year history in providing for the Dutch infrastructure: dikes, roads and waterways. Examples of Public Works projects in these working areas are:

- the Oosterscheldekering (the Oosterschelde storm surge barrier), a sea dike which can be closed at high tide and opened in order to allow tidal action in a Dutch coastal lake;

- the design, construction, management and maintenance of the Dutch motorway network;

- water quality care of Dutch surface waters.

An engineer's way of thinking has long been a central cultural characteristic of the Department of Public Works. Problems are charted with a problem-solving approach and a choice once made is implemented through mostly exact methods.

In the last few decades the Department of Public Works as an organization, along with its senior management, has been under increasing pressure. The environment is demanding more and more that the DPW contributes to thinking rather than doing all the thinking itself. The environment is also increasingly demanding alternatives or applying these itself. Furthermore, the area in which the Public Works manager currently operates is far more complex and dynamic than a few decades ago. Not only have stakeholders appeared on the scene, the organization is also increasingly surrounded and influenced by 'driving forces': European integration, for example, as well as growing environmental awareness, the call for a smaller government and the continually growing mobility.

For the DPW manager it is becoming ever less clear for whom he is working and which products he must provide. Sometimes he is reproached with promoting the interests of the construction industry if he labours for new infrastructure. Sometimes he receives more reproaches than gratitude for developing an environmentally-friendly product such as electronic road pricing.
These developments place new demands on the DPW manager. More outward-thinking, openness, flexibility, and creativity are required and less 'action-oriented thinking.' These new requirements are diametrically opposed to the engineer's solution-oriented way of thinking, often making it difficult for the DPW manager to accept alternatives which have been brought in by 'outsiders.' It also disturbs the DPW manager that both the discussion of problems and the choice of solutions are increasingly taking place outside the service.

Consequently, the DPW Director General states in 1990 that something must be done about the issue. He asks the interim manager currently charged with the reorganization of staff group planning and administration of Central Management to come up with a proposal for him.

The interim manager is of the opinion that the crux of the matter is to get the managers to a point where they will adhere less rigidly to previously gained ideas and opinions and develop their creativity and flexibility. In his view the main topic for the organization as a whole must therefore be organizational growth. Because the people in an organization determine organizational growth he asks himself the question: how do you get people firstly to discover and then to learn? He thinks centrally prepared and guided alteration programs will be unsuitable for this. The title of the Harvard Business Review article by Beer et al (1990) says enough: "Why change programs don't produce change." The interim manager then recalls a newspaper article about flocks of birds which learn better in a group than individually. He gets in touch with Arie de Geus, the author of the article. The result of their meeting is that in early 1991 a project takes off which is named Nostradamus, after the great sixteenth-century French visionary.

2. The aim of the Nostradamus Project

The Nostradamus Project is directed at the DPW's 140 top managers and will cover a two year period -
from early 1991 to the beginning of 1993. If the managers find the project successful a following cycle
will begin in early 1993. The intention behind the project is to bring the managers to a point where their
'world-view' or perspective begins to shift.
The preparation and implementation of the project is in the hands of the QI group, a kind of small-scale
Shell Group Planning. The QI group consists of three full-time employees with a budget of one million
dollars.

Initially, the aim is to build Shell-type scenarios: visions of possible developments from the present until
ten to fifteen years from now. In the second half of 1992 the managers will be confronted with these
scenarios per team in a two-day workshop. 'What would you do if' is the basic question to be put to the
teams during the workshop. The teams will generate several options per scenario for their strategy (De
Geus 1988 and Van der Heide 1988).

At the beginning of 1991 the QI group sets up a preliminary plan of approach for the workshop,
comprising four main activities.

a   Inside discussion about outside and inside
        Stimulation of discussion within and between the management teams about possible significant
        environmental developments - driving forces - and the consequences of these for the DPW. The
        discussion must lead the managers to establish which of the driving forces they find most
        important, among other things. This will provide the topics for the scenarios.

b   Setting up the scenarios
        Scenarios here mean a vision of possible environmental developments from now until ten or
        fifteen years from now.

c   'Warming-up' for the managers and teams
        Preparing the managers for the workshop: ensuring that they are curious, interested or even
        enthused, and seeing to it that they enter the workshop as a team and with a strategic question
        which they consider to be very important, and for which they have not yet found a solution.

d   System-dynamics
        If possible, creating a computer-assisted learning environment which enables the management
        teams to couple their strategies with the scenarios.

