The "standard method": Scripts for a group model building intervention

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Abstract

The process of model building with a client group involves techniques and procedures for a modeler to elicit knowledge and mental models from clients, and to guide the whole team through the conceptualization of causal structure into formal models and potentially simulation models. The literature provides a comprehensive overview of system dynamics model-building processes, which are commonly used in client group interventions. This article extends the discussion of group model-building procedures with a description of conceptual activities and scripts using the "standard method" in a client group intervention. While the "standard method" is not explicitly aimed as group model building intervention, we have used this approach to work with a small client group from the Gloucester Community Development Cooperation to support system conceptualization, model formulation, and decision making for the build-up of a fish factory. The "standard method" is discussed in light of this group modeling intervention and some of the insights gained from client feedback and reflection by the stakeholders are presented. The case discussion describes how we used a set of scripts in a group modeling intervention to help understand and agree upon the basic structures, rather than examining quantitative validation of the simulation model.

Keywords: Group Model Building, Scripts, Insights

Introduction

The purpose of this article is to describe the scripts used in a group model-building initiative with the Gloucester Community Development Cooperation and to discuss the lessons learned from applying the standard method as framework in a group environment. Building system dynamics models with client groups has a long tradition in our field and is well documented (e.g. Morecroft and Sterman 1994; Richardson and Andersen 1995; Vennix 1996). In the literature several approaches to group model building are discussed (e.g Richardson and Pugh 1981; Roberts et al. 1983; Vennix 1994) with varying stages on how the process of constructing a computer simulation model involves a number of conceptual activities. This article discusses the outcome of a group model initiative, using "the standard method".

The "standard method" refers to a framework of steps to identify key variables, reference modes to formulate a dynamic hypothesis and finally to conceptualize a simulation model. The idea behind the standard method is not to think directly towards a solution at the beginning of the modeling intervention, but to gain knowledge and insights from each individual phase in the project together with the client. Besides the iterative nature of the model-building process, Hines' "standard method" specifies steps that a system dynamics modeler should consider in a consulting environment. For example, the importance to identify key variables, which usually involves in-dept discussion with the client, a reference mode to express a "hope" and "fear" scenario, and in-depth analysis of the different loops in the system. The steps of the standard method (Hines 2001) are:

1. Problem definition
    a. List of variables
    b. Reference modes
    c. Problem statement
2. Momentum policies
3. Dynamic hypothesis (i.e. causal loops)
4. Model first loop
5. Analyze fist loop
6. Model second loop
7. Analyze second loop
8. Etc.

The method is an evolutionary descendent from Randers guidelines for Model Conceptualization (Randers, 1980). Randers' emphasis on explicitly testing the dynamic hypothesis ("dynamic behavior or reference modes" and their hypothesized "basic mechanism or causal structures") conform this approach as well as the emphasis on the iterative process ("reference modes and hypotheses can change") (step 1 and 3). Momentum policies are a novelty; the term is borrowed from GM's problem solving process and they are defined as "a solution that your client would implement now if he or she had to make a decision immediately" (Hines 2001). Another essential difference is the loop by loop building approach, rather than starting from stocks and flows (step 4). Together these two differences show the deviation in emphasis: where Randers (1980) focused mainly on how to "address a meaning full whole", the standard method emphasizes generating insights throughout the process.

Besides applications in regular consulting, the method is mainly used as a pedagogical framework for the course "Applications of System Dynamics" at the Massachusetts Institute of Technology. Over the term of the semester, students address a problem that has been predefined on a coarse scale by a real client and use the standard method to gain insights towards and during conceptualization and analysis of a simulation model and. Throughout the 15 week semester, students discuss with each other their specific experiences insights and issues in breakout sessions to each other, while in a general session potential next steps are discussed. Although students are guided through the process more or less in phase; each will have their challenges and insights at different steps in the process. We discuss our experience gained from a project while taking this course. The project was continued after the semester project. In most of the cases, students deal with one client. Because the project we have chosen for this course involved the interaction with a group of policy makers and stakeholders, we applied the standard method in a group modeling environment.

Group Model Building Processes

Richardson and Pugh (1981) define seven stages in building a system dynamics model: problem identification and definition, system conceptualization, model formulation, analysis of model behavior, model evaluation, policy analysis, and model use or implementation. Roberts at al. (1983) suggests a similar approach to construct a simulation model. Vennix el al. (1994) summarizes the steps and stages in model building as shown in table 1.

Stage	Steps
Problem formulation	• Define time horizon • Identify reference mode • Define level of aggregation • Define system boundaries
Conceptualization	• Establish relevant variables • Determine important stocks and flows • Map relationships between variables • Identify feedback loops • Generate dynamic hypothesis
Formulation	• Develop mathematical equations • Quantify model parameters
Analysis/evaluation	• Check model for logical values • Conduct sensitivity analyses • Validate model
Policy analysis	• Conduct policy experiments • Evaluate policy experiments

Table 1: Stages in model building initiatives

The stages and steps as shows in table 1 draw on long years of experience in group model-building initiatives from leading scholars in this field. Besides the established procedures in group model-building, Andersen et al. (1997) suggests that modelers who engage in modeling with groups rely on fairly sophisticated pieces of small group process, which he calls "scripts". He defines as "a continuous stream of small-group activity that generates produces such as a stakeholder analysis, a precise description of a problem to be solved, a sketch of model structure, or the determination of a set of actions to be taken". Vennix (1996) defines a group model-building process as an initiative to support a decision making group in structuring a messy problem and designing effective policies to deal with it.

While Vennix el al. (1994) proposes a highly structured and well defined approach for group modeling interventions (see table 1), Hines' "standard method" seems to emphasize a more emergence and intuitive framework as some of the steps are not explicitly stated. For example, Hines' "standard method" does not explicitly propose to define the system boundary or to calibrate the model, and yet it is assumed that a good modeler will do this intuitively. It is suggested that because the "standard method" is less rigorous in terms of the level of detail, it provides a learning experience for a modeler when going through the different stages of a model intervention. Following a less rigorous framework in a group modeling intervention might lead to possible errors during the conceptualization of the model. However, the "standard method" provides enough guidelines to capture the important stages in a model building initiative, while it requires a combination of skill and intuition to bridge the procedures which are not explicitly stated. As Andersen et al. (1997) concludes "it becomes clear that group model building is still more art then science". We have used the "standard method" following the explicit procedures and at the same time used our intuition about what will work in a group model intervention.

