MONASH UNIVERSITY
FACULTY OF BUSINESS & ECONOMICS

THE USE OF GROUP MODELLING TECHNIQUES AS A TEACHING TOOL

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Working Paper 21/99
June 1999

Abstract

This paper discusses developments in the teaching of System Dynamics Modelling In the Department of Management at Monash University. The subject, Dynamic Systems Modelling, is a core unit in the Master of Management (Organization Systems) program. Developments in the teaching program over the last three years, leading to the use of group modelling techniques as advocated by Andersen, Richardson and Andersen and Vennix, are discussed. In particular, the use of different roles for group members is discussed with particular reference to the manner in which the expert modeller worked within the groups. The impact of logistic and time constraints on the curriculum, in relation to class based case studies against work-place based simulations, is examined as an on-going issue. Questions of disseminating SD techniques into the wider business community are discussed. The evaluation of the success of the use of group modelling techniques is based on learning diaries and reports from the students, all mature aged and part-time. The paper draws some conclusions on the usefulness and role of group modelling techniques and suggests future developments.

THE USE OF GROUP MODELLING TECHNIQUES AS A TEACHING TOOL

The unit, Dynamic Systems Modelling teaches students competence in the use of the modelling tool think ™. The philosophical basis for the unit is classical SD theory. In outlining the fundamental differences between Systems Thinking and System Dynamics, Gould-Kreutzer (1993) cited Forrester :

"in general, it (Systems Thinking) does not refer to the quantitative and dynamic analysis that constitutes real system dynamics...., a genuine understanding of systems lies in the rigorous system dynamics-driven structuring of models and in the simulation based on these models. Only these simulations, and nothing else, can reveal the deep inconsistencies of our mental models."

Morecroft and Sterman (1994) outline the role of modelling:

Models should capture the knowledge and mental data of policy makers; model should blend qualitative mapping with friendly algebra and simulation; models can be small; their purpose is to support team reasoning and learning; they encourage systems thinking and scenario planning. Simulations provide consistent stories about the future, but not predictions. This modern view repositions the role of the model and the modeller. Models are "owned" by the policy makers, not by technical experts. They are created in a group process. The policy insights are disseminated throughout the organization in hands-on workshops not presentations.

Richmond (1993) defines seven critical thinking skills for systems thinking. Of these the unit's focus in on 4 - 7.

1 Dynamic thinking is understanding behaviour over time

2 Closed loop thinking is feedback thinking which helps see situations not as a result of external forces but as a result of the dynamics of the structure.

3 Generic thinking is understanding the similarities that emerge across systems.

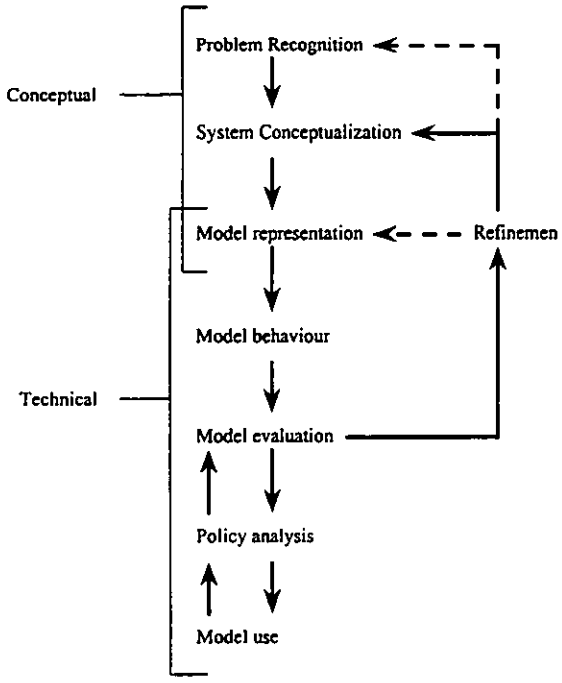
4 Structural thinking deals with the rate-flow-stock problem.

5 Operational thinking is an extension of structural but includes the dynamics over time. The focus is on conservation and flow.

