

A case: Using System Dynamics and Simulation Gaming Modelling for Understanding and Learning about Socio-economic Systems

Andrii Miroshnychenko, co-head of Earth Citizens for Conscious Media, junior fellow of WAAS

Abstract

The purpose of this paper is to share the case of using the combination of system dynamics and simulation gaming methods for two purposes: studying and learning of complex socio-economic systems. In this article I explain the context of the case: Ukraine just after the Revolution of Dignity (spring 2014), before the Russian invasion has begun. This paper contains five main points: (1) system dynamics and simulation gaming are a good match; (2) roles help to organize the play; (3) experts bring the very important quality to the process; (4) our approach helps to achieve a relatively high level of analysis; (5) we recommend it for further implementation at various levels of decision-making.

Introduction

The history of combination of two modeling methods: system dynamics (SD) and simulation gaming (S&G) accounts for many years. The most successful applications were developed by John Sterman, Dennis Meadows (Meadows, 1989) and other colleagues. They are being widely used as learning tools and help to promote the results of complex modelling. One of the most recent studies was from the Simulation and Gaming journal that was fully dedicated to that. The main challenge identified was “that the greatest need for **future research** on system dynamics and its contribution to simulation-gaming is **demonstration of improvements in learning and performance**” (Davidsen & Spector, 2015).

In order to analyze the wide range of the possible variety of learning simulation games that have the SD tools in it I have composed a table (Table 1). On the left hand we have almost pure SD tools that are using the advantages of the software interfaces (like in Stella/Ithink or AnyLogic) where a user can turn on / off some parameters, input values for variables or choose in between the pre-constructed scenarios and then see how the behaviour of the system changes over time on one or several graphs. Usually such plays are facilitated by their creators and could be presented to a person or a group. Then the audience makes some “decisions” and can see the outcomes. Usually this is compared to some basic scenario – either “business as usual” or some “preliminary decision”. Then the audience might be presented with the structure in the form of stock and flow diagrams and main feedback loops that produce such a behaviour. The term “game” in such a case is rather an exaggeration but has its motivational attributes of cause (especially if we define the

game as the self-motivating activity – Kavtaradze, 2009). In many study-courses like those we teach it is a must to have such an interface and proper explanation together with it so that the user/client can use the benefits of the model and learn of it sometime even without digging into the model itself.

The second type would be the one promoted by Dennis Meadows and his colleagues (Meadows, 1989) when you have either a fully computerized environment or a game-board enabling the interaction in between the participants (if it is not a single player game) and the gaming environment that is producing its behaviour on the basis of system-dynamics model behind it. Then players usually have higher range of freedom behind their decisions and can observe the results of their decisions over time (usually 5 years and more). In such a case we use players as the model of social sub-system (or decision-making sub-system) of our model. This provides a lot of learning possibilities for understanding the policy-making mechanisms, tactics, strategy etc. There is lot of widely used games. Among them are: Fishbanks Ltd. (Meadows, Fiddeman, Shannon), Strategem (Meadows & Sterman, 1984), Beergame (Sterman, 2001) etc.

The third type is the gaming extreme. Those are closely related to the gaming and SD but have interactive elements in them and help the users to understand the system thinking principles. The main example is fairy tale / story. Linda Booth Sweeney (2008) has done a great job in collecting and publishing the folk tales that have been teaching the basis of system thinking since the ancient times. Linda has collected the stories from different cultures and put them together with very meaningful pictures. Thus it makes them possible to learn from for even rather small children, although the best way is for mutual adult-child learning, of course

The fourth type is proto-games or gaming exercises. There are many created by Dennis Meadows and Linda Booth Sweeney (2010) or many others involved in K-12 teaching (see Creative Learning Exchange web-site www.clexchange.org). All of them are easy to use without any computer either in class or outdoors. They are meant to learn in a group and explain some basic elements of system dynamics / system thinking like positive / negative feedback loops, delays, open / close systems, difference in between stocks/flows and many more.