More importantly, the explicit challenge according to the standard method is to learn from each step and appreciate that, rather than working towards a solution. Emphasis on "slowing down" the building process and therein the loop-by-loop building approach, facilitate this process. Slowing down is difficult with a client that sets high expectations, based upon monetary rewards and is used to translate that into "solutions" to "known problems". In that sense the course context makes life easier, because of the absence of the reward system.

A Messy Problem

Gloucester in Massachusetts is one of the oldest fishing ports in the United States, with a 370-year history of harvesting a variety of fish species. Particularly with the harvest of groundfish (the National Oceanic and Atmospheric Administration [NOAA] classifies groundfish as a group of fish, which consists of a mixture of bottom-dwelling species including Atlantic cod, haddock, redfish, hakes, and flounders), Gloucester became economically and culturally an important fishing community in New England. With the growing pressure on the stock of groundfish, primarily from distant-water foreign fishing, and fleets of factory-based trawlers from Eastern Europe, Asia, and elsewhere during

1960-1975, the stocks declined rapidly (NMFS 1999) which forced the government to impose new fishery controls and regulations.

The constraints from the traditional groundfishing, which changed the economic situation for the local fishing industry, posed a challenging task for the Gloucester Community Development Cooperation (GCDC). How could the declining revenues from groundfishing be compensated to achieve a sustainable fishing community? Besides the lack of revenues from traditional groundfishing, the community is also losing its identity for being an important fishing port. Fishers fear that empty wharf space will attract real estate developers to create condominiums, motels, and retail outlets, inalterably changing the landscape of Gloucester. One of the possible answers was found in a new and patented process to extract Surimi out of pelagics or dark fish (for example Herring and Mackerel). Surimi in Japanese means "Minced Fish", it's pronounced "Sir-Ree-Mee”, and is traditionally produced with skinless Alaska Pollack (a white fish). Surimi in brief is fish minced meat that has been leached by washing with water then mixed with sugar and other additives then frozen. It's widely used in Japan for the manufacturer of Fish jelly products such as imitation crabstick (http://www.surimithailand.com/Surumi.html).

The new and unique technology for processing Surimi out of inexpensive dark fish, which is available in almost unlimited resources, (according to NOAA, Herring and Mackerel are underexploited species) proved to be a feasible alternative to taken into consideration for subsidizing the lack of revenues from traditional groundfish. Although the pelagics stocks are considered to be underutilized based on current research survey results and historic landing pattern, there is the likelihood that an intensification to catch these fish species could lead to unexpected interactions in the biomass. For example, there is little information about the function of pelagics in the food chain for predators (mainly groundfish), so if the pelagics stocks decrease, predators will find less prey, which then influences the sustainability of the traditional groudfish stocks.

Under normal conditions, we could assume that there are enough pelagics to harvest, considering the current stock assessments. However, a successful launch of the Surimi factory in Gloucester could invite other fishing communities to also tap into this lucrative business. According to GCDC the total market for Surimi is approximately 760,000 mt, growing at 10 – 20 percent per year, with Japan consuming 60 percent of the total production. In other markets like Europe and the US, where consumers become more health conscious, consumption of Surimi could easily reach staggering numbers. With all the uncertainties to determine sustainability of fish stocks, lacking of decision points to build a sustainable Surimi factory, and uncertainty of the socio-economic implications for the community GCDC faced a highly unstructured decision environment. Articulating the problem the client was facing was also not easy because of this highly unstructured environment.

Stage 1: Problem Definition

Together with the client group, who consisted of Dr. Carmine Gorga, Dr. Steve Kelleher, Dr. Damon Cunnings, and Joe Sinagra, we conceptualized a simulation model in an iterative process with weekly meeting within the team, and bi-weekly meeting with the client during a fifteen week (one semester) period. In the fist phase of the project we challenged our client's assumptions of what the boundary and the problem of the project should be. The initial focus from our client was related to sensitivity issues around the factory project, for example water and electricity usage, and other constraints influencing the desired Surimi throughput. Following the "standard method", we elicitated in our first meeting with the client about 60 variables and parameters. By focusing on the identification of variable, we also wanted to keep the client from thinking about solutions at the beginning of the project.

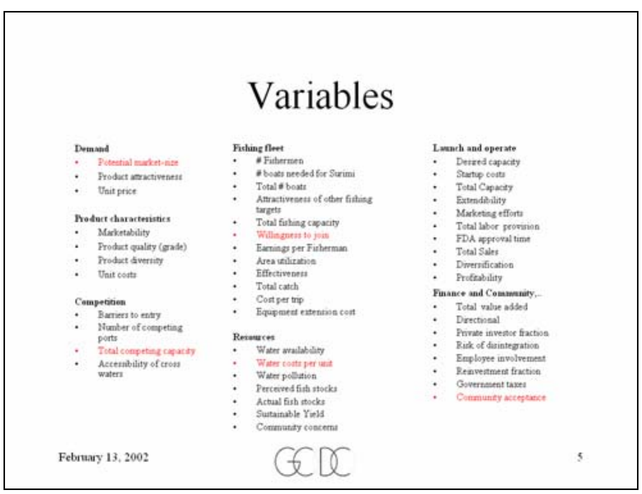


Figure 1: Screen Shot of Variables

We then narrowed the list down to a number of key variables, which we clustered into three sectors as shown in figure 2. The purpose to cluster the key variables into three high level sectors was primarily to focus our attention to the interactions between the key variables and for clarification of the system boundaries.

