Solution of the Production Management case (EN)

dr. Erik Pruyt

September 2012

1. (/8) Make a System Dynamics simulation model of this issue on your computer.

   /5 – Model: 4 stock-flow structures and rest of fbl structure

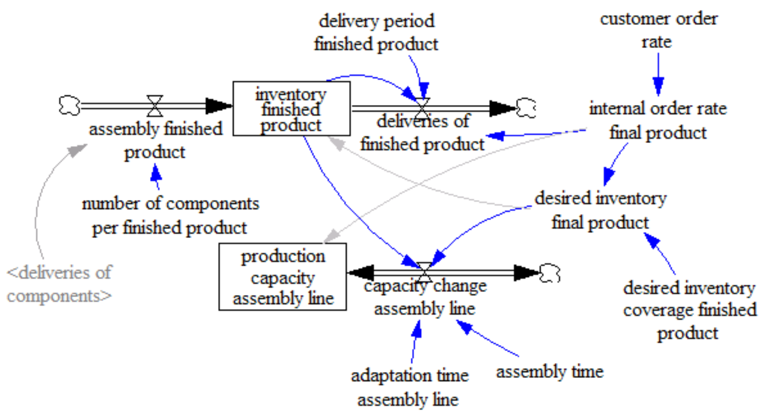
   /1 – Settings: time step, integration method, time horizon

   /1 – General specification: equations

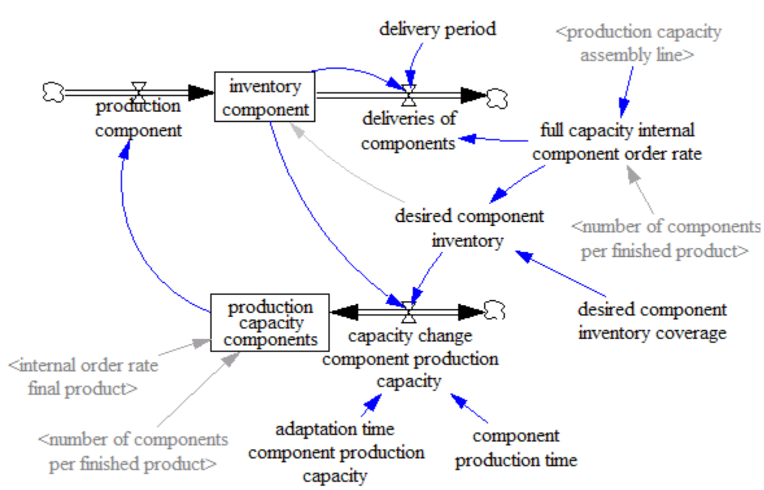
   /1 – Specific functions: 2 min function to protect the inventory outflows

   IN VENSIM:

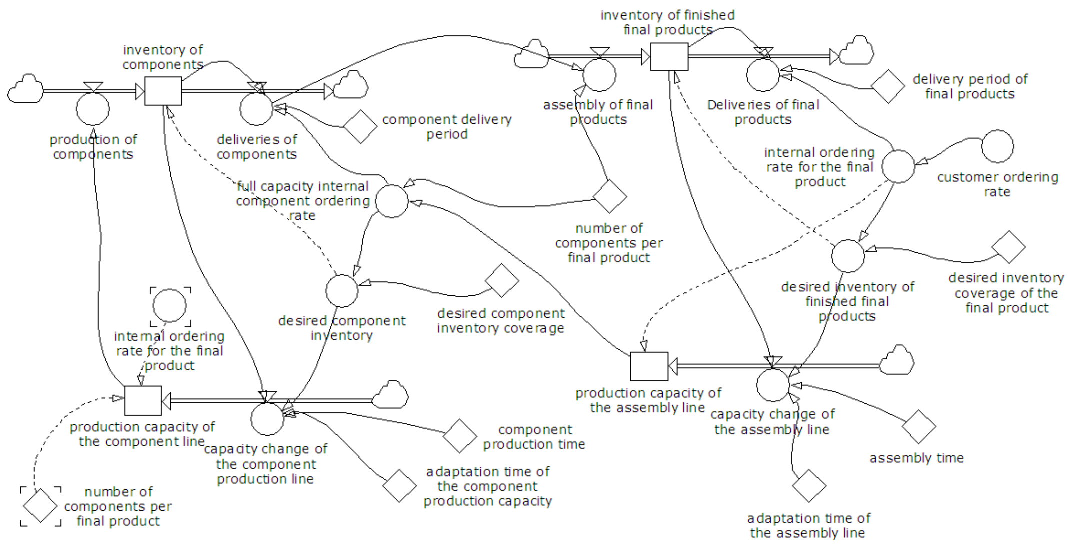
   Assembly of Finished Products:



