

Program Review Report (Programsensorrappport) 2016:

**Master's Degree in System Dynamics (Systemdynamik)**  
**Department of Geography**

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- Section I: Overview and content**
- Section II: The study programs- existing and planned**
- Section III: The students**
- Section IV: The faculty**
- Section V: Conclusions and recommendations**

This report is summary and update of my last report from a year ago. After meeting with faculty and a couple of students, studying new papers and theses, taken part of other reviews, and reviewed the budget and plans for the system dynamics group, I have updated figures and added some comments based on my visit to the University of Bergen on January 23, 2017. Since most of my report issued January 2015 is still valid, I am attaching this report and only include updated figures and new observations in this document.

**I. Overview**

System dynamics is a robust and growing field of study. The number of corporations, government agencies, and other organizations applying system dynamics are growing. 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. 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. The university should ensure that this is reflected in the educational policy, and the 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 globe. The system dynamics program in Bergen is one of the top programs 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 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 2016 are almost identical to the ones discussed in more detail in my 2015 report. 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
- MOOC<sup>1</sup> 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.

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

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.

The master programs

The curriculum for the master programs is described 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 2016

Spring 2016 – Subjects taught spring semester 2016

Subject	# of Students		Average Grade	% distribution of grades					# of Fail ( F )
	Registered	Completed		A	B	C	D	E	
Policy Design and Implementation	43	37	B	12	20	5	0	0	0
Experimental Methods in Social Systems	58	45	B	4	12	15	12	2	0
Model-based Socioeconomic Planning	50	44	B	32	12	30	0	0	0

Fall 2014 - Subjects taught fall semester 2014

Subject	# of Students		Average Grade	% distribution of grades					# of Fail ( F )
	Registered	Completed		A	B	C	D	E	
Fundamentals of Dynamic Social Systems	60	51	B	19	18	6	6	2	1
Model-based Analysis and Policy Design	37	32	B	18	10			0	0
System Dynamics Modelling Process	45	41	A/B	10	21	9	1	0	0

The number of advanced degrees awarded during 2016:

Master's: 18

### **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 8 are in the final stages.

The PhD program is also highly international. Currently 16 PhD candidates are enrolled in the program. Close to two PhD degrees have been awarded during the past seven years and three new PhD degrees are imminent. Two new externally financed students are on their way in.

The creation of an undergraduate program will 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 one of the top centers of system dynamics in the world. The faculty, including Prof. Davidsen, Moxnes, and Wheat, 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 the 2017 review. Dr. Kopinski is a part-time faculty member who shares her time between Bergen and Zurich. She is financed by a five year stipend that expires in March 2017, but will be renewed pending an evaluation by ERC.

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. During 2016 a new agreement was made with the The Luc Hoffmann Institute, Switzerland. This institute (LHI) was established as a partner of WWF (World Wide Fund for Nature) to strengthen the connection between science, policy and practice. The agreement, that also involves the Department of Geography at UiB, establishes a long-term collaboration that will further the development and use of integrated systems models for policy formulation and evaluation in the field of conservation. This will involve the strengthening the competence in using system dynamics for conservation at the University of Bergen. UiB will provide

expertise and technical capacity on system dynamics research and modelling for selected projects that are of particular interest to The Luc Hoffmann Institute and WWF. A first grant has been awarded and the work began on a project within the framework of the agreement.

The faculty is carrying a heavy work load and there is an imminent need for a faculty recruitment plan. Professor Wheat is about to retire in September 2017 and Professor Davidsen and Moxnes are at the stage when it is necessary to start to plan for their replacement when they retire. Dr Kopainski's future is uncertain since her participation is based on "soft" money. Professor Wheat's position has been secured and is now advertised. He himself will move from Norway, but will continue as the project leader for the collaborative projects in Ukraine and with University of North Dakota.

The current work load is probably not sustainable and 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 the system dynamics program should be provided base financing. A new faculty position should also be offered and search for its filling should begin. It may take more than a year to find the right candidate for such a position.

## **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 aging. 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 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 a number of faculties. This would facilitate the recruitment of graduate students from Bergen and 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

## Appendix

# Report January 2015

### Content

- Section I: Overview and content
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### Appendices

## SECTION I—OVERVIEW AND CONTENT

### Background and Visit

Since its establishment in 1995 with the admission of its first graduate program, The System Dynamics' program development has been steady. A PhD program was initiated at the time of the Master program startup. From the start the programs were designed to be international. Since 2010 the educational programs include a European program (EMSD) founded and run with three European university partners. The various programs presently have a combined enrollment of about 60 students, with a diverse demographic and constitute one of, if not the, leading institution in its field in the world.

