SIMULATION MODELING APPLICATIONS IN THE HEALTHCARE INDUSTRY

or

Simulation – the art of drawing a dynamic picture of any issue that lives over time!
Conflicting perspectives in Healthcare

The "organisation" of Sweden

National / state level

County level

Community level

Elderly care

County level ⇒ responsibility for Healthcare

Politicians
- Majority
- Opposition

Ownership role (corporate governance)

Purchaser role (contractual governance)

Provider role ("production" of Healthcare)

Citizens, Patients

Hospitals
- "Public"
- Private

Medical centers, GPs

Boards

Different clinics, Different professions

"Public" "Public" Private Public..." on...

The Academy
The inflow to the healthcare system is a very heterogeneous one. The inflow partly lacks an upper limit – it increases as an effect of a more efficient system. The resources in the system are also very heterogeneous. Some of these resources are fought over by more than one mission, even though the individual processes per mission are different. This makes the planning – to get processes + resources to cooperate to handle a varying need – a major challenge. All this, together with the fact that healthcare involves many different organizations with separate agendas, makes the system extremely complex. A complex system can never be “optimized”, but only handled, prioritized, and balanced.
Decision taking in the Healthcare sector
(relating to operations, business, ... - NOT medicine and clinical decisions)

Healthcare

Many other industries

100% "non-rational"

100% rational

Therefore – especially in Healthcare:

How we utilize and look upon (the art of) dynamic simulation (modeling) – and the role simulation should take!

Value adding potential

Amount of relevant data available

Very simplified sketch of competence & culture

- Medicine
- Gen. Mgmt.
Value adding potential through simulation

More “non-rational values” are added through the model and simulations

Here the value added comes from that by capturing the essence of complex issues in one-and-the-same place (the model) and making this model “visual” (relating to both logic/system, relevant parameters, relevant result indicators, and animation of course of events), we are able to support and clearly raise the level of understanding, communication, discussions, and/or (thereby) decision-making!

“Rational value” is produced through the simulation(s)

Here the value added comes from that by stochastic modeling, considering a bigger picture, better breaking the system down in relevant components, ... the values of the output of the simulation is of better quality than what would be the alternative!

An evidence based approach is an option

To fully utilize the value-adding potential of dynamic simulation modeling, an approach where simulation is seen as a form of art, rather than “a method”, is needed – the art of drawing a dynamic picture of more or less any issue that lives over time!!
**Why simulation? – logic 1:** Simulation-Based Management (SBM)

SBM is no miracle cure that in all situations should be used. It represents an approach and a mindset that in many situations has a lot to offer though, during and before change initiatives – both on an operative and more strategic level, both when mapping/reviewing processes and when policy decisions are considered.
The NKS (New Karolinska Hospital) models, meta level, DES

- **Purpose:** To raise the understanding related to how well the objectives/visions for different organizational blocks fit together in an operational reality. When the first patients come in roughly five years time, to what extent will we get acceptable care for the billions invested? Is the system in balance and not just the budget ...?!  
- **System:** The care giving part of NKS (not research etc.)  
- **Stakeholders:** HSNf, NKSf (and indirectly others)  
- **Time frame:** Tight  
- **Simplifications etc.:**  
  - Focus on structure/building and its resources  
  - No limitations in personnel resources  
  - No breaking down of volumes per specialty, theme, clinic, ...  
- **Usage, results:** Usage quite wide, in many arenas. Results mainly qualitative – by packaging a complex and “infected” issue in the same place, visualizing this, and identifying the relevant dimensions, thereby clearly raising the level of understanding.  
- **Miscellaneous:** From a capacity perspective, the conclusions are a bit in the high end – since several important limitations have been disregarded. New version is being modeled!
Some reflections:

- Simulation can be “seductive” – a dilemma for good and for worse!
  - Visualization can – if one decides to – almost always put the issue on a “higher (more informative)” level than the alternatives
  - If the visualization is removed/reduced, one of the major objectives is often lost – to support understanding
  - And without the visualization, one often has a hard time convincing the stakeholders of that the various conclusions/results are correct/relevant – independent of quality!

- To mix detailed data with visions/forecasts
  - If relevant detailed data is available, this will of course not hurt the big picture analytically – but it might do this when it comes to expectations
  - Hypothetical ex.: \( A + B = ? \quad A = 7.198; \quad 5 \leq B \leq 11 \)
    - The answer is now not 15.198, but rather somewhere between 12.198 and 18.198!
  - There is a risk that the “exact value” creates a totally faulty level of expectations and a tendency to request “hard facts” (from data bases or elsewhere) to have something to “hold in the hand” when taking difficult decisions. It can be questioned whether this is so good.
Dependency between abstraction level and input characteristics for an issue

**High abstraction**
- Fewer details
- Macro level
- Strategic level

**Normal abstraction**
- Normal level of details
- Meso level
- Tactical level

**Low abstraction**
- More details
- Micro level
- Operative level

**Abstraction level**

- Data based on history etc. (“evidence”)
- Estimations, guesses, “visions” – and rather intervals than values

**Input characteristics**

**Risks with “wrong position”**

**Too “detailed” data**
1) In theory not wrong, but risks establishing faulty expectations and consume unnecessary time
2) Risks reducing an issue to a more mechanical “data mining” one instead of focusing on the essentials – the system, ...
3) Even if some input is “exact”, other input is almost inevitably not this in an abstract issue – so the exactness is more or less wasted!
4) Risks creating a focus on the existing (or historical) rather than the future – which the issue often is related to!