   Production of Components:



IN POWERSIM:



2. (/2) Verify the model very briefly. Include formulas/code/structures that ensure that the *production of components* and the *assembly of final products* cannot become negative. Name 2 other variables necessarily need to be greater than or equal to 0 and explain why. (Do not necessarily 'protect' these variables, monitor them instead, and only protect them later on if really necessary.)

   /1 – Verification: Units

   /0.5 – Verification: Max functions?

   /0.5 – Name 2 other variables that need to be ≥ 0 & Explanation?

   The *production capacity of the component line* and the *production capacity of the assembly line* always need to be positive because negative *production capacity* simply does not exist in the real-world.

3. (/1) Simulate the model over 4 years. Is your model in equilibrium? **Yes, it should be! This is a rudimentary validation test…**

4. (/1) Now suppose that the *customer order rate* amounts to 11000 in weeks 5 until 10 (week 10 not included). Hint: you may for example use two step functions to model this temporary increase. Rename your model (use for example …`-disturbance`), model this temporary increase, and simulate your model.

   E.g. in Powersim: *customer ordering rate* = `10000<<unit/wk>>`

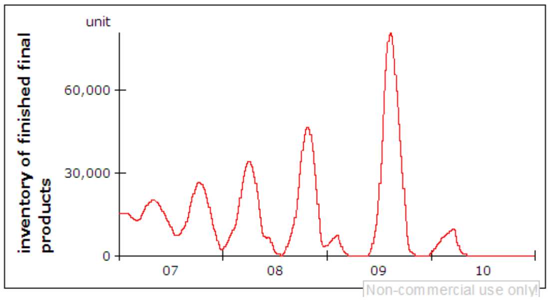
   `+ STEP(1000<<unit/wk>>,STARTTIME+5<<wk>>)`

   `- STEP(1000<<unit/wk>>,STARTTIME+10<<wk>>)`

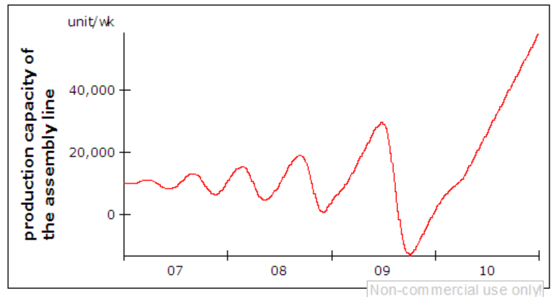
5. (/3) Make graphs for following variables: the *inventory of finished final products*, the *production capacity of the assembly line*, the *inventory of components*, the *production capacity of the component line*. Sketch them on this exam copy too.

6. (/1) Validate the model extremely briefly given this change. Check whether everything works fine. If not, describe the problems. Only adapt your model if absolutely necessary, that is to say, if the policy you propose below (in (10)) does not allow to solve the problem.

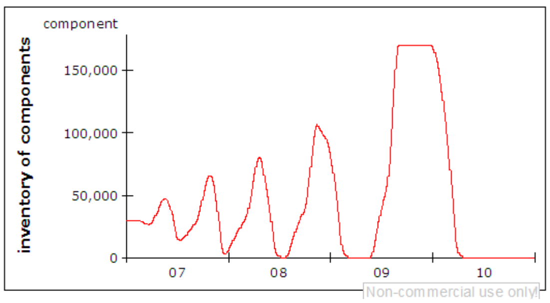
   The production capacity of the components becomes extremely negative (-500000) and the assembly capacity also becomes negative. That is impossible: the model



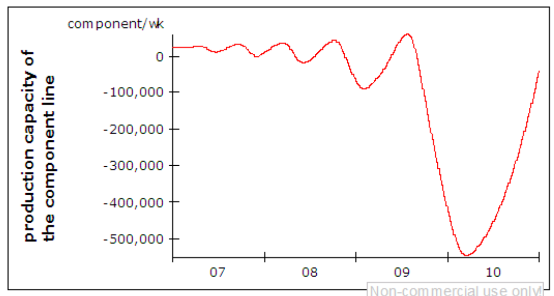
(a)