This report is the result of a two-day visit to the System Dynamics Group in Bergen and after having taken part of several documents about the program. The visit took place December 3.-4., 2014. During the visit I had discussions with all faculty members individually as well as a group. I also interviewed several master thesis students and two PhD students. Documents reviewed included curriculum documents, department programs, work load data, several master and PhD theses as well as research papers by the faculty.

### About System Dynamics as an academic discipline in Bergen and elsewhere

System dynamics is a “paradigm” and methodology for understanding and changing the behavior of systems. It is used by governments and corporations to formulate and analyze policies. The fast economic and technological development together with the global nature of most issues has made System Dynamics and “System Thinking” more important than ever.

System Dynamics is a model based analysis and policy design method. It centers around the development, analysis and use of formal computer models that:

1. Apply the accepted system dynamics theory of structure (endogenous behavior, positive and negative feedback loops, accumulations and delays, and representation of decision-making);
2. Are constructed following the scientific method (problem defined in terms of a reference mode of problem behavior, dynamic hypothesis as a theory of that behavior, formal computer model of the hypothesis, testing of the model/hypothesis against data, extensive analysis, and policy design); and
3. Use best practice tools and techniques (system dynamics software, units checking, standard formulations, generic models and building blocks, graphical functions, etc.).

System dynamics courses are taught at a growing number of universities throughout the world. However, only a small number of institutions offer graduate degree programs with substantial training in system dynamics. In most cases, the system dynamics curriculum is part of a larger curriculum in a school of, for example, Business or Public Policy, and the primary means of educational delivery beyond a few introductory courses is research mentorship with individual system dynamics faculty. In a few cases, the system dynamics curriculum is part of a larger “system sciences” program that covers a wide variety of different modeling approaches. The System Dynamics program in Bergen is one of the few programs in the world that offer substantial coursework and a graduate degree in System Dynamics. It is internationally unique in its comprehensive coverage of the field.

## **Section II**

### **THE STUDY PROGRAMS – EXISTING AND PLANNED**

#### **Degrees and curriculum**

The System Dynamics group offers two master programs in System Dynamics: an M.Phil. and a Joint European Master. There is no undergraduate program and students are recruited from a multitude of disciplines which makes the graduate programs truly interdisciplinary. The group also offers a PhD program in collaboration with University of Palermo.

#### ***Master's Programme (M.Phil)***

The two-year masters curriculum (120 ECTS credits) has as a goal to train students in the development and analysis of simulation models that represent the cause-and-effect structure of socio-economic systems, to derive their dynamics by way of simulation, and to investigate the relationship between the two. This combination of skills encourages collaboration and teamwork in daily decision-making as well as long-range planning.

The curriculum consists of six courses during the first year and a thesis during the second year. In addition, special topics courses are offered each semester. Each course consists of 36 lecture hours and about the same number of computer lab hours. All the courses require independent student modeling projects in the form of a variety of case studies. The six courses, in sequence, are:

*Principle of Dynamic Social Systems:* An introduction to SD in which students learn to observe behavior of dynamic systems and identify problems. Examples include global warming, unemployment, epidemics and price fluctuations. The students learn how to represent hypotheses for social and economic problems, and how to use simulation to understand why a certain, often problematic, behavior of a systems occur. They learn how policy decisions very often have unintended effects and how to apply the scientific method to socioeconomic problems.

*Model-based Analysis and Policy Design:* Deeper knowledge of the SD method. Emphasis is on the relationship that exists between structure and behavior of complex systems. A series of case studies from various domains are used to train students in how to recognize and investigate the dynamic properties of generic system structures. The students learn how to use casual loop diagrams, that represent their understanding of problems, to facilitate communication with stakeholders.

*System Dynamics Modeling Process:* A project-based course that develops the skills needed to build explanatory models of dynamic problems that emerge from real-world complex social and economic systems. Each student undertakes a six-week assignment modeling and experimenting with a specific dynamic problem. A list of recent student projects is appended to this report.

*Policy Design and Implementation:* Modeling and communicating policy options based on both the SD and public policy and management literature. Cost effectiveness is emphasized.

*Experimental Methods and Social systems:* Theory and methods for the design, programming, and analysis of laboratory experiments. The course includes optimization and provides links to more traditional scientific methods.

*Model-based Socioeconomic Planning:* An advanced course putting the students in the role of a strategic planning consultant to a developing country. A hypothetical country provides the setting for typical developmental issues such as poverty, high mortality, land degradation, and water scarcity. The students must make policy recommendations to the government.

*Thesis project:* The students study a socio-economic systems problem, often very large-scale, and develop a model that explains possible behaviors and explore different policy alternatives.

The assignments in the courses I have reviewed have a high degree of relevance to real life situations and problems. Overall, the students perform well as illustrated by the factual data exhibited later in this report. I have been the external examiner of several master theses in Bergen, and I have in all cases been very impressed. The volume and quality of the work as well as the scientific contributions have been far more than I think is required at academic institutions that I have served at in the US and in Sweden. In my judgement, the theses that I have read have the quality of licentiate theses at Swedish universities.