3. The implementation of Nostradamus

In the spring, the QI group holds twentyfive interviews with internal and external key figures for the
DPW. In the summer of 1991, the QI group issues a report concerning the interviews: 'the DPW in a
crystal ball' (QI group 1991). The report discusses possible environmental developments, the DPW's
strong and weak points, and formulates strategic dilemmas - in draft form - in the manner of Hampden
Turner (Hampden Turner 1990). The report is intended as a discussion catalyst for the management
teams. The management teams find the report highly inspiring and react extremely positively in August.

Also in the spring, an advisor, Jac Vennix, is consulted about the construction of the learning environment. Various test plans are developed in cooperation with him at the request of the Nostradamus team (Vennix 1992).

In September 1991 the DPW's twenty-four directors agree on the set-up of Nostradamus. They also agree to assign tasks for Nostradamus. Along with the reaction to the 'crystal ball,' their first formal decision is to indicate what they consider to be the most important environmental developments: driving forces for the DPW. The driving forces selected will form the subjects of the scenarios to be constructed. They opt for European integration, administrative changes in the Netherlands and sustainable development.

4.   System-dynamics within Nostradamus

Initially, the intention is to accord system-dynamics a very central position within Nostradamus, namely in the learning environment to be created for use by all the teams during the workshop. Consultation of literature on the subject confirms for the QI group that this kind of learning environment is feasible (see Senge and Sterman 1991, and Morecroft 1988, for example). Consultant Jac Vennix sets up an initial plan for the learning environment: a computer-based learning environment for the DPW scenario-management game (see Vennix, Experiences with the first phase of Nostradamus, Utrecht, 1992).

The set-up of the computer-based learning environment is based on participatory model construction (Vennix, 1990). 'Model' here stands for a system-dynamic description of the DPW in interaction with its environment. All teams will construct part of the model themselves during their workshop. This is expected to be an educational experience.
Both internal DPW commentators and external ones, including the Stratix Consultancy Group, ask critical questions. They also observe that the entire course of intended participatory model construction is only followed by the small group of managers who help to prepare the management game; how do you induce twenty-four teams to see this game as their own? Or: will they see the underlying model as theirs?

In the summer of 1991 the QI group undertakes a study trip to the MIT and to Albany. The journey provides a second option for the learning environment: a DPW management flight simulator. Jac Vennix provides a plan for this too.
The management flight simulator is based on the idea of the transitional object. Learning by playing. The DPW flight simulator will comprise an already system-dynamic model of the DPW in relation to its environment. Management teams can have options (which they themselves generated) calculated, and are confronted with sometimes unexpected outcomes. The unexpected outcomes should be educational with respect to the current role to be played by the DPW.

However, as the commentators ask, what if people come up with options which cannot be calculated? And still more critical questions come from the commentators, including: can the mechanistic and strongly rational angle of approach which characterizes a flight simulator serve as an image for an organization which is made up of living beings and functions in a political environment?

The decision has to be made in the autumn of 1991. Should there be a learning environment or not, and if so, which kind? It proves impossible to convince the Nostradamus leadership to opt for a computer-based learning environment. The leadership sees too many uncertainties, including as regards the educational effect. They also hesitate as to the modelling possibilities for the scenario designs provided by the management teams in September 1991. All three are of a highly qualitative nature. The project's leadership also argues that working with scenarios demands so much adaptability from the managers that
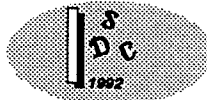
presenting a learning environment as well might be too much of a good thing.
It is decided not to construct a computer-based learning environment.