6 Continuum thinking is established with simulation and outcomes that are continuums based on the dynamics of the model not a result of "if-then-else" thinking.

7 Scientific thinking introduces the need for quantification and hypothesis testing.

The methodology used in the unit is based on Andersen and Richardson's (1980) model:



The unit, Dynamic Systems Modelling, is taught as part of the Master of Management (Organizational Systems). This degree is positioned in the market to provide specialist Systems Theory based alternative to the generalist MBAs offered at all six universities in metropolitan Melbourne. The students who enrol are mature age, part-time full-fee paying students with full-time jobs which could be typified as middle management.

Students who enrol in the program will usually have completed one and possibly two post-graduate units in the area of Systems Theory. This served to eliminate problem outlined by Richardson and Andersen (1994) of the model builder having to fill the role of modeller/explainer/educator. Indeed the issues surrounding this relatively high level of knowledge surfaced for some groups.

When the unit was first taught five years ago, the emphasis and focus was on developing the technical skills of SD modelling. This was in preparation for the use of modelling tools in a capstone Action Research project which the students did to complete their program. Over time it became obvious that not all students were confident enough in their modelling skills to use them in the AR project. This distinction became increasingly obvious in the workplace project component of the modelling unit. This project involved building a model around a problem which had the potential to be solvable in SD terms, ie had complex interactions and inter-relations, multiple feedback loops, lagged effects. The students would then present the model to senior managers as their major piece of assessment.

A group of students emerged who found SD modelling interesting but who were not predisposed, for a variety of reasons, to develop their skills to a level where they would be useful in the workplace. This group would often articulate a desire to understand but not implement the process of SD modelling. For them, the workplace project was not particularly meaningful and the results did not justify the effort required. Each project required the member of teaching staff to attend the presentation. With each presentation effectively taking a morning, a class of twenty students equated to two full weeks spent assessing final presentations. This became an unreasonable demand on staff time.

In contrast, another group emerged who were quickly able to master and apply modelling skills in the workplace. For these students, the workplace project often represented a major opportunity for advancement and a number have moved into new roles as a result of their organizational visibility which emerged with the development of their models. A number of organizations have continued to use systems methodologies as a result of this intervention. This has met the long term goal of moving Systems Thinking and SD modelling into organizations in Australia and made the time commitment worthwhile.

During our students' work in their organizations in previous years, it became clear that technical modelling skills alone did not guarantee success. There were a number of issues around the modelling process which, if not managed properly, would overwhelm the quality of the modelling work. The most important of these was the management of a group of people who had the knowledge around which the model would be built and who were later to become the stakeholders in the model. The first challenge was to help such groups to think systemically and to think in terms of stock-flow-rate structures. The second was moving the group, normally volunteers, to a point where the model produced results with in the time constraints of a semester-based unit. The third was to produce results that were sufficiently convincing to be the basis for change in the organization.

There were thus two impulses towards change. The first was the existence of a group of students for whom a working knowledge of SD modelling was perhaps a realistic goal and who wanted to set SD modelling in a broader context of organizational change. The second was a group of enthusiasts who wished to maximise the impact they could have in their organization using the skills they had developed in the program but who needed more than a basic competency in SD modelling to succeed and who wanted to develop relatively high technical skills.

Nonetheless, this remains a dilemma for us. Many writers (Forrester, 1961, 1967, 1973; Goodman, 1994; Morecroft, 1994; Petersen, 1994; Sterman, 1994; Wolstenholme, 1994) and a small number of our staff, build their pedagogic structures around model building and simulation of the type which is central to system dynamics. This remains an issue that will be resolved over time. However, the authors' are inclined to the view is expressed by Sterman (1994).

Does this mean that everyone who wishes to think systemically must become a computer modeller?: I believe the answer is no, as long as we understand the limits we place on ourselves as a result. Systems thinking without computer simulation can short-circuit the process by which we develop human intuition. Without modelling, we might think we are learning to think holistically when we are actually learning to jump to conclusions.