The fifth type is right in the middle of this range. These are quite sophisticated simulation games that involve a lot of human interaction and either have the system-dynamics models as the basis of their structure / main logic and / or help the participants to develop their own model or adapt the existing one. So it is similar to the group model-building sessions (Rouwette et al., 2009) or community based participating modelling (Hovmand, 2014), but with more metaphors used. Also sometimes they do not include talking / learning about system dynamics during the game itself. But usually they do put emphasis on the systems and their behaviour at the debriefing sessions. An

example of it could be Coordination game about the counter-terrorist policy-making (Kavtaradze & Surin, 2005).

Type of game	“Playing” with robust SD models	Game play is supported by the SD model	Gaming prevails over SD environments	Proto-games (learning exercises)	Metaphoric exercises
Examples	Using interfaces for “playing” (World 3 etc)	Fishbanks, Strategem, Beergame etc	Playing for Ukraine, Coordination etc	System thinking Exercises (K12, Meadows & Sweeney)	System thinking tales (Sweeney)

Table 1. The variety of games in the SD / Gaming continuum

We give some examples of such combinations. They all are being used for both purposes: learning and studying. We put our approach in the middle of this range since it approaches the SD as one of the possible analytical tools but not the only one. We will elaborate on this type of games in the following section describing the case of **Playing for Ukraine** game.

Playing for Ukraine game

The aim of Playing for Ukraine game is to comprehend the complexities of the Ukrainian socio-economic and environmental systems. And the tools we use are from S&G and SD toolbox.

Historical Context

The game was developed in Spring 2014 just after the Revolution of Dignity in Ukraine. This is revolution was triggered by many factors but among the most important was the question of economic ties. Should Ukraine join the Association agreement with EU countries or should it become a part of economic union with Russia, Belorussia and Kazakhstan. There were many rumors and news reports stating how much Ukraine will loose after joining the Association agreement. But still the majority of people were really upset with the decision not to go for this agreement. So what we wanted to do was to explore what was the state of socio-economic and environmental systems of Ukraine and then study the possible wins and loses from either of economic unions. This knowledge was to transfer from multidisciplinary experts to the young activists with international and multiple backgrounds (NGOs, public administration, media, environmental studies).

We designed our game into a two-day workshop and had a break of one month in between each session. The break was used for the in-depth interviews with the main experts to properly prepare the settings of the next session. Each session lasts 8-10 hours with a coffee-breaks of course. The number of participants was 50+ in the first session and 30+ in the second one. There were 2-3 game-masters/moderators. The interviews on average lasted for 3-6 hours each.

A special thanks goes to Skip Cole (USA, expert in participative model building and gaming), Elisabeth Leigh (Australia, member of steering committee of the International Simulation and Gaming Association), Bohdan Hawrylyshyn (Switzerland-Ukraine, member of the Club of Rome), David I. Wheat (Norway, system-dynamics group) and Leonid Ivanenko (Ukraine, expert in the simulation games based on computer simulations and collective decision-making) who were consulting the author on how to design the game and its sessions in the most appropriate way.

Game-context

According to the briefing players are the representatives of a highly developed alien nation from far-away future. And they are members of the institution that seeks important historical periods to intervene and change them to a better way. This time they have chosen Ukraine just after the Revolution of Dignity.

The task is therefore to understand what is happening before actually coming to the place. There are several project-teams with a fixed role-structure. There are four roles. Each of the roles was associated with one of the main archetypes that are widely used in the cinema and fiction.

“Archetypes are recognizable patterns of human behavior. They vary slightly from culture to culture and era to era but always have certain basic things in common. It is these commonalities that make them resonate for audiences in every time and culture. Think of an archetype as a role into which an individual falls for a certain time, taking up those characteristics and living out that story: the trickster, the virgin huntress (noble tomboy), the abundant fertile mother, the martyr, the hero, and so on” (Smith, 2016).