(b)



(c)



(d)

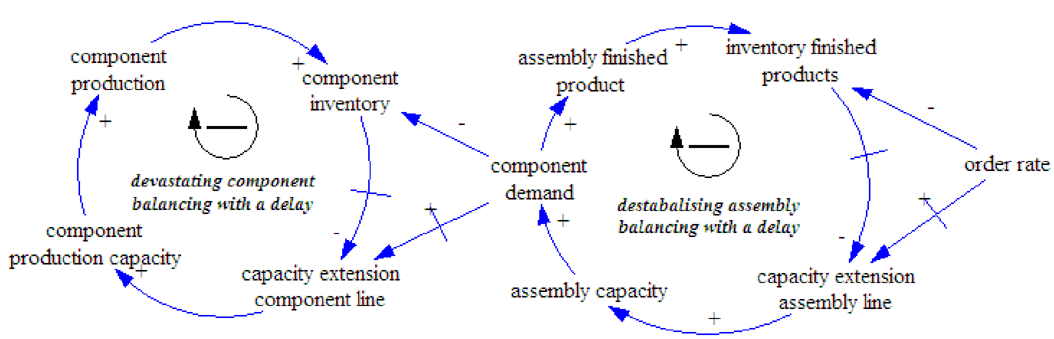
clearly generates behaviour that is impossible. However, the protection of the capacity variables is cumbersome and need not be done if a good policy is applied in (10). The purpose of the model was to reproduce the increasing fluctuations, which is successfully replicated!

7. (/4) Draw an extremely aggregate/simple *causal loop diagram* of the system to help you communicate (only) the main feedback effects responsible for the disruptive internal fluctuations.

   /2 – General diagram: names and link polarities

   /1 – Feedback Loops and Loop polarities

   /1 – Intelligently named loops



8. (/2) What is the real cause of these extreme internal fluctuations? Is it really caused by small external disturbances? If not, what causes these extreme internal fluctuations? In other words, explain the link between structure and behaviour.

   The small external disturbances are not the root cause of the extreme internal fluctuations. The explosive fluctuations are actually caused internally by detrimental policies related to information exchange and capacity balancing. The

component division does not receive the correct and timely information; they only receive delayed and already fluctuating information. The capacity extension policy might also have to be changed. The negative FBL with a delay turns disturbances into increased fluctuations, which are in turn increased in the balancing component FBL with delay.

9. (/3) Save your model under a different name (e.g. ...`-policy`). Change your model such that small external disturbances do not lead to extreme internal fluctuations. Briefly explain the changes you made to the model. Explain the policy briefly in words the manager would understand. Test the policy and sketch the resulting dynamics of the *inventory of finished products* and *inventory of components* on your exam sheet.

   /1 – Changes?

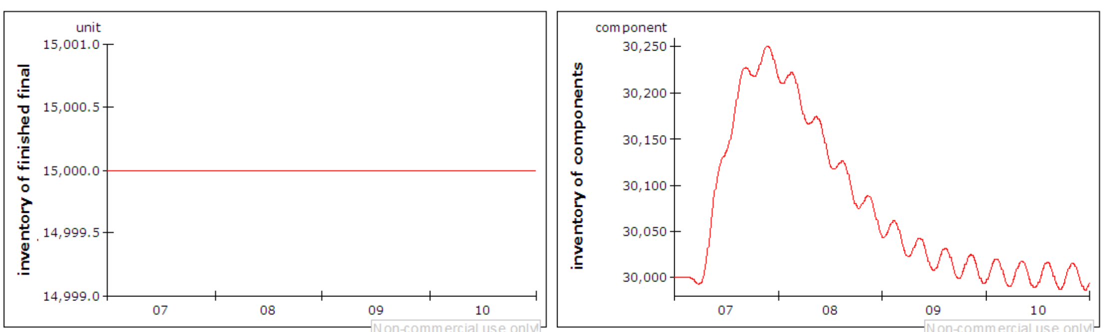
   /1 – Behaviour?

   /1 – Explanation?

   Possible changes:

   - Sending information related to the *internal ordering rate for the final product* directly to the component division.
   - The *internal ordering rate for the final product* might also smooth the *customer ordering rate.*
   - Capacity adaption policies might be changed too.

   That might lead for example to:



(a) (b)