

# Narrative-Driven Scenario Development

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## Introduction

Most scenarios have two components, a qualitative analysis – the *narrative* – and a quantitative analysis – the *numbers*. While it might seem surprising, the model employed in most scenarios is actually contained in both components, which compliment and support each other. The quantitative component is usually explicit, while the narrative component is usually implicit. The narrative component reflects the shared mental model of its authors. Such a combined narrative and numerical model is often preferable to a purely quantitative model when studying social systems. The challenge in scenario development is to combine narratives with formal mathematical analysis in a way that builds on the strengths of the two approaches.

## Start With the Narrative

There is more than one way to combine narratives with a formal analysis, which may be qualitative, quantitative, or both. In the approach described in this note, the narrative drives scenario development, with the formal analysis largely responding to the narrative development. However, the process is not all one-way, as the formal analysis also informs the narrative scenario. There are four main roles that quantitative scenario development can play in this approach:

1. Force a clarification of terms and mechanisms.
2. Expose contradictions in mental models.
3. Provide a feel for the scope of possible outcomes within a narrative framework.
4. Illustrate a particular scenario narrative.
5. Make a study replicable, extensible and transferable.

The first two items provide direct feedback to the narrative team about the content of the scenarios. The first item, forcing the narrative team to clarify what it means, is always a good thing to do, and building a formal model (either qualitative or quantitative) is a particularly useful way in which to do it. When a narrative is translated into a formal structure, many potentially ambiguous points must be nailed down and key decisions must be made. This process sharpens the narrative analysis, as the narrative team is forced to address its ambiguous goals and statements.

The second item, exposing contradictions in mental models, highlights the role that scenarios play in fostering cognitive development and learning. People actively construct mental models through which they filter their experiences. The mental models they create are remarkably resilient, and are given up only when they are shown (repeatedly) to be inconsistent. Narratives reflect the mental models of their authors, and by translating them into formal terms, contradictions can be exposed. This benefit of formal scenario exercises often goes unnoticed, because generally when a formal model does succeed in changing the narrative team's mental model, it is not mentioned in the written report. There are at least two reasons for this. First, researchers do not report their conceptual errors—they report the understanding they achieve through their

research. Second, when someone's mental model changes, it is extraordinarily difficult to capture the original pattern of thought. Whatever the reason, it is too bad that the insights are not reported. Incorrect mental models are widely shared, and are likely to be held by many readers of the report. If they are not explicitly addressed, they are likely to persist.

The third item, that of providing a feel for the scope of possibilities within a narrative, offers indirect but generally very useful feedback to the narrative team. This is most often provided by a quantitative model. Even with the simplest formal models, the results from an exploratory exercise can be surprising. Something that was initially thought to be a severe constraint may turn out not to be so constraining, or not the main factor determining the evolution of the scenario; an undesired outcome may turn out to be avoidable only with heroic efforts; and a factor that is initially small may turn out to be surprisingly large by the end of the scenario period. Exploring the boundaries of the model can provide valuable insight to both the narrative writers and the model builders.

The next item, illustrating a particular scenario narrative, is generally provided by a formal quantitative analysis. It is an opportunity for the scenario developers to share their insights with others and invite external critique. The narrative, refined by interaction with the formal analysis, is finalized and disseminated, along with one or more quantitative illustrations of the scenarios. Ideally, these illustrations will be developed with the input of the narrative writing team through an exploration of the model boundaries.

The final item points out that a formal model structure (again, either qualitative or quantitative) can be reused. Potentially, this offers great advantages. By making the model explicit, it can be subjected to outside review. However, formal models should *not* be reused uncritically. In the approach described in this note, the narrative and modeling teams engage in a mutual critique. When a scenario model is reused, it should again be subjected to critique. One way to encourage this is to always start fresh, with a new set of narratives, but allow the modeling team to reuse an existing set of models if they seem appropriate for those narratives.

## The Modeling Team's Role

A modeling team or individual modeler can provide many services to a narrative team. To be most effective, the modeling team should be familiar with a number of qualitative and quantitative models and modeling approaches in several domains. It should also be familiar with major data sources and data-gathering techniques. Such knowledge is important not only in filling in initial data, but also in restraining the modeling team from attempting to create models that cannot be validated or initialized with existing data.

The principal role of the modeling team is to model a particular narrative. That is, the modeler should try to make one or more formal constructs that match the assumptions that support the narrative. For initial feedback to a narrative team, a qualitative model (e.g., a causal loop diagram) can be used. This is a diagrammatic representation of the main components of the system being studied and their interactions. If the narrative team is in agreement with the qualitative depiction of the system, then the modeling team can move forward with quantification, where appropriate. Some parts of the qualitative model may not be quantifiable, in which case they must remain in the narrative or present as exogenous assumptions. Other parts can be quantified either by constructing new models or by using previously developed models.

Any formal models and assumptions, including the quantitative models, should then be carefully checked by the narrative team and, if possible, by outside experts. This is time consuming, and places an extra burden on the modeling team, in that it must effectively communicate the model structure, but is crucial to the process of scenario development. If the narrative team does not feel confident in the results of the

quantitative analysis, it will weaken the final statement on the scenarios. Once the narrative team feels confident about the formal representation of the scenario narrative, then it can begin to explore the model boundaries. In the case of a quantitative model, they can do this directly, by putting in different input assumptions and examining the outputs.

The most interesting situation, from the modeler's standpoint, is when outputs from a reasonable, valid quantitative model nevertheless disagree with the narrative. In this case, the modeler has attempted to reproduce the model implicit in the narrative, has started with reasonable assumptions, and has found a result at odds with what the narrative team anticipated. When this happens, both the narrative analysis and the quantitative analysis should be carefully checked to understand where the discrepancy lies. This process can often lead to greater insight.

One recommendation with this approach is that wherever possible, the quantitative analysis should simply implement constraints, and give the narrative team enough "levers" that they can explore the implications of those constraints. Constraints on total available land, water, renewable energy production, etc., often turn out to be surprisingly strong or weak to a narrative-writing team. Moreover, quantitative models that focus are constraints are less controversial than other kinds of formal models, since they are built around a physical limit. In practice it is usually not sufficient to implement constraints alone, except for relatively simple single-sector analyses, but it is a good place to start when doing quantitative scenario analysis.

One potential difficulty with using a constraint-based model is that by themselves they are not predictive, and it is sometimes difficult for traditional modelers to accept this. After all, a key test of a model is its predictive power. Indeed, some would question whether a constraint-based model can properly be called a "model" at all. This is a debatable point, and perhaps a more neutral term, such as "framework" would be preferable. In any case, it is important to remember that the full scenario model lies in both the narrative and the quantitative analysis, and the combined narrative and numerical model should, indeed, be predictive.

## Summary

A scenario model lies in both the narrative and the numerical analysis. This is at odds with traditional modeling approaches, in which the model resides in the quantitative analysis. However, such combined models can often do better when analyzing social systems than a purely mathematical model. In the approach described in this note, the narrative drives the scenario development, while the formal analysis responds to the narrative. However, the response is the start of a dialogue, in which the narrative and modeling teams give each other mutual feedback as they learn about the system they are studying.