1. **Master of the Game.** Archetype: Magician. Main group task: to give expertise to junior colleagues and help them to see the bigger picture. We had professors, ex-members of parliament, consultants and government agencies experts as the masters of the game;

2. **Space officer.** Archetype: Warrior. Main group task: to be a future leader i.e. to facilitate rather than command to the rest of the group members. Those were professional project managers / leaders;

3. **Psycho-sensual.** Archetype: Lover. Main group task: to ensure that each and every team-member feels satisfied and has the feeling of ownership of the decisions made. Those were

members of Bohdan Hawrylyshyn program “The Young Generation will Change Ukraine” (Choni, 2014);

4. **Piezo-kobzar** (musician). Archetype: Monk. Main group task: to maintain the high motivation of the group as the whole and each of the participants individually.

5. **System scientist**. Archetype: Scientist. Main group task: to facilitate the group-model building the form of the stock and flow diagrams. The participants were graduates of Erasmus Mundus System Dynamics Programme and current PhD and master students from Norwegian-Ukrainian program on teaching system-dynamics (Wheat et al., 2015).

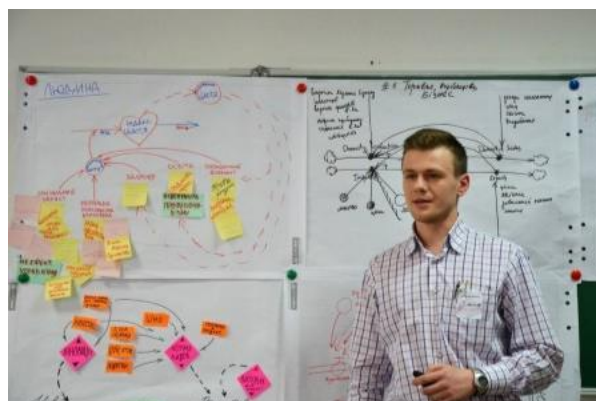
Additionally to their group tasks as well as **the main task** – to create kind of mental model that can be used for understanding of the issues.

Like in the group-model building approach we start from the creation of the list of problems in each of the groups (Hovmand et al., 2011), then we created the common list of them; then – cluster them. Then each of the teams picks up the cluster and models one or more of them. Then they present their “submodels” and try to link them to each other.

As the result of 1st session we came up with four main clusters:

1. Economic / Financial;
2. Environmental / Natural Resources;
3. Public administration / Governance;
4. Social / Happiness.

Each of them had a lot of issues included and some sort of mental model in the form of so-called stock and flow diagram. Why so-called? Well, one of the groups, working on the happiness issues decided to draw the main stock in the shape of the heart. And that was not the limit of the participants' imagination (see picture 1).



Picture 1. Final presentation of the submodels. The heart stock is in the upper left corner

That is the end of the 1st session.

Work with the experts

Then we worked with the experts on the each submodel and developed it further. We held individual in-depth interviews with 4 experts that were invited for the session. Each interview lasted for more than 4 hours. We were developing the original proposals of the teams. But in many cases we failed to follow their logic so we were actually creating a new model and preparing it for them to comprehend.

Those updated submodels then are linked to each other and used for the second session.

To combine the submodels (clusters) once again we use the approach described by Donella Meadows – the Leverage points and that goes beyond the SD modelling per se (Meadows D.H., 1997).

So we came up with the 3d model.

The bottom layer was representing the resources. We used a basic stock and flow diagram that was divided into three levels: administrative resources, financial resources and natural resources.

The middle layer was capturing the actors that were in charge of the resources from the first layer. Namely: oligarchs, middle class/small businessmen, officials/politicians.

The upper layer was representing the world of ideas: anthropocentrism, domination, and consumerism.

2nd Session

Second session was started with the presentation of this revised model.

The aim this time was to solve the problems that were set up during the first session and the in-depth interviews and to present the solutions at all 3 levels.

