

Program Review Report (Programsensorrappport) 2017:

Master's Degree in System Dynamics (Systemdynamik)

Department of Geography

External examiner: Hans Björnsson, Chalmers, Gothenburg, Sweden

Date: March 20, 2018

The Mission

The external examiner shall evaluate the scientific basis of the field of study and the study program. The quality should be assessed and compared to national and international standards. The evaluation should be based on data for a full calendar year.

Specifically, the examiner shall visit UiB once a year and during this visit

- *talk to students, faculty and program leaders*
- *evaluate study plans and syllabuses*
- *evaluate nature and level of a representative selection of course tests and answers*
- *evaluate the execution of the study program and the availability of resources*

This report is produced after my visit to UiB on March 20, 2018 and data refers to the 2017 calendar year. During the visit I met with faculty and a couple of students, studied new papers and theses, read other reviews of plans and projects, and reviewed the budget and plans for the system dynamics group.

I. About the field of study

Methods of systems thinking and system dynamics are increasingly applied to a wide range of management settings around the world, from business and management to public policy. System dynamics may best be explained as model-based studies and simulation of policies and strategies. The major problems faced today are often not bounded, but spans several disciplines. Consider current environmental and climate issues, innovation and technology development, demographics and migration, threats of pandemic diseases or changes as a result of new working conditions, automation, etc.. System dynamics is particularly well suited for the analysis of socio-technical systems, that is, systems in which human behavior plays an important role and in which people interact with physical and technical subsystems in a social and/or economic context. There is a general agreement among academics and practitioners that understanding complex systems and the ability to work effectively across disciplinary boundaries will be even more important in the decades to come. System dynamics is a robust field of study and the university should ensure that this is reflected in the educational policy. System dynamics expertise can serve as an engine to create new interdisciplinary research and study programs

There is a shortage of well-trained individuals in system dynamics at all levels (bachelors, masters and doctoral) and current programs are not enough to satisfy the demand from businesses and consultancies, government agencies, and other organizations. New programs are being started at universities around the world, but the shortage of academic experts in the field limits the opportunities. The system dynamics program in Bergen is the top program in the world. The number of courses offered, students examined, publications, and awards received is very impressive, especially considering the rather limited resources the program draws on. Although there is no undergraduate

degree offered in system dynamics, the group at UiB is well positioned to develop such a program which should be based on interactions with other disciplines (such as geography, economics and environmental sciences) at the university. The university should ensure that enough resources are available so that a top-quality, interdisciplinary undergraduate program can be developed.

II. The study programs/ existing and planned

The study programs 2017 are almost identical to the ones discussed in more detail in my 2015 and 2016 reports. The following is just a brief list of the programs, courses and international collaborations on education undertaken during the year.

- M Phil in System dynamics, 32 students
- Erasmus Mundus M Phil (European Master program in SD), 20 students
- M Phil in Modeling and visualization (with NTNU) (no students at UiB)
- Erasmus program in Economics with two Ukrainian universities
- Several seminars for the national banks of Ukraine and Lithuania
- Ph D program (with University of Palermo)
- Research Methods course for Ph D students
- MOOC¹ on Natural Resource Management (replaced earlier Experimental Methods in Social Systems, GEO/SD306) (with University of Iowa); more than 100 students
- MOOC Integrated Development Planning (with the Millenium Institute (NGO)); several national planners from a number of developing nations
- Platform has been developed on which several new MOOC programs can be offered. One such program is a planned learning environment on policies to cope with climate changes
- Planning of Nordic Master Program in System Dynamics with Islandic and Swedish universities.
- Plan for Bachelor degree program approved by administration, not yet implemented

The system dynamics group pioneered social science laboratory experiments in Norway. The group also pioneered the development of a new type of MOOCs. It is model based, fully interactive, based on recent advances in instructional psychology, and offers an online exam with advanced testing for cheating. Through funding from the PEK-program, the technology has been improved to a stage where professors can build MOOCs with little help of people with programming skills. The platform was developed in collaboration with the University of Iowa.