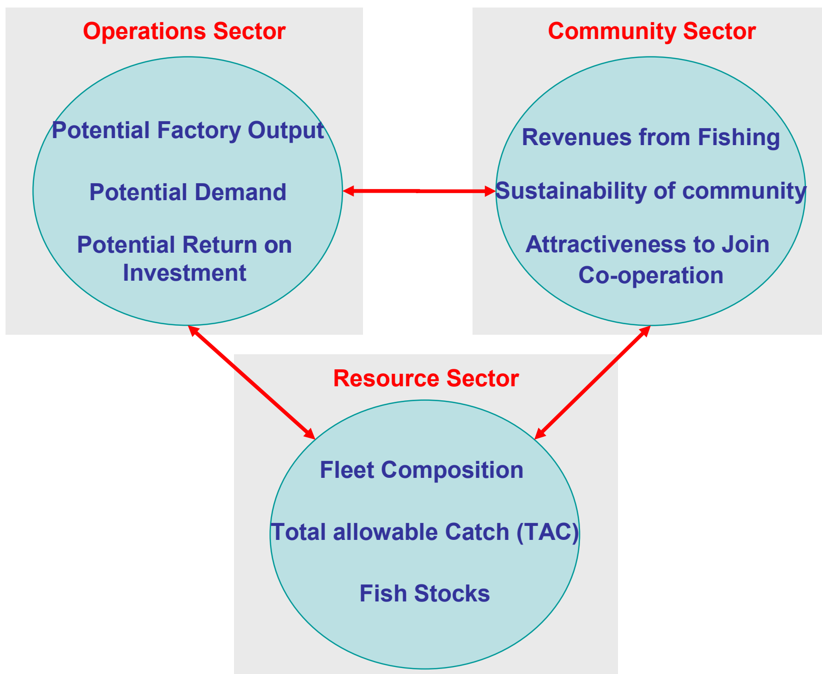


Figure 2: Key Variables and Sectors

The clustering of the variables was done within the model building team and then discussed with the client. In reflecting the selection of key variables with the client, we made sure the group as a whole shared the same view of the system. Visualizing the high level view of the system - as illustrated in figure 2 - helped the client team to focus their attention on the important factors and levers influencing the project. While we conceptualized a number of reference modes at the beginning of the project, we only used those as discussion boards to define the dynamic hypotheses, explained in the next section.

With the knowledge we have gained after the first two meetings with the client and in discussion with individual stakeholders, we formulated seven reference modes, of which one formed the based for our problem statement (fig. 3) to represent the expected behavior of the system. We presented the reference mode using the visual as shown in figure 3 to the client group to first get their agreement on the expected system behavior. Second, after the client group agreed on the reference mode, we have used this stripped-down representation of the system in dialog with some stakeholders. The reference mode communicated very easily even without lengthy explanations about the underlying assumptions, to establish a shared framework of what this project is all about.

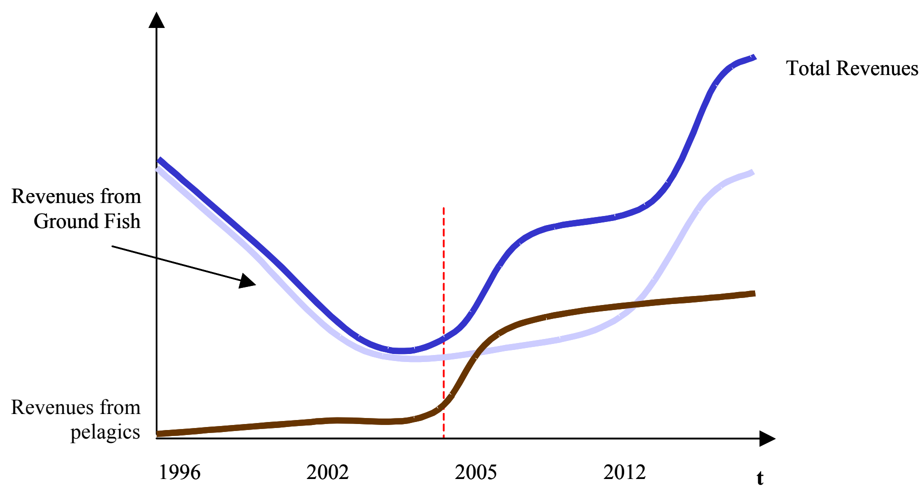


Figure 3: Reference Mode

The reference mode in figure 3 captures the decay of revenues from groundfish, due to declining fish stocks and curtailing from the government. By 2004 the new Surimi factory should be operational to compensate for the lack of revenue from groundfish. We hypothesize that traditional fish stocks would bounce back due to a multispecies approach, taking pressure away from groundfish stocks. The underlying assumption in this scenario is that the factory would attract a number of fishermen willing to retrofit their boat for harvesting pelagics. By retrofitting a number of groundfish trawlers into pelagics trawlers, we assume to take pressure away from groundfish stocks. This assumption does not hold however, if the retrofitted trawlers are replaced by other groundfish trawlers. Using the reference mode as "concept" board, we formulize the following problem statement in discussions with the client group:

The decline of traditional fish species and the curtailing of fishing efforts by the Government require the fishing industry of Gloucester to identify alternative resources to sustain their industry…

…A Surimi factory – harvesting fast renewable fish stock – might compensate for the missing revenues from traditional white fish until their stock returns to a sustainable level…

After the first two workshops with the client group, we were able to identify the key variables, determine the boundaries and scope of the project, and agreed on the problem statement, following the first stage in the standard method. The whole modeling group moved rapidly in the first stage of the project, because the role of the main contact person and the group structure was well defined right at the beginning, an important factor in group modeling interventions, which is also emphasized by Richardson et al. (1992), and Richardson and Andersen (1995).

Stage 2: Momentum Policies

Hines (2001) summarizes the benefits of recording momentum policies as following:

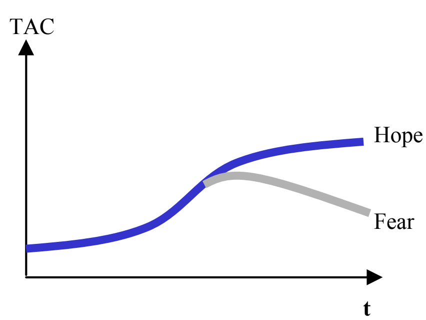
Momentum policies clarify for the client what solutions are currently implemented, being implemented or simply "in the air". The modeler will learn more about the concern if he or she understands how people are thinking of solving it. Momentum policies may also help to create dynamic hypotheses, because each momentum policy is implicitly based on a dynamic hypothesis. Recording momentum policies will provide the team with a mile- maker for judging how far the team and the client travel during the project.

Because the project was in a very early stage, recording momentum policies was difficult. The client group was not able to formulate policies for immediate implementation. However, we discussed a number of possible momentum policies related to the build-up of the Surimi factory. For example, resource constraints to use the factory to compensate for declining revenues from white fish, and extending the capabilities of the factory in converting fish leftovers in byproducts such as oil for the pharmaceutical industry. We used the outcome of these discussions in formulating the dynamic hypothesis rather then recording individual momentum policies.