And Andersen and Richardson (1980) who saw "transferability of structure" as an important tool in systems conceptualization.

In simple systems students can predict behaviour from structure or at a more complex level predict structure from behaviour. Building and deconstructing models in class and observing behaviour at each stage can also be helpful.

The dilemma is, on one hand, providing a program which is accessible for both groups of students and on the other, to keeping the focus on the central model building, testing and simulation aspects critical to systems dynamics. In the short run, the decision has been, probably rightly, for intellectual accessibility through an emphasis on the aspects of system theory more closely related to, and recognizable within, a framework of established management theory. However, unless we are able to develop the skills and technology for modelling and simulation, we may fail in our aim of integration of system theory and management theory. Richardson and Andersen (1994) and Vennix (1996) have outlined a methodology called Group Model Building (GMB) and it was this that provided the basis for the changed direction of the unit.

Richardson and Andersen (1994) describe a model that has two fundamental components: the definition of five specific roles for the process and team work in model building. The five roles are: a facilitator to monitor the group process and to elicit group knowledge, a modeller/reflector to focus on the model

building, a process coach to focus on the dynamics of the team, a recorder to write down the groups processes as a basis for later reflection and learning and a gatekeeper who is close to the client group and who takes responsibility for the project.

The students were required to work in groups and to allocate each of the roles of the Andersen and Richardson and Andersen model to members of the group. It was decided not to use workplace problems as the subject of the modelling but to use a case study, in this case People Express (PE). PE was chosen because there is a rich source of case material including extensive documentation and the PE simulation which the Department had used some years previously. The students' task was to read the source material and to build a policy model suitable for analysis within the context of the PE case using Andersen and Richardson's Group Model Building processes. In addition to completing the model, the students were required to keep a group diary and to comment on the effectiveness of GMB as a learning process. The following commentary is based student feedback and discussion.

STUDENT FEEDBACK

Group 1

In common with all the groups, the members of this group had worked together previously in group work and all group members were known to each other, having completed a semester of study together previously. This group was characterised by a the fact that in terms of modelling skills, three of the group members had great competency in this field as a result of the earlier software training program, while the others were not so highly skilled. This tension surfaced in discussions involving the balance between getting the detail of the model correct and facilitating the group modelling process. This was manifest in the development of a gap in terms of levels of understanding and differing competencies in the group. This group used a de-briefing process at the end of each session to resolve these tensions including those that had developed between members who wished to move ahead and complete the model and those who wished to concentrate on the group processes. The gap between the two sub-groups became more apparent and was exacerbated by feelings of guilt regarding the disproportionate workloads.

The group found that being able to sit around a large computer screen, which everyone could see, helped the group process and that two hour sessions of model building were the maximum period the group could work. It is important to remember that the groups were made up of part-time students with senior full time jobs and that this group worked from 6pm- 8pm in the evenings after working all day.

At this stage, the group felt that building the PE model was too restrictive and that just producing a model that worked and was a replica of the standard model missed some of the points they would have liked to explore.

In assessing the roles designated by Richardson and Andersen, the group observed that the facilitator was pivotal to the successful functioning and needed strong modelling and interpersonal skills, the modeller/reflector role was also seen as fundamental but in this situation was strongly biased towards the modeller aspect with the group as whole taking on the reflector role. The process coach was the other key role identified by the group and this role served to mediate between the two sub-groups. This group did not use the gate-keeper role. The group also observed that the role were strongly adhered to throughout he process.

Comments

The divisions within the group, primarily focussed around modelling competence highlighted an emergent problem in using group modelling and in fact, served to exacerbate the problem it was designed to solve. Those students who were less competent modellers were naturally drawn to the idea of the process of facilitation, while those who were more competent modellers were drawn to the outcomes, namely completion of the model. A factor in this may have been that of all the groups, this group had a larger proportion of students who were less confident in their modelling abilities.

