Table 2. RCA-based system dynamics modeling process for difficult problems

## 1. Problem Articulation

**A. Initial problem perception:** Study the large, vague, complicated problem. Develop an understanding of what the problem is and why it's a problem.

**B. Collect problem clarification data**: Collect the information required for the next step.

**C. Formal problem definition**: Define the problem using the standard format: Move system A under constraints B from present state C to goal state D by deadline E with confidence level F. Modify the format as necessary to fit the problem. This step defines the original subproblem.

## 2. Formulation of the Static Hypothesis

**A. Begin detailed data collection**: This continues throughout the process as necessary.

**B. Problem decomposition**: Decompose the one big problem into the standard subproblems for the problem type, plus additional subproblems as needed. Innovate as necessary.

**C. Social Force Diagrams**: Develop an SFD for each subproblem.

**D. Explanation of the Gestalt Whole**: Arrange the SFDs into a single high-level causal diagram, with optional feedback loops, that explains the problem as a cohesive whole.

## 3. Formulation of the Dynamic Hypothesis

**A. Subproblem structure**: Develop a causal loop diagram (CLD) for each subproblem, starting with its SFD and using the five substeps of analysis. The CLD must be endogenous and may be a hybrid with stocks.

**B. Whole problem structure**: Integrate the CLDs into a single high-level CLD.

**C. Additional mapping**: Supplement A and B with additional mapping tools as necessary to reach the point of a solid and clear foundation for the next step.

## 4. Formulation of a Simulation Model

**A. Construct the system dynamics model**: Build the model using the above artifacts as input, with emphasis on modeling the causes and leverage points identified on the SFDs. Behavior must arise endogenously from model structure.

**B. Qualitative behavior**: Tune the model to qualitatively behave realistically in terms of leverage point behavior. Estimation of parameters, equations, and structure is usually required at first, since not all data has been collected and the structure is evolving. Once you are satisfied the model has proper qualitative behavior and structure, move on to the next step.

**C. Quantitative behavior**: Determine which estimations must be based on real data, collect the data, then change and tune the model to use that to achieve sufficiently accurate behavior.

## 5. Theoretical Testing of the Low and High Leverage Points

Proceed as in the Sterman Testing step, except emphasis is on leverage point behavior. The reference mode occurs when present superficial solutions are applied. The model should be able to simulate the hypothesized behavior of the SFDs, including mode changes. The model is now theoretically rigorous, in that it reflects real world problem structure and behavior.

## 6. Policy Design and Evaluation

**A. Proceed as in Sterman**: Design policies to push on specific high leverage points.

**B. Empirical testing of solution elements**: In this additional step testing is done empirically in the real world, with laboratory experiments, field experiments, and pilot projects as necessary. This step ends when there is a high probability of solution success. The model and solutions are now theoretically and empirically rigorous, and can be said to be well engineered.

## 7. Solution Implementation

**A. Policy recommendation**: Recommended policies are presented and justified. The problem owner(s) has engaged in the process at many points up until now, so this should go well.

**B. Policy implementation**: The policies are translated to what the problem owner requires for implementation, approved, and then implemented. Due to process design, implementation should go smoothly, in an engineering-like manner with a minimum of surprise and solution adjustment, due to high predictability of how the system will respond.

## 8. Solution Learning

**A. Policy results monitoring**: How the system responds is monitored.

**B. Learning**: There will almost always be some deviation from solution behavior prediction in difficult problems. The monitoring data is evaluated and used to improve what was learned in any of the above steps. If others will use the same process or solutions, they are standardized and improved as more is learned.