Stage 3: Dynamic Hypothesis

The primary purpose of a dynamic hypothesis is an explanation for the reference mode (not solutions), including a structure and an expected behavior pattern, while making the assumptions explicit. In that sense, dynamic hypothesis are theories that a certain structure or process could contribute to certain behavior patterns (Hines 2000). Based on the information we gathered in the first two stages of the project, we formulated a number of dynamic hypothesis, which we presented to the client group.

We were astonished how easy those concept modes communicated, even for people who never before have been exposed to causal loops or similar types of diagramming techniques. The client group was immediately involved in what we assumed was going on in the system and was able to articulate agreement or disagreement of the structure and expected behavior. The conceptualization of the dynamic hypotheses was en emergent process and not only helped to define the clusters of hope and fears but also to discuss and reevaluate the boundaries for the project. From a list of eight dynamic hypotheses, which we discussed with the client, we identified the following two (fig. 4 and fig. 5) as most relevant to capture the structure and behavior of the system.



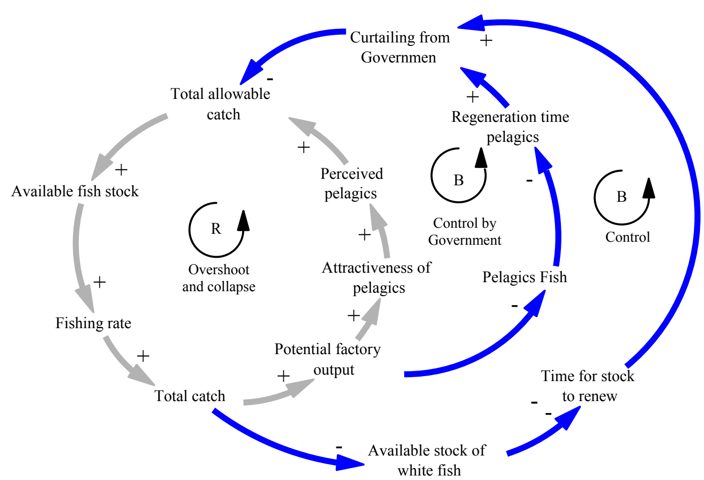


Figure 4: Dynamic Hypothesis "Control and Utilization"

The dynamic hypothesis shown in figure 4 captures the influence from the control and overutilization loops on the number of "total allowable catch" (TAC) provided by the government. The reinforcing loop "overshoot and collapse" contributes to the decay, or the fear scenario, whereas the two balancing "control" loops stabilize the system, indicated with the hope scenario in our graph over time. Thus our hypothesis states that without control from the government, the fish stock could deplete due to an increased attractiveness for pelagics and less available white- or groundfish. The underlying assumption from the hypothesis suggests that the sustainability of the system is maintained by the government and not because of self-control from the fishing industry.

The dynamic hypothesis shown in figure 5 was used to capture the dynamics of the variable "community quality of living", a term which the client used to relate the impact of the Surimi factory to the quality of the fishing community in Gloucester. This variable does have multiple facets of quality for the community, like creating or keeping jobs in the fishing industry, generating revenues, and enable Gloucester to remain what is was; an important fishing port in the USA.

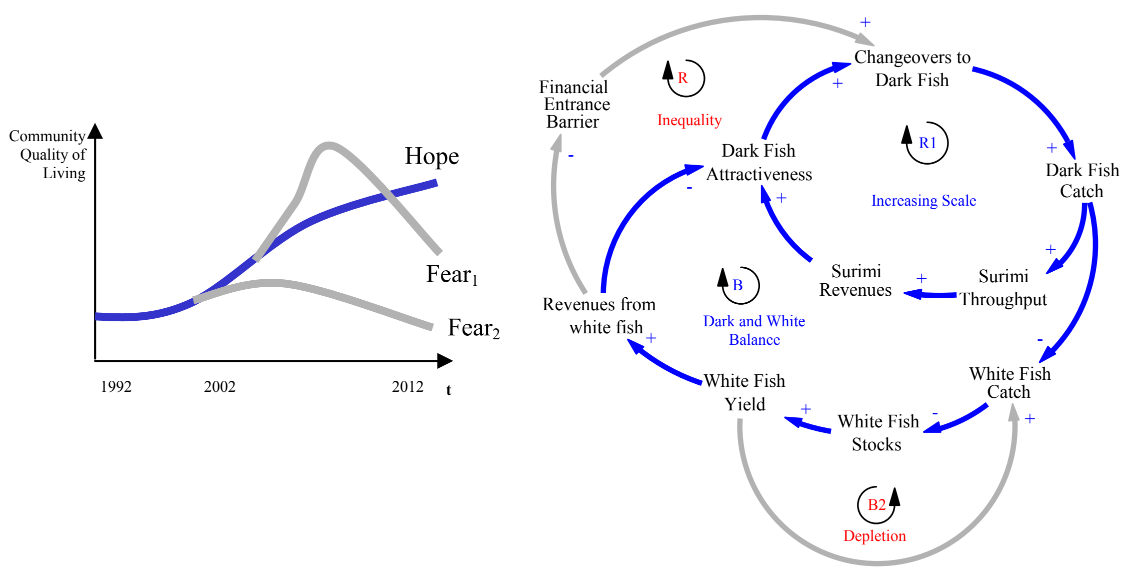


Figure 5: Dynamic Hypothesis "Community Quality of Living"

In this hypothesis it was the total revenues on the right that contributed to the community quality of living[1]. The hope scenario assumes that there are enough renewable resources

[1] The variable as defined in the vertical axis on the reference mode should coincide (in name and meaning) with one of the variables of the causal diagram. This is essential for hypothesis testing. Here we show our exact "script", which shows that we were not fully accurate.

in the ecosystem (both white and dark fish) to make reinvestment in plant and to create rising stability, which reinforces the "quality of community living". As noted before, the factory would also act as an "incubator" to facilitate research in new fish process technologies. Thus reinvestment in factory enables funding of these research activities, which results in rising stability. The behavior of the slope "fear1" suggests that the factory could have too much success, where increasing revenues result in increasing competition from other fishing communities, which could lead to fish stock depletion and or unequal/unfair profits within the fishing community of Gloucester. With the "fear2" scenario, we hypothesize a delay in takeoff due to a lack of the FDA (Food and Drug Administration) approval, sales below expectation, or increased competition from other fishing ports along the North Atlantic cost.