Coming into the group while it was working, the observable configuration was symptomatic of the division within the group, with the modellers clustered around the whiteboard discussing issues as such as methods of modelling price elasticity while the remaining members sat watching and not understanding or contributing at the level of the discussion. This is indicative of an underlying problem that the "modellers" can move ahead of the group in terms of their knowledge of the workings of the model. This leads to isolation of the "non-modellers".

The group's observation of the importance of the facilitator is pertinent in that the group contained two assertive personalities who expressed the views of the two sub-groups. Mediating between these two individuals was clearly one of the roles that the facilitator filled. The modeller/reflector role was filled by a highly task orientated individual who often articulated frustration with the delays perceived in considerations of process. The groups, and the roles to a lesser degree, were self-selecting which makes it difficult to mix and match personality types to the roles. However, this aspect constituted a problem for this group. The process coach was filled by a highly process orientated individual who articulated the need of the sub-group of non-modellers to make a contribution which they felt was important. This was in part inherent in the process the group used. The group designed the model as a causal loop diagram which the modeller and facilitator would then take away and turn into an ithink model. As the computer model took on a life of its own the familiarity of the designers with the model and the relative unfamiliarity of the rest of the group with it, increased the gap between the two sub-groups.

This group appeared to take the role of process coach more seriously than other groups. Each session was concluded with a debrief of the group processes. Given the tensions that arose and the need of all group members to feel they were making a contribution, this produced a useful focus on the group processes and the importance of the contributions of all of the roles. This may indicate that relatively heterogenous groups, in terms of modelling skills may focus on process with the corollary that homogeneous groups may focus on model content. If this suggestion is correct it has implications for the manner in which the mix of groups supports the aims of the subject.

Also the difficulty of having a number of people in a group with modelling competency can produce two problems. The development of competing models where the skills are high and where the skill gap is large, a sense that the less skilled are not making a contribution. This continues to be a dilemma as the original idea for using the group modelling methodology was to minimise the impact of this skill difference by providing roles for all group members.

Group 2

This group was characterised by all four members having equal ability in terms of model building however, the group perceived that this level of skills would not be high enough to build the PE model. This emerged as a strength as the group processes became designed to enhance modelling skill. The group was also characterised by a lack of knowledge of each others group facilitation skills. Consequently, allocation of the Richardson and Andersen and roles was arbitrary.

The focus of this group initially was on the task of model building and eliciting the material relevant to the model itself. Once this was done, each member of the group went away and built their own model. This was prompted by a desire to "get their teeth into" the techniques of model building. They realised that this was a departure from the process recommended by Richardson and Andersen. The consequence of this course of action was the development of competing models, whose merits were argued strongly by the individual owners. This proved time consuming and counterproductive and led to a realisation that the group needed a common mental model and a decision to use a single model as a vehicle to move forward with. At this point the group also realised that the modeller role needed to be shared around and this in turn led to greater fluidity in the other roles. Like group one, this group found that a large format, in this case a data show, and the seating arrangements suggested by Richardson and Andersen were a key tools in keeping all members up to speed with the developing model. The seating configuration also served to formalise the role of facilitator/modeller although this role continued to be changed amongst the group. The group recognised that, while the Richardson and Andersen model suggest that the role remain stable, they found that as a tool for learning, it was more important to ensure that the roles were maintained rather than filled by the same person.

The group highlighted the perceived lack of modelling skills as a major limitation for them in addition to a lack of facilitation skills. The group recommended that the facilitation role be filled from outside the group, preferably by someone with modelling skills and that the modeller role be separated out.

The group expressed frustration with their level of knowledge of PE in comparison with their own industries. They also observed that, in using a case study, they had developed higher levels of skills, than in previous years where students had quicker and dirtier models built around work situations.

Comments

While this group may have perceived that their levels of modelling skill were low, the observation would be that this group was characterised by relatively high levels of skill in modelling and that the facilitation process was the area where they lacked skill. This was clear in the vehemence and level of detail at which debates over the model were conducted.

This group also highlighted the problem in using a case study, even one as well documented as PE: it lacks real world credibility.