Another effort is to develop courses in hands-on model building. This takes place in collaboration with iSee Systems in New Hampshire. This company is now adding features to their market-leading simulator Stella to enable course developments.

In this context it is worth mentioning that the system dynamics group, in cooperation with Powersim Software, has developed an advanced optimization package for complex, non-linear, dynamic problems. As a consequence, the group was invited to write a chapter in a new book on Analytical Methods for Dynamic Modelers published by MIT Press. Today the group provides important input to the Stella Simulation language, the dominating system dynamics language.

The undergraduate program is ready to go as soon as permission is given and resources are approved. The program will be interdisciplinary and will benefit collaborating departments. It will likely increase the attraction of the system dynamics field among Norwegian students that otherwise do not have a natural introduction to the study area.

¹ A massive open online course (**MOOC**) is an online course aimed at unlimited participation and open access via the web.

The master programs

The curriculum for the master programs is discussed in detail in the 2015 report and in this document only updated numbers of students, student study results, and degrees will be provided.

Below is a summary of enrolment and results from the courses taught during 2017

Spring 2017 – Subjects taught spring semester 2017

| Subject | # of Students | | Average Grade | % distribution of grades | | | | |
|--|---------------|-----------|---------------|--------------------------|---|----|----|---|
| | Registered | Completed | | A | B | C | D | E |
| Policy Design and Implementation GEO-SD308 | 19 | 17 | B | 4 | 9 | 3 | 1 | 0 |
| Experimental Methods in Social Systems GEO-SD330 | 35 | 22 | C | 0 | 8 | 5 | 8 | 1 |
| Model-based Socioeconomic Planning GEO-SD321 | 33 | 23 | B | 6 | 6 | 10 | 11 | 0 |

Fall 2017 - Subjects taught fall semester 2017

| Subject | # of Students | | Average Grade | % distribution of grades | | | | |
|--|---------------|-----------|---------------|--------------------------|----|----|---|---|
| | Registered | Completed | | A | B | C | D | E |
| Fundamentals of Dynamic Social Systems GEO-SD302 | 67 | 56 | B | 11 | 21 | 15 | 7 | 2 |
| Model-based Analysis and Policy Design GEO-SD303 | 45 | 38 | B | 20 | 10 | 7 | 1 | 0 |
| System Dynamics Modelling Process GEO-SD304 | 68 | 59 | B | 19 | 22 | 14 | 2 | 2 |
| Spec Topics in System Dynamics, Policy GEO-SD322 | 21 | 18 | A | 14 | 2 | 2 | 0 | 0 |
| Special Topics in System Dynamic, Applications GEO-SD323 | 1 | 1 | A | 1 | 0 | 0 | 0 | 0 |

Degrees awarded

The number of advanced degrees awarded during 2017:

Master's (regular): 19

Master's (Erasmus-Mundus): 5

PhD: 2

The subjects of the two PhD degrees are worth noticing, especially from an interdisciplinary point of view:

“The Dynamics of Food Availability in Sub-Saharan Africa – An Endogenous Perspective on Food Production System” (Andreas Gerber)

“Intellectual property rights, economic growth, and the business cycle: A dynamic macroeconomic impact assessment study”

The master theses represent in the same way actual complex problem areas of socio-economic-environmental environments. They illustrate how system dynamics can be used to shed light on solutions to complex problems otherwise difficult to understand with traditional disciplinary methods.

III. The Students

The Bergen program has been successful in attracting highly qualified students from around the world. Students come, and continue to do so, from many countries around the globe. The interest is steadily growing which will continue to increase the competitiveness of available student slots. Notably however, is the low number of domestic students. There is no natural creation of awareness of the systems thinking/system dynamics field of study.

The students enter the master programs with various background, but all at least with an undergraduate degree, BSc or similar, in relevant fields. Students with a background in social sciences, including business administration and psychology, as well as natural sciences, including engineering, are eligible for admission. The Erasmus Mundus program attracts more than 100 applicants. How many will be accepted depends on the scholarships available from EU. UiB has the coordinating responsibility of the program that is one of the 13 programs of 44 applications that was awarded the status of Erasmus Mundus. The rejection fraction is high.