In reflection, the process to formulate and discuss the dynamic hypotheses with the client helped the whole team to clear and consistent communicate of what the problematic and preferred behavior of the system could be. These scripts were also used to communicate with other stakeholders, e.g. NOAA, and to draw their attention to the important aspects and issues throughout the project. Finally we tested the hypotheses by building the loops. Especially failure of the test provides a rich source for generating insights. For instance balancing resources (the hope scenario) turns out to be extremely hard, because of the natural self-defeating disconnection between fishermen and regulator in combination with measurement delays: success of "adding an additional resource" naturally leads to seeking the limits of sustainability. This will be discussed later.

While numerous approaches exist within the systems thinking, soft systems, and system dynamics literatures for eliciting problem statements from groups (Lane 1993; Morecroft and Sterman 1994; Richardson et al. 1994), Hines' standard method focuses to sketch graphs over time of problematic and preferred behavior, following the classical tools suggested by Randers (1980) and Richardson and Pugh (1981).

Stage 4: Conceptualizing the Model

The standard method suggests conceptualizing the model structure of the system loop after loop. This approach is also emphasized by Andersen and Richardson (1997); beginning with a very simple picture of the system and add successive layers of complexity. After we conceptualized the dynamic hypotheses, we merged then into three sector causal loop diagrams, as shown in figure 6. We used those causal loop diagrams to discuss the model boundaries and scope for the project. After presenting the sector causal loop diagrams to our client group, we realized that (a) we exceeded the level of comprehension for a group modeling environment and (b) pushed the system boundaries too far.

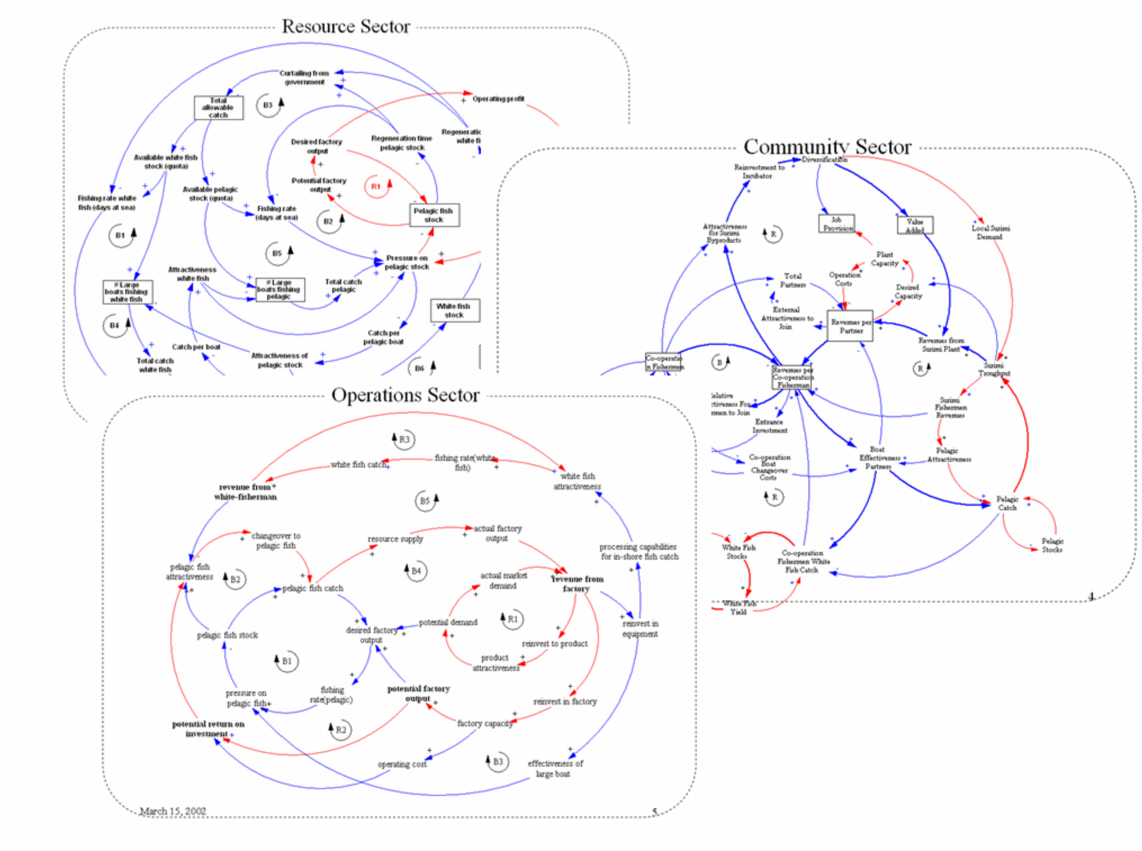


Figure 6: Sector Causal Feedback Loops - Spaghetti's

At this point in the project, we went back to the reference mode and the dynamic hypotheses to re-focus the boundaries of the project. Before we drew any new causal loop diagrams, we discussed the scope of the project at an aggregated level with our client one more time extensively. The diagram shown in figure 7 was used in discussion with the client group to reflect what we considered as project scope and to get agreement for the indicated model boundaries.

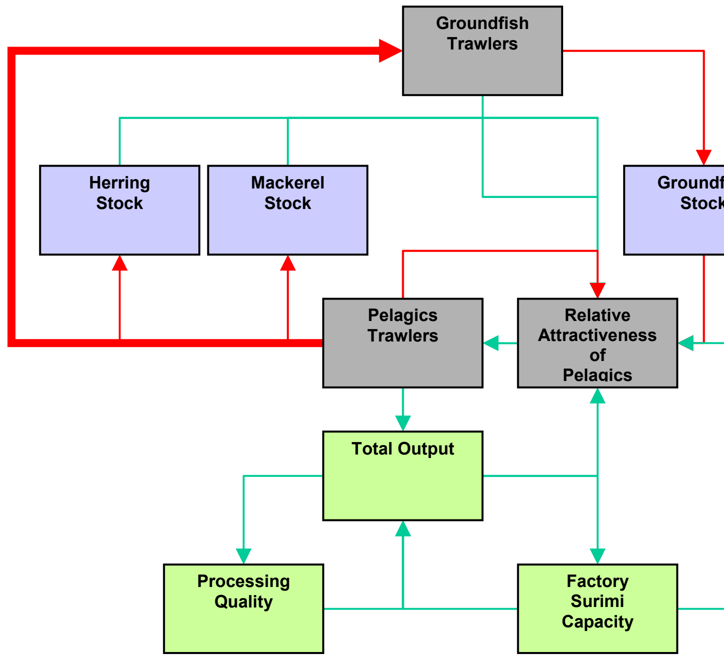


Figure 7: Scope and Model Structure

Figure 7 shows the suggested scope of the project and the model structure, which is composed of nine modules: 1) Processing quality of Surimi, which could differ depending on the composition of biomass, 2) Factory capacity, initially adjusted to 10,000 MT output per year, 3) Total Output, which it the actual output of the factory per year, 4) Pelagics Trawlers, as number of boats used for catching the necessary quantity of fish for the factory, 5) Relative attractiveness of pelagics, 6) Groundfish stock, which includes primarily white fish, 7) Herring stock, 8) Mackerel stock, and 9) Groundfish Trawlers, as a number of boats harvesting white fish (Inshore and offshore).