Subsequently, the organization of the workshop is adjusted in the Working Document Phase II (QI group 1992). For the teams, the entire workshop now takes on the form of a team discussion. This means that the fixed agenda items - scenario interpretation, option generation, option evaluation - should be solved in a 'meeting' situation.
However, an agreement is made to make provisions for modelling the scenarios in a system-dynamic way. These models could then potentially be used at the team's request to calculate effects of options.

Though the approach chosen initially seems to be 'safety first,' a decision is nevertheless made to provide the teams with two new discussion aids for within the workshop, both regarded as springboards for the intensive application of system-dynamics in subsequent Nostradamus cycles. In principle, on the first workshop day, each team will utilize hexagons, a technique developed by Hodgson (Hodgson 1990), in which ideas and opinions of all team members produce a team vision in a number of steps. On day two, each team, in principle, will use conceptual system-dynamic model construction in order to chart the scenario and the team's own problem.
The QI group thinks that these two discussion techniques can incite teams to look further into discovering possibilities for use and underlying philosophies.

In order to test the option for the use of conceptual model construction, a test group is composed of DPW managers who, at the beginning of 1992, spend seven half-days modelling strategic dilemmas set up in the manner of Hampden Turner. The test group notes connections and links between its own work and the environment of which it was initially hardly or not at all aware. The test team also establishes that the interaction between sections of the DPW and the environment are considerably more intensive and complex than first suspected.
However, the test team seems to need a considerable 'crystallization' period - about two months - to absorb the technique.
These conclusions lead the Initiative Group to include conceptual system-dynamics only in the workshop programme for teams which explicitly request it following an introduction to the technique.
Application of the hexagon technique as a group discussion aid meets with less hesitation. Test exercises show that this technique can be used without prior introduction with regard to its use and method.

5.   Evaluation of the use of system-dynamics in Nostradamus.

In April 1992, at the halfway stage of Nostradamus, when we try to balance up the intended and actual use of system-dynamics in the project, the marked difference between intentions and facts becomes apparent.
While the intention in early 1991 was to apply system-dynamics as a central activity within Nostradamus, a good year later little remains of this intention. System-dynamics has assumed a role in Nostradamus, but clearly a peripheral one.
Why the regression? Should we conclude that system-dynamics has little to offer on a practical level in organizational growth? We keep an open mind.

Within system-dynamics, conceptual system-dynamics and quantitative system dynamics can be differentiated. Conceptual system-dynamics is taken to mean the design of a qualitative causal diagram. Quantitative system-dynamics involves the further elaboration of the qualitative model to form a quantitative one with the aid of the computer programme such as Ithink, for example. Both forms have

practical value for projects aimed at organizational growth, although only under certain conditions. On the basis of experience with Nostradamus the following can be concluded:

Conclusion A   Conceptual system-dynamics is of value as a supplementary aid in organizational growth projects, notably in the preparatory phase, for problem structuring and problem formulating and achieving a shared vision of this.

> With Nostradamus, experience has been gained by small groups in the conceptualization of formulated strategic dilemmas such as centralization/decentralization, and key questions such as: when is the DPW a learning organization? and: how can the DPW mobilize and develop its potential for creativity and flexibility? These exercises were found to be very satisfying by the groups themselves.

Conclusion B   The QI group was hardly able to find practical examples for quantitative model construction which could serve as examples for Nostradamus; partly for this reason the Nostradamus leadership could not be convinced of the usefulness of quantitative model construction.

> The QI group has seen very little practical experience of projects of organizational growth in which quantitative system-dynamics is used as a guiding aid.

These two conclusions say nothing about the possible use of system-dynamics as the most important vehicle for organizational growth within a large organization. We believe there are possibilities here for system-dynamics but that this 'market' is unclear partly by the lack of systematic documentation of experience with system-dynamics in qualitative projects on organizational growth.

On the basis of our experience as a client with system-dynamics we have derived two hypotheses.

Hypothesis A   Conceptual system-dynamics is particularly favourable as a central supporting aid in organizational growth projects when the aim is to reach a shared vision regarding the organization's mission; the chance that projectleaders of projects on organizational growth will choose for conceptual system-dynamics will be greater when they can overview the practical experience.