**Too “rough” data**
1) Results from a detailed model is “reduced” to the data level
2) Often the only feasible alternative for some input; does not have to be a problem if handled in a sensible way
“Practical system thinking”

Reality
Focus with a more system based thinking

System
Dimensions, Components, “Jigsaw pieces”

Dimensions, Components, “Jigsaw pieces”

Quantifiable data

INPUT

FORMULATED ISSUE

RELEVANT ASPECTS

PROBLEM IN REAL LIFE

Focus often currently

NUMBERS, VALUES
Evidence based? No, definitely not!!!

- **Level of “certainty”**
  - Faulty comparison to make – but unfortunately very common!
  - A well carried-out simulation project
  - Right comparison

- **The alternative**

Sometimes simulation (and other modeling-based methods) are called “the third science”
**Why simulation? – logic 2:**

Model – protected “jobshop”

THE MODEL

Simulation, Analysis

“Model world”

Reality

PROBLEM

(based on slide from XJ Technologies)

SOLUTION

Too expensive or impossible!
County of Stockholm – future needs for operations/surgery, macro level, ABM+DES

- **Purpose:** To raise the understanding related to how well different investment scenarios will handle different scenarios of need for operations/surgery

- **System:** The whole county

- **Stakeholders:** SLL (The county)/HSNf, (and indir. others)

- **Time frame:** Unclear – continuous support during long-term decision process

- **Simplifications etc.:** Focus on need – and different scenarios
  - Estimates of the various “capacities” of the major hospitals (model limited to the 8 major hospitals) will inevitably build on estimates by each hospital, and will thereby partly be subjective

- **Usage, results:** Usage so far non-existing! Logic/model “finished” since 1.5 years, but too “sensitive” to get restraint input from several hospitals. Model is therefore “hibernating”, to hopefully be used later on! The aim is to support some of the needs that will appear in the decision-taking process. The hope is that different scenarios – of investments, needs, … - will be better understood/evaluated over time. Under which time periods will **Demand** not be matched by **Availability** of capacity – given different change scenarios?
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(acc. to Michael C. Jackson, "Systems thinking")

Hard systems thinking, OR, Systems analysis/engineering, Optimization, ...
Why simulation? – logic 3:
Complement to static data analyses

Analytical models

Data/numbers + formulas, equations, algorithms, ...

Simulation based

Data/numbers + developments over Time
+ Dynamics (Variations)
+ Dynamics (Dependencies)
+ Processes/Resources
+ Decision logic

Animation of the big picture and course of events

Data/numbers are excellent when we look back, follow up, ...

When we look forward, change, improve, ... there often is a need for something more than just data/numbers, especially so in complex issues!

Conclusions, Understanding, ... about/related to the future

Conclusions, Understanding, ... about/related to the future
Pfizer model – comparing 2 treatment types, meso/micro level, DES

- **Purpose:** To sell - by raising the level of the discussion with potential customers! Stimulating discussions about not only the cost, but also what costs that will be saved!

- **System:** The treatment process(es) – or “care chain” from the patient’s perspective

- **Stakeholders:** Pfizer, the customer – and now county

- **Time frame:** Roughly 1 month

- **Simplifications etc.:**
  - Patients that can’t have alternative treatment are not processed – just counted
  - Staff scheduling etc. not modeled in any elaborate way (is in model not allowed to hinder the process)
  - The system/model is “objective” – but the values put into the parameters are subjective!

- **Usage, results:** Quite massive – at least by some individuals in marketing and sales. International interest – and wish to have similar models for other treatments/products. In the county of Stockholm, this model is used as inspiration for how we can evaluate new methods of treatment – to complement more traditional and static health economic models
The modeling process

Prerequisites

(Sub)Reality
+ Issue
- Purpose
- Abstraction level
- …
+ Stakeholders
+ Time, “deadline”

Choice of model type

Analytical / Mathematical

Simulation model
1) System dynamic
2) Agent based
3) Discrete event
4) Dynamic system
5) Manual
6) …

Modeling decision

• System definition
• Limitations
• Included “objects”
• Input / Output
• Degree of visualization
• Degree of interactivity
• # parallel users
• …

MODELING?

NO!

Other
Generic Emergency Dept. model, micro level, DES

- **Purpose:** To help evaluating capacity expectations, given different structural alternatives. To support investment discussions, to a little better know when it is motivated to build more – and not!

- **System:** The generic ED patient process – with “all” relevant variations, dependent on actual organization, style/preferences, circumstances etc.

- **Stakeholders:** The ones in charge of the facility decisions

- **Time frame:** No more than 1 month

- **Simplifications etc.:**
  - Layout is not considered – to make it generic
  - Staff is not divided into various roles (doctor, nurse, ...)

- **Usage, results:** Still not much – but has raised interest. Might soon be used in relation to a study trying to pinpoint the real need of CDU’s (Critical Decision Units) and Emergency Rooms in the future ED of NKS – but we start off with a mini model there
THANK YOU FOR YOUR ATTENTION !!!