This script turned out to be quite useful in determine the system boundaries as well as lay out the ground for the model structure. Even without explicit feedback loops, the script capture the interrelation between variables and sectors, and provided a structure, which we used as framework to conceptualize the simulation model.

Stock and Flow Scripts

Before we presented first stock-and-flow diagrams to the client group, we introduced the methodologies of quantitative system dynamics simulation in very broad terms. We felt this short introduction was necessary to help the client understand the diagrams, which we presented in the meetings. Due to time constraints, we were not able to facilitate a group session in which we conceptualized the stock-and-flow diagrams together with the client group. However, we used simple model scripts to capture structural elements of the system, which we then discussed with the client and if necessary changed during the meeting. The starting point for the different stock-and-flow diagrams which we initially presented to the client, were based on the dynamic hypotheses. Because we already had agreement on the structure and expected behavior pattern of the sectors, conceptualizing the stock-and-flow diagrams was relatively easy. Form our dynamic hypotheses, we selected a first loop to conceptualize in a stock-and-flow model, which was central to the problem and easy to represent, and captures one of the major concern from the client. The picture below illustrates the level of detail with which we presented the stock-and-flow script to the client group.

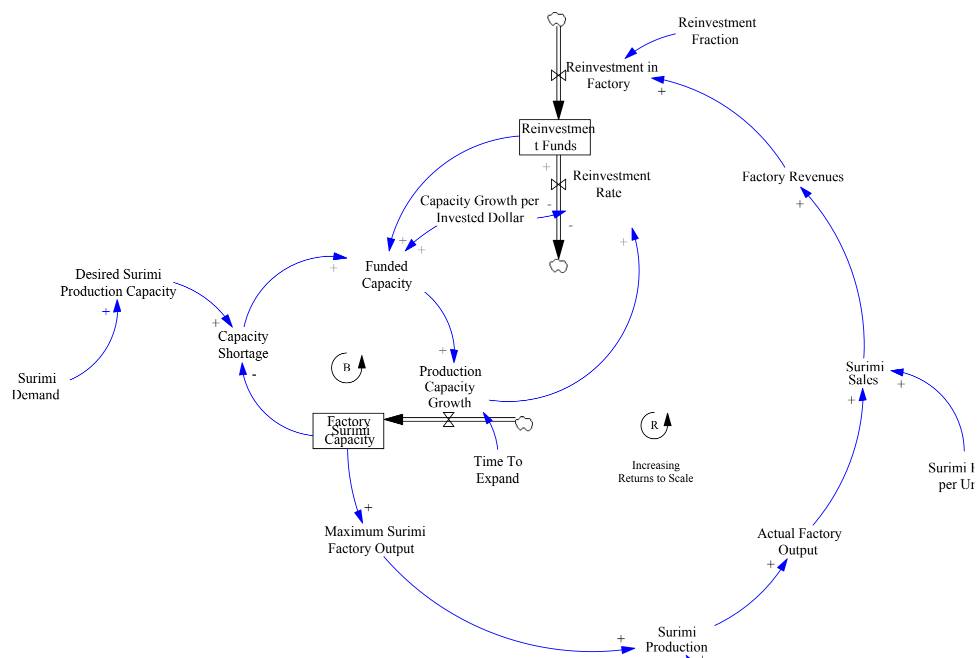


Figure 8: Stock-and-flow diagram

One argument for of using a direct and straightforward approach, presenting relatively detailed stock-and-flow diagram is time efficiency. The disadvantage is that this approach does not involve the client group in the detail conceptualization of the model structure. To choose either approach is not only a matter of time but also based on the level of previous exposure to quantitative methods in the client group. Because our client group consisted of experienced people in economics, control theory, and natural science, we felt confident to use the direct approach to sketch the model structure.

Quantitative Model, Mental Models and Client Engagement

While building a model is an exciting phase for a system dynamics practitioner, it is also the moment to lose ones' client. As soon as this process starts, there are great risks of divergence of mental models for several reasons: the client is less involved, operationalization changes level and form of representation and finally the mathematics is more abstract. In that case, a likely response after an intense and successful qualitative stage is purely confirmative validation – a self-defeating danger of a successful initial stage. Critical client discussions are as important during the simulation model building process and in the analysis stages.

While true importance depends on the ultimate purpose of the project, we (normally) want to refrain ourselves from selling an end product or just achieving buy-inn. Moreover, there are lots of direct learning opportunities for the client as well. How to keep the client engaged during this stage of the simulation building process, a process of specialization and thus separation, in the case that the client is not engaged in the actual building itself? How can we make sure to keep mental models in line, while remaining productive?

The standard method supports this crucial process by building up the model loop by loop (dynamic hypothesis by hypothesis). Each time a loop is added, behavior should be fully understood. All "surprises" marked down. After about 2 loops, the outcomes, "surprises" (and or insights) should be communicated to the client. In this gradual way the client learns along the process and in addition (not less important) mental model differences are resolved (and can generate new insights or work to be done).

On the other hand the 15 week course also implied serious time constraints, and this is where we could not fully follow the suggested path. Our approach resulted in the two intermediate communication topics. The first was centered on "assumption discussion" and the second involved a model behavior check on one specific sector. Both will be discussed in more detail below. While in reality those steps took place through a more iterative and emergent process, we will discuss them as two separate entities.