The group's recommendation for the role of facilitator may be possible to implement through volunteers from previous year's classes. Such volunteer facilitators would have been through the process themselves, and by self selection be interested, and skilled, in the modelling process

The comparison between the outcomes of the previous year and this cohort are informative and crystallise a key issue for the program and one which is far from resolved. Do we aim for high levels of modelling and group facilitation skill, developed through a case study methodology or do we aim to have students working in their own organizations, in relative isolation, developing quick and dirty models that seek to embed SD modelling in the organization by demonstrating its usefulness to managers ?

Group 3

This group observed fluid exchange between the roles with the exception of the modeller, which was filled by an individual with observably more skill and enthusiasm for model building than most other members of the group. This group highlighted the frustrations in the dual roles the group had to fill. The first role was defined as the client, responsible for providing the raw material for the model. The second role was that of modelling team and being simultaneously responsible for building the model.. Once the model was completed the observation was that the roles had been consistently maintained throughout and agreed with Richardson and Andersen's proposition that all the roles are necessary to the process. They also observed that ithink has limitations as a group modelling tool, in that only one person can build the model and that this inevitably means that the modeller develops a deeper understanding of the model than the rest of the group.

Comments.

This group highlights an important problem in the need to be both client and modelling team at the same time. Other groups also commented on this during the process. The practicalities of dealing with this are considerable. On the one hand, the practice adopted here is logistically simple but lack reality. On the other hand, having the team work with a real client would involve time commitments either on the part of the client group (in coming to classes on Saturdays) or on the part of the team in visiting the client during work hours. A workable solution, which may be adopted next time will be for one member of the team to fill the role of client and use a problem from their own organization as material for the model.

Group 4

This group had a significant number of similarities with Group 2. The group observed that the lack of an experienced modeller in the group was a drawback and became focussed on developing skills to complete the actual model. This proved to be the stimulus for the development of modelling skills in all group members. In seeking to develop the modelling skills of each member however, competing models were developed and a considerable amount of time was spent trying to reconcile them. This group also shared the Richardson and Andersen roles between them and observed that this was because the group lacked a recognised sufficiency in modelling, in the reference system to be modelled and in knowledge of group processes.

The group was unable to allocate the process coach and facilitator roles or continuously acknowledge a single member to fill them. This was explained by a lack of sufficient detachment from the process and the results of the model for one member to fill this role consistently. The group interpreted the gatekeeper role as the one which Group 3 would have characterised as the client. In this group, the gatekeeper role was to provide information about the reference system and as such was shared by all members of the group. The role of modeller was an emergent one, with one member of the group establishing the trust of the other members in his ability and then continuing in that role. In contrast, the group reported that the model building was a group process with the model being built in "real time" rather than after group sessions by the designated modeller. The reflector role was not filled consistently and the process of reflection itself was limited to questions of modelling rather than discussions of the dynamics of the group processes.

The group suggested that an experienced facilitator, their suggestion was the teacher, would greatly improve the process of model building. The group saw skills associated with each role as being crucial. They also observed that the early allocation of roles, based on these defined skills, would greatly improve the speed of the process.

Comments

The group was characterised by high levels of interpersonal tension over the form of the model. One member, in particular, consistently slowed the process down through protracted arguments with all other members of the group. It is possible that a clearly defined facilitator role would have mitigated this process.

The definition of the gatekeeper role is indicative of the some confusion over that role. It also indicates that this role as defined by Richardson and Andersen was unimportant in this application of their process.

This group, and their progress, provided a clear indication of the importance of roles being clearly defined. The group also draws attention to the need for skill development in each of the roles designated by Richardson and Andersen. The introduction to the GMP was simply "read the article". It is probably desirable that some time be spent in class defining and discussing the skills and behaviours associated with these roles.

GENERAL CONCLUSIONS:

Whether the same person should necessarily fill each roles appears undecided from this case study. However, the importance of these roles was emphasised by every group. However, in this situation it must be emphasised that this work was part of a assessable exercise in a university program. It may be unrealistic to expect students to be overtly critical of the teaching staffs' pet theories.