Economic / financial team:

- * Resource dependency;
- * Low labor productivity;
- * Low investments;
- * Technological gap;
- * Inability to become happy following consumerism

philosophy. Environmental team:

- * Scarcity of resources (they are non-renewable and will be over in 20-30 years);
- * High level of environmental footprint;
- * Nature is not a subject at the state's decision-making level.

Public administration / Governance team:

- * Ineffective governance;
- * Folk and nation are not subjects of the decision-making. Social / Happiness team:

- * Unequal distribution of the resources;
- * Limited access to the information on the state of the environment;

* Inability to become happy following consumerism philosophy (parallel discussion to the economic group).

This time the participants were free to choose their roles (despite the experts who play the masters of the game that was prescribed to the experts). And then once again they are free to choose the group or to move in between them.

This wide range of the freedom had led to a creation of a new group – combining people out of the already mentioned groups. This type of group is quite typical for games. And in general they give very valuable comments.

The groups were problem/solution based. But we were also asking them to gather in their “role” groups to discuss the progress/problems arising in the meanings and in fulfilling of their role-tasks. Also in such a way we were helping them to keep the flow of the overall modeling process.

After the group work teams presented their proposals placing them on the game field that was placed right in the middle of the room. First they put their SD structures. Then they were placing team-members to explain the new social structure and then – raising their ideas for the new paradigm.

Consequently all the people were connected by the rope – showing what social layers/structures are in charge of the social processes (picture 2).



Picture 2. Final group presentation. Ideas, resources, actors.

And then the 5th group entered the discussion and commented on the “new” ideas and

Structures presented by the other teams. In short, it appeared that:

(1) there is still social domination of one group over the rest (middle class over the oligarchs & statesmen);

(2) what was proposed as the prevailing economic ideas was just the economic policy used by totalitarian Germany;

(3) all the ideas proposed are still anthropocentric;

(4) yet there was too little efforts spent on the creation of multi-systems;

(5) the communication of different value groups is to be implemented through the help of facilitators but there is still a lack of such volunteers.

So they proposed to adopt the Concordia Nova philosophy that is to change the social order considerably.

1. Is based on the synarchy principles of plurality, universal wellbeing and non-domination;

2. Ensures the right and the freedom of the Concordians to choose and realize their own

way;

3. Provides and protects the legal personality status of Nature;

4. Provides the cooperative management of the Concordians' property and action-plans;

5. Protects the Concordians and their communities from any kind of domination:

either inner or outer (Bebeshko, 2014).

After this debriefing a special musical program was given by the traditional Ukrainian music player Taras Sylenko singing about the creation of the new world. How it was captured by our ancestors thousands of years ago The idea was to inspire the participants to go on with the new experience and to implement it in the decision-making sphere. And it worked. All the participants confirmed that this part was the peak of the session and has made the emotional impression lasting and meaningful.

Conclusions

1. The combination of system dynamics and simulation gaming with the domination of the last one works as an effective tool for learning and analytics. It also bears a high motivational capacity for its participants to continue using the insights from the game sessions and expand their knowledge about system dynamics and systems in general.

2. The use of a role-playing element is important for its organizational effects. Although some people who have insufficient gaming experience might be protective from the beginning, active involvement in the sessions together with sticking to the role description helps them to come

out with new insights and valuable contributions to the results of the session.

3. The involvement of the multidisciplinary experts in such settings might be highly productive. They do share their knowledge and comprehension with “junior” colleagues. Moreover, they produce complex ideas and shape them with the help of the game settings and other participants. These ideas in turn make the simulation process really rich, evolving and interesting. Most of them have managed to become opinion-leaders and thus forced the participants to follow their unusual / unconventional patterns of thinking and behaviour. That has enhanced the overall creativity and performance. As a result there were very important results to take-away for all the participants and organizers including the presentation of Concordia Nova philosophy that seems to address most of the problematic issues identified in the economic, administrative, environmental and social spheres.