Assumption discussion

During the building process all assumptions and its sources had been carefully documented (i.e. beyond mathematical formulation). The parameters or relations that we considered most crucial for careful communication, were those that either contained high levels of uncertainty in their values (e.g. resource regeneration fraction, carrying capacities), had emotional load (e.g. “fisherman desired days at sea”), or yielded large implications for the dynamics (such as the table function relations as for yield per unit of effort, price elasticity to quality and fractional birth/ death rates).

The first of those three will be addressed in a subsequent section; the second class implied a careful process of selection and discussion and is something that comes up regularly in group model processes. Communicating on the last group is crucial not only for “validation purpose” (elicitation), but offers an opportunity for constructing sense of what the model dynamics can do, under specific assumptions.

After discussion of the role of a table function, and the relevance of shape versus quantitative values, several table functions (e.g. harvest yield per unit effort, fractional birth and death of fish, effect of investment on quality of product) were sketched through a “democratic group process”. Figure 9 shows a sample of charts that we used for discussing the shape of the table function. We drew the shapes of 7 different table functions (spread over the various sectors). As discussed in Ford and Sterman (1998), who address the issues of “knowledge elicitation”, we focused on the value at the extremes, some intermediate points, the transient shape and finished with fitting the estimates (i.e. ”drawing the derivatives”).

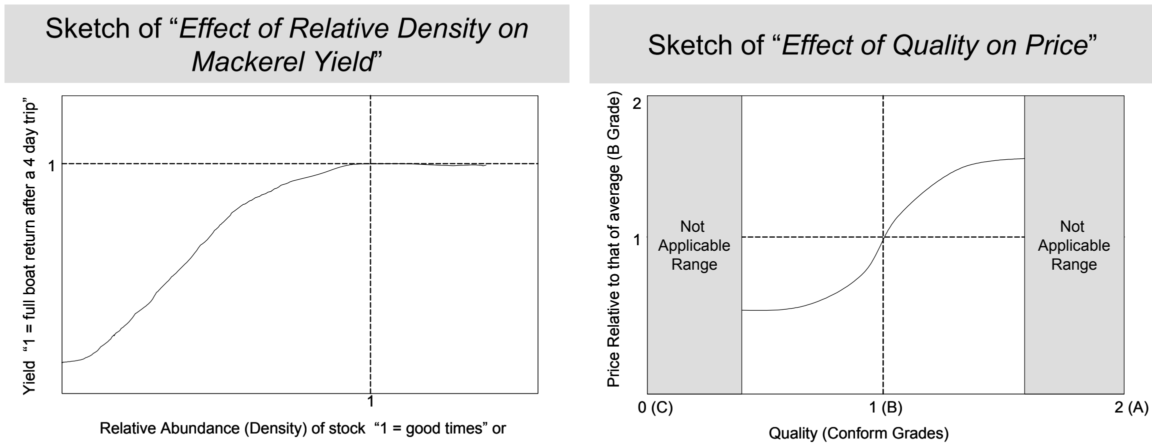


Figure 9: Script for Table Function (regenerated sketches)

While in the discussion of Ford and Sterman (1998) the emphasis was on "knowledge elicitation", for us the key objective really was on taking the mental model of the group one step further and bridging between qualitative dynamic hypotheses to that of quantitative model and model behavior.

We noticed that the active discussion on the role and shapes of table functions adds a lot of value to understanding the interrelation between structure and behavior. We also believe that this process was valuable as an investment for later stages, when model behavior was to be analyzed at group level. Because of time-constraints, we only discussed a few of those sketches, other table functions were presented to the client for validation only; we doubt that in these cases we obtained the necessary feedback as well as provided contributions to increased understanding for the group.

Analyzing model behavior – a sector

We choose to discuss one sector in detail with the group, what became the resource sector, since it was tangible in terms of central loops. In addition, especially from the clients' perspective it contained a lot of "uncertainties" in terms of data, structure and the modeling process had revealed some key insights in these.

Since most uncertainty and doubts had emerged around this area, we involved an additional specialist group in the process, which also was a stakeholder in the process: the NOAA (National Oceanic and Atmospheric Administration). This meeting had various benefits: first it provided a valuable means for validation. Second it increased (positive) contacts and understanding among Gloucester community and a key stakeholder / actor in the system. Finally, it was an excellent trust-builder for the model (as concept).

Discussion of the model dynamics was centered initially around one simple stock-and-flow diagram, its core assumptions, its behavioral implications and interpretation of it (figure 10). Throughout the project, concerns had been raised on the uncertainties about specific parameter values, to which our response was the relatively little importance when focusing on behavior patterns. However, we feel that only after this phase this insight was shared among the group.