Currently 38 master thesis projects, representing 22 countries, are underway and several are in the final stages.

The PhD program is also highly international. Currently 17 PhD candidates are enrolled in the program. Two PhD degrees have been awarded 2017 and 3 or 4 new PhD degrees are imminent. Two new externally financed students are on their way in.

The creation of an undergraduate program, connected to other fields of study, would be a significant step forward. There is a great value in coupling undergraduate education with a robust graduate program. Students who learn about system dynamics as undergraduates are more likely to pursue advanced studies in the subject. The faculty of the program also has the ability to assess the capabilities of these students in depth before accepting them into graduate programs.

IV. The Faculty

The system dynamics program at the University of Bergen stands out as the top center of system dynamics in the world. The faculty, including Prof. Davidsen and Moxnes are leaders in the field and have won a variety of awards for their research and service to the field. These achievements were reported in an earlier review report. Dr. Kopinski is a newer faculty member with a special focus on engaging with stakeholders in the modeling processes of decision making in social-ecological environments. Professor Wheat retired in 2017 and has moved from Norway, but he continues part-time as the project leader for the collaborative projects in Ukraine and with University of North Dakota

The faculty members have taken leadership positions in the field, and have published important, prizewinning work, which has appeared in many top academic journals. Many of the doctoral

graduates have gone on to tenure-track positions in universities around the world. These Ph.D. graduates are among the emerging leaders of the field of system dynamics. The graduates of the master's program have taken positions in firms, consultancies, non-profit research organizations and government agencies. Several of the graduates of the program have won the Donella Meadows Award, presented annually at the International System Dynamics Conference for the best work by students.

As discussed at length in the 2017 review report, the faculty engage, in spite of its heavy teaching load, in several international collaborations.

The faculty is carrying a heavy work load and there is an imminent need for a faculty recruitment plan. Professor Davidsen and Moxnes are at the stage when it is necessary to start to plan for their replacement when they retire in a few years. Dr Kopainski, who replaced Professor David Wheat, will then, if no new faculty is recruited, be the only senior researcher in the program. **It is doubtful, to say the least, that the so successful program can continue under such a condition.** Professor Wheat's has moved from Norway, but continues as the project leader for the collaborative projects in Ukraine and with University of North Dakota.

The high work load of the current faculty is not sustainable. To remain a leader in the field the University needs to provide the program with new resources. Faculty in the field do not abound and the competition for most qualified are intense. The work load that currently leaves too limited time for research may render the program less attraction by young potential faculty that needs to build their CVs by doing research and not only do teaching. As a first step to facilitate this, the system dynamics program should be provided base financing. It is urgent to start the recruitment process for new faculty members. Replacing the two retiring members and possibly recruit one further new faculty will take time and search for its filling should begin immediately. It may take more than a year to find the right candidates for the positions.

V. Conclusions and recommendations

The System Dynamics program is a world class program with a reputation that serves University of Bergen well. The university has an opportunity to use the SD faculty to further its ambition of being a leading institution for interdisciplinary education and research. The demand for graduates with competence in systems thinking/system dynamics is growing which has been expressed by many not least in strategy documents of EU.

The most urgent issue has to do with the faculty that is soon retiring. **If recruitment of new faculty is not initiated in the very near future, the whole program is at risk.** To sustain the program for the future and to be able to educate more students, the program will need more faculty, base financing, and, over time, more administrative staff. To allow more students to take classes in system dynamics at the undergraduate level, it is important that the various departments at the University of Bergen allow their students to take a minimum of classes outside their own department.

The planned undergraduate program should be implemented jointly with several faculties. This would facilitate the recruitment of graduate students from Bergen and would also initiate interesting collaboration between disciplines.

In summary:

Great potential:

- Internally for interdisciplinary programs and research
- Great demand of graduates
- Leading the global field

- Many research opportunities

A prime resource at risk:

- Overextended faculty
- Lack of resources – add faculty and base financing
- Faculty recruitment plan urgent