4. The freedom usually associated with games together with the analytical power of system dynamics approach gives the possibility to reach the relatively high scope of understanding the systems. As it was pointed by Donella Meadows (1997) there are twelve leverage points to intervene into a system. And it seems that our approach provides the possibility to work at least partially with all of them. Having said that it is still a task to help the participants not too loose the attention concentrated on lower levels (feedback loops, parameters, information flows etc). Nonetheless both briefing and de-briefing sessions were organized in such a way that participants have to comprehend and comment on all the layers not only those they have been concerned with the most.

5. There is a big need to implement the results of such sessions. Though it could and should be supported by the learning and teaching. Learning about the best ways to involve the decision-makers into working/experimenting under similar settings. And teaching the students of different profiles how to approach complex tasks and benefit from multidisciplinary teams and experts as well as application of proper analysis methods like system dynamics.

List of References

- Bebeshko, T. (2014) *Vlada Protv Ladu (The Power vs Concordia Nova)*,
http://www.academia.edu/11118184/%D0%92%D0%BB%D0%B0%D0%B4%D0%B0_%D0%BF%D1%80%D0%BE%D1%82%D0%B8_%D0%9B%D0%B0%D0%B4%D1%83
- Choni, K. (2014) *The Young Generation Will Change Ukraine*,
<http://www.bradleyherald.org/2014/02/19/the-young-generation-will-change-ukraine/>
- Davidson, P.I., Spector J.M., (2015) Critical Reflections on System Dynamics and Simulation/Gaming in *Simulation Gaming* June-August 2015 vol. 46 no. 3-4 430-444

Hoppenbrouwers, S., Weigand, H., Rouwette, E. (2009) Setting rules of play for collaborative modeling in *International Journal of e-Collaboration (IJeC)* 5 (4), 37-52

Hovmand, P.S. et al. (2011) *Scriptapedia: A Handbook of Scripts for Developing Structured Group Model Building Sessions*,
<http://www.systemdynamics.org/conferences/2011/proceed/papers/P1404.pdf>

Hovmand, P.S. (2014) *Community Based System Dynamics*, Springer.

Kavtaradze, D.N., Surin, A.V. (2005) 2006 Paradoxes of Security: Limits of Effectiveness // *Security, Terrorism and privacy in Information Society. Proceedings of the Third International Security Conference*, Dusseldorf, 2005 Verlag GmbH & Co.KG Bielefeld, pp. 209-221

Kavtaradze, D.N. (2009) *Obuchenie I igra (Learning and Game)*, Prosveshchenie, Moscow

Meadows, D.H. (1997) *Places to Intervene in a System*, Whole Earth, Winter 1997,
https://center.sustainability.duke.edu/sites/default/files/documents/system_intervention.pdf

Meadows, D.L., Sterman, J. (1984) *Strategem-2: A Micro-computer Simulation Game of the Kondratiev Cycle*, <http://www.systemdynamics.org/conferences/1985/proceed/sterm878.pdf>

Meadows, D.L. (1989) Gaming to Implement System Dynamics Models in *Computer-Based Management of Complex Systems, Proceedings of the 1989 International Conference of the System Dynamics Society*, Stuttgart, July 10–14, 1989, pp 635-640.

Meadows, D.L., Fiddeman, T., Shannon, D. (2001) *Fish Banks, Ltd. A Micro-computer Assisted Group Simulation*

Meadows, D.L., Sweeney, L.B. (2010) *The Systems Thinking Playbook*, Chelsea Green Publishing Company

Smith, P.J. (2016) *Conscious Media: Part 4*, <https://www.writersstore.com/conscious-media-part-4/>

Sterman, J. (2001) *Business Dynamics*, McGraw-Hill, New York, 2000

Sweeney, L.B. (2008) *Connected Wisdom: Living Stories about Living Systems*,

Wheat, D.I., Stelmashenko, I., Lukianenko, I. (2015) *Learning Economics with Dynamic Modeling. A Norwegian-Ukrainian Collaboration Project*,
<http://www.systemdynamics.org/conferences/2015/papers/P1371.pdf>