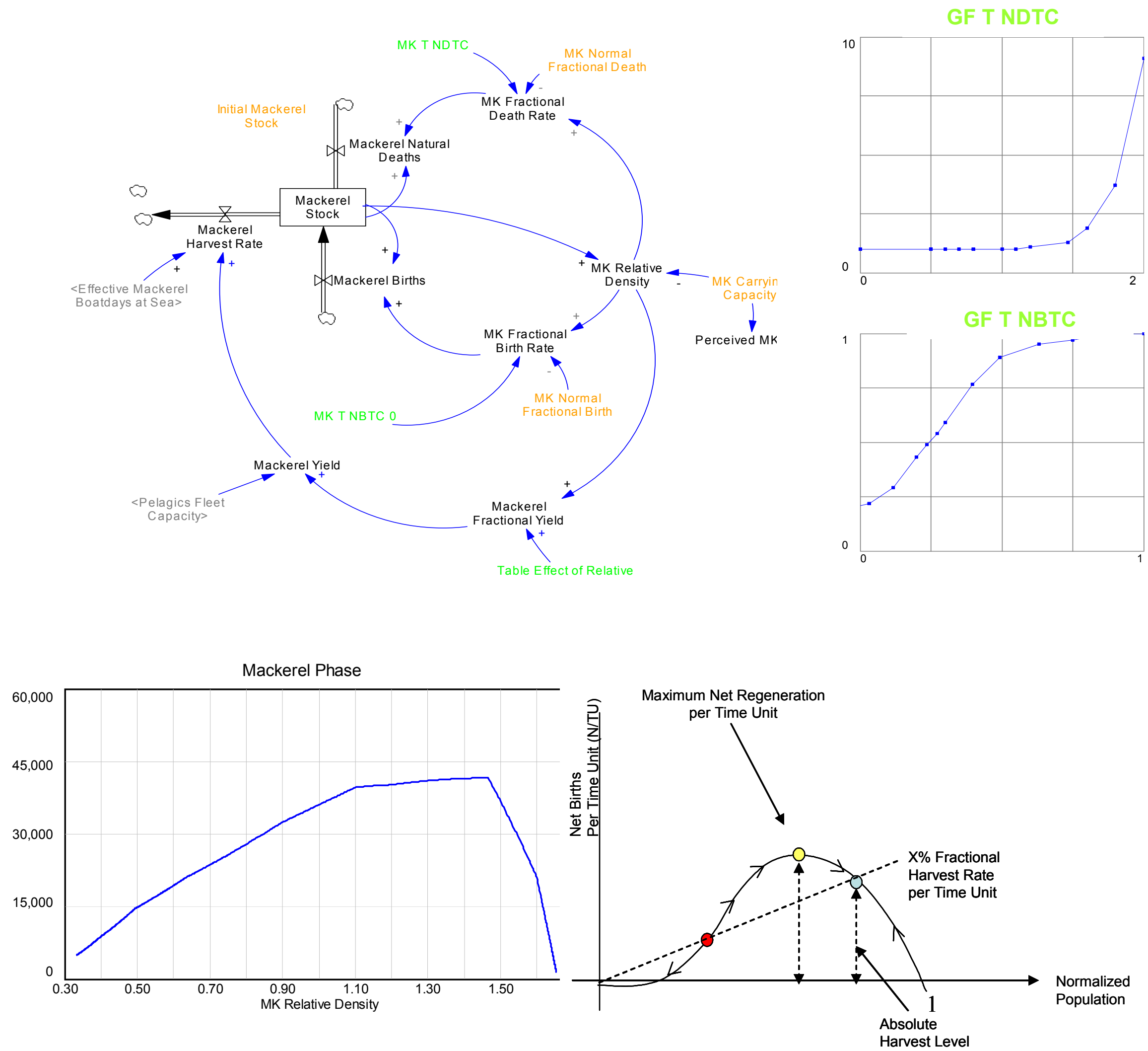


Figure 10: Sample of level of detail for discussion: Basic Structure, Table Functions, Dynamics and Explaining Dynamics

Yet, while we always emphasized that the process was about insights and generating a common perspective on the problem to enhance discussion, it had probably not always been clear to the participants what that meant and the attitude had mainly been dispersed around one of "healthy benefit of the doubt skepticism". From this time on, however, when the numbers began to play, and the generated patterns were confirmed by the audience and third parties, the atmosphere seemed to have switched to "wildly enthusiastic" and "quantitative truth teller". Here our role as moderators of the process was extremely important, to emphasize the qualitative results, rather than the quantitative.

Results of the simulation effort

The project started with a diverse client group with an ill defined problem statement. Given the complexity of the problem, the quantitative analysis contributed enormously to the qualitative level of understanding. Central in this is the criticality of the relative values of regeneration parameters, non-linearity therein and its relation to factory and market response times as well as scale. Throughout the process, the separate steps each had their independent contribution. However, we think, the understanding generated, would not have been possible with detailed involvement of the client during the whole process. In addition, the trust in the analysis would not have been sufficient. The next step for the team is to bring these qualitative understandings under the light for a wider audience.

Discussion and reflection

The following discussion is based on our observation and lessons learned from the outcome of the group modeling intervention for the Gloucester Community Development Cooperation. Our insights and conclusions are based on only one case where we applied the "standard method" thus, we have no empirical evidence that the results of using this method would differ from applying another approach for a group model building initiative.

We believe that the method we applied in our group model building project provides enough explicit procedural steps to guide a team through the different phases of elicitation and model conceptualization. The scripts helped us to communicate with our client and stakeholders throughout the different phases of conceptualization and simulation. We were able to visualize a complex system in an easy understandable way, using causal loop diagrams, and graphs over time.

Based on our observations from using the “standard method” we would argue that the initial stage of the process and in particular the use of dynamic hypotheses together with “hope and fear” scenarios, results in making the system structure and expected behavior pattern more explicit than a reference mode. We have used a reference mode to help define a problem statement and then used dynamic hypotheses to capture the expected hope and fear behavior of the system. In combining the dynamic hypothesis with the hope and fear mode of the system in one script, the client group was able to articulate their interpretation of the system behavior and challenged the assumptions from the expected hope and fear modes. These scripts easily communicated with stakeholders and proofed to be a valuable tool throughout the initial stage of the project. The group model intervention helped the client to gain insights into the dynamics of the relationship between fishermen, the community and pelagics fish stocks. Using causal loop diagrams and dynamic hypotheses improved our understanding into the dynamic behavior of the system in the first stages of the group model building intervention, even without a running simulation model.

The project also raises the issue on when and how to formulate the system boundary, in the case of a “messy problem”. Strictly following the loop-by-loop “standard method” implies keeping flexibility high to make use of insights gained and knowledge acquired along the process. This results in a late formulation of the boundary. Although we definitely benefited from this perspective in our project, we also felt the need for some structure along the way. This resulted for example in the “indicated project scope” as shown in figure 7.

The experience we have gained from applying the “standard method” in a group modeling process, lead to the conclusion that (a) especially combining the dynamic hypothesis with a hope and fear scenario in one script provides not only a check for “meaningful and focused representation”, but directly provides an opportunity for client group and stakeholders to obtain important insights into the structure and behavior of the system, even before using the simulation model. This script, which can be subject to change, can be used throughout the process for different purposes and provides thus a very powerful addition to those normally used in group model building initiatives. And (b) while the framework of steps and processes guides the team through the process, a modeler still needs a certain amount of intuition to facilitate a group model initiative, as indicated in the literature (Andersen et al. 1997). Specifically, this flexible process on what to do when and how leaves room for intuition and thus, emphasizes the specific learning experience in a model building initiative. For us the most insightful phases were in the dynamic hypothesis formulation (which enabled us to go back identify the actual problem statement) and the modeling of the hypotheses that related to the "pelagics versus ground fish" dynamics. A critical condition for this is a client that is willing to learn from the steps, rather than from the conclusion.

In reflecting the experience we have gained from this case, we would argue that the strengths of the "standard method" in the context of group-model intervention with "clear-cut guidelines" is to leave more flexibility for intuition, as well as that it provides a unique script to visualize and test the expected behavior of the system by combining causal feedback loops with "hope and fear" reference modes.

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Back to the Top