> The Nostradamus leadership did at the end of 1991 agree with the introduction of conceptual system-dynamics but only after a succesfull try-out within the organization. The Nostradamus leadership did not choose to use conceptual system-dynamics already in an urgent strategic discussion partly because of the lack of overview in practical experience.

Hypothesis B   Quantitative system-dynamics is favourable as a main supporting aid in organizational growth projects when the individual mission is clear and the organization is directed steadily at a quantifiable output and at its environment.

> We are under the impression that DPW appeared unreceptive to ideas of a computer-based learning environment and a management flight simulator partly because the organizational problems were shown to lie on a more fundamental and abstract level. 'The DPW is very preoccupied with itself,' as an advisor put it, 'with formulating collective and individual missions'. The focus on organizational growth seems for the DPW to be based primarily on improving
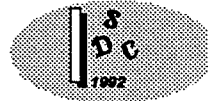
'perception' and 'thinking,' to use Kolb's terminology (more on this later). This can mean that the idea of a computer-based learning environment can probably thrive in organizations in which an issue manifests itself on the level of 'deciding' and 'doing.' This can occur in output or environment-oriented organizations such as commercial sales organizations, for example.

Partly in view of the next Nostradamus cycle, we are very interested in the vision of system-dynamics experts concerning the above-mentioned conclusions and hypotheses. If we may anticipate the reactions, we as a client consider three actions which could be useful for breaking through the limitations we see imposed by system-dynamics on system-dynamics.

Action A   Design (together with the organizations) a typology for kinds of use of system-dynamics according to types of organizations and kinds of problems.

The QI group feels that system-dynamics could be more concerned with system-dynamics marketing issues and balancing demand and supply. If a typology were successfully designed for both the kind of use of system-dynamics and the type of client and the sort of problem, this would constitute an effective aid to enable potential clients to assess the potential usefulness of system-dynamics for their specific wishes. (If this had been available to the QI group, system-dynamics would probably have assumed a greater role within Nostradamus in a shorter period of time.)

Action B   Document experience within the designed typology.

Both via its own orientation and its advisor Jac Vennix, the QI group has come across a limited selection of ad hoc documented experience gained elsewhere with system-dynamics in major projects on organizational growth.

Action C   Regularly demonstrate the possibilities of system-dynamics for current topics.

We are under the impression that system-dynamics is potentially of use for many current (societal and organizational) policy, management and strategy issues (see the annex). In our view, system-dynamics could contribute towards formulating problems step by step, with increasing clarity and more well-founded. The evident striving of many system-dynamics experts to arrive at THE MODEL seems to us less important than the realization of discussion itself.
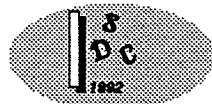
For option C we see possible questions arising such as: 'what concrete advantage does organizational growth offer the organization?' and: 'what specific direction does an organization take in order to stimulate and develop its potential flexibility and creativity?'

An exercise we carry out, partly with Jac Vennix, produces a number of results. When we get the results of the conceptual system-dynamics back in the Kolb learning cycle: doing - percieving - thinking - deciding - doing - ... the following picture emerges (Swieringa and Wierdsma 1990 made the connection between organizational learning and the Kolb learning cycle).

doing
- product development
- process development

perceiving
- knowing your clients
- feedback to your clients
- knowing market situation
- feedback to employee

deciding
- choice of collective mission
- choices of individual missions
- choices for mobilizing potential

thinking
- collective mission
- individual missions
- generating options for mobilizing potential

This outline shows us that organizational growth really influences the 'hard output' of an organization. It promotes what many organizations wish to promote: product development and process development. Furthermore we conclude that in an organizational growth process, individual and organizational learning go hand in hand in a permanent process of both individual and collective doing, perceiving, deciding and thinking.
We think that options to stimulate creativity and flexibility are both necessary and workable here: rewarding innovative behaviour, creating pleasure in work and increasing individual commitment and responsibility for tasks.
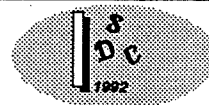
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