Nonetheless, this exercise has highlighted a number of issues:

Despite our best efforts, there are wide discrepancies in modelling skills within groups. The lesser skilled will not go back to their organizations as dedicated modellers however, by training and choice they do go back as systems thinkers, possibly capable of initiating and supporting modelling exercises. The use of group modelling techniques allows such students to see the added depth that SD modelling can provide to the systems thinking perspective. Such people can, and have, played significant roles as gate keepers after their graduation.

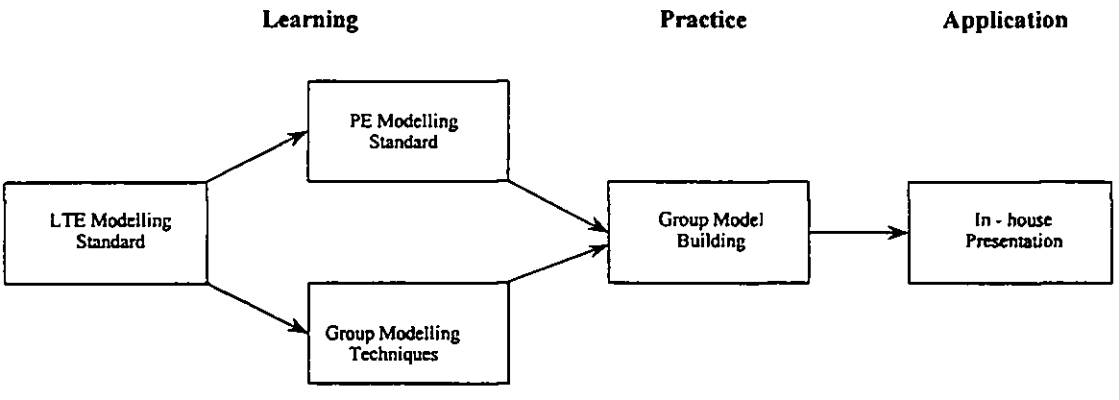
The problem to be modelled needs to be more closely related to the real worklife experiences of the students. The teaching culture of our degree programs has always been to link high level theory with practical problems and this continues as an expectation of our students. Clearly PE does not meet this expectation while still providing a good "laboratory" modelling experience. The practical difficulties of using group modelling techniques with a real world problem, which would involve access to members of a host organization and part-time graduate students with full time jobs and hence limited time, remain large.

The emphasis has been on the use of the five role for modelling. This ignored Richardson and Andersen's (1994) guiding principles and scripted techniques for model building. The question of emphasis in the program is called into question: do we aim to produce as many highly competent modellers as possible by focussing on mastering the technical aspects of the ithink package or do we accept a lower overall standard of modelling skills and aim to set those skills in a practical framework that students can take back to the real world.

Using the "laboratory" approach with PE in favour of real world models loses the opportunity to place good working models in front of our students managers. This has the advantage that it provides a marvellous PR opportunity not only for SD modelling but also for the work done at Monash. When students did individual models of work problems, teaching staff had to spend many hours working with the students on their models, often up to an average of an hour per student per week. Even with a class as small as 10 students, this represents a huge time commitment. However, this approach required student to facilitate the modelling process in the workplace. The difficulty was, that without adequate supervision during this process, the quality of the learning could not be ascertained.

Future Directions

For the next semester, we will consider cutting our losses on the "make everyone an expert modeller" approach and accept that a lower level of skill may be sufficient for those whose natural predisposition is not towards modelling. This will involve clearly define standards that are required so that the "less than expert " (LTE) modeller can make a contribution to the group modelling process. Provision will need to be made for the "potential expert" (PE) modeller to develop their skills. Attention to the mix of skills in groups would take on a priority not present in the past. The LTE modellers would then be able to take responsibility for process issues within the group including a familiarity with the group modelling literature and the co-ordination of the external clients. The learning pathway would be:



This plan may help meet the multiple goals of producing skilled modellers, meeting the educational needs of individual students, and establishing a community of skilled and active SD practitioners in the business community.

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