### ***Joint European Master's Programme in System Dynamics (EMSD)***

This program is a joint offering with Radboud University in the Netherlands, the University of Palermo in Italy, and the new University of Lisbon, Portugal. This is an EU-program and EU offers

stipends to both European students and students from other parts of the world. Students visit at least three of the four universities over a two-year period.

The program requires students to move between the participating universities. 60 ECTS total from the partner institutions other than the University of Bergen is in general required. The first semester is spent in Bergen, the second and third at either of the partner universities. The fourth semester (master's thesis) is spent at any of the four partner institutions.

Besides the three partners, there are a number of associated partners to the program. Among these are SUNY Albany (USA), University of North Dakota (USA), Kairo University (Egypt), National University of Colombia (Colombia), Universidad Estadual de Campinas (Brazil), and Talca University (Chile). Prospective partners include Bogazici (Turkey), University of Southampton (UK) and Malmö Högskola (Sweden).

This program recently underwent a certification process by EU. Out of a total of 44 programs, only 17 programs were deemed worthy of the status as an Erasmus Mundus Programme, - among them the EMSD program.

### **New Course Developments and planned degrees**

The faculty is continuously engaged in improving and further developing the program. An interesting development is underway in terms of a MOOC (massive Open Online Course) and the cooperation with faculty elsewhere in distance learning. Such examples include a course on Natural Resource Management, developed in cooperation with the University of Iowa (60 students), a SD/economics course in Virginia and the development of an economics learning program with Ukraine.

A new undergraduate program leading to a Bachelor's degree has been planned by the faculty. While the graduate program offers the students who enter the program - i.e. specialized scientific knowledge and skills in the use of the System Dynamics Method, the undergraduate program will provide both application domain knowledge and an introduction to the methods, techniques and tools of Systems Dynamics. The arguments for an undergraduate program are many. First, such a program would improve the possibility to recruit Norwegian graduate students. Today the student body is overwhelmingly international. Second, the need for students with ability to analyze and model complex problems is growing. Third, such an undergraduate program would require collaboration with other programs offered by several other departments making the degree program offer a true interdisciplinary experience and competence. A study plan has been developed and the degree program can be implemented immediately provided adequate resources are being allocated.

### **Course enrolments, Results and Degrees completed**

Below is a summary of enrolment and results from the courses taught during 2014. Detailed reports are attached to this report.

Spring 2014 – Subjects taught spring semester 2014

Subject	# of Students		Average Grade	% distribution of grades					# of Fail ( F )
	Registered	Completed		A	B	C	D	E	
Policy Design and Implementation	31	27	B	50	33	17	0	0	0
Experimental Methods in Social Systems	23	13	B	31	46	15	8	0	0
Model-based Socioeconomic Planning	38	27	B	41	30	30	0	0	0

Fall 2014 - Subjects taught fall semester 2014

Subject	# of Students		Average Grade	% distribution of grades					# of Fail ( F )
	Registered	Completed		A	B	C	D	E	
Fundamentals of Dynamic Social Systems	53	51	B	30	34	15	9	9	4
Model-based Analysis and Policy Design	26	23	B	13	48	26	13	0	0
System Dynamics Modelling Process	37	37	A/B	49	32	19	0	0	0

The number of advanced degrees awarded during 2014:

Master's: 18

### Section III

#### The students

The students are recruited on an international basis and the program has been successful in attracting students from all over the world. This is certainly the result of the reputation of the program and the network the faculty has built with colleagues on a global basis. The last five years' masters cohorts include students from 65 countries and PhD students come from 19 countries. One observation is that, while the programs are attractive internationally, very few Norwegian students choose to sign up for the program. One would have expected that a considerable percentage of a class would come from University of Bergen.

The admission fraction over the years has been fairly high. This is because a very restrictive admission policy has been in place both at the national, institutional and department (group) level. It has been required that students originate from collaborating institutions, have or are granted funding, and satisfy top level academic standards. As a consequence, many potential applicants have been discouraged from applying for admission to the program. The System Dynamics Group has relied on a network of academic relations targeting institutions and programmes that educate undergraduate students that are particularly well suited for the program in Bergen. In these institutions, full professors in the field have been consulted as part of the admission process. Among self-financed students, the rejection fraction is currently more than 60%.

The students enter the program 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 number of students enrolled in different courses varies since not all follows the full degree program, but spend shorter time to study specific course(s). Also, the number of students from partner universities varies depending on their individual study plans. About 40 to 60 students are accepted each year for the masters programs and 75 M Phil degrees has been awarded during the last five years.

Currently 15 master thesis projects are underway by students from 13 different countries. Only two of the projects are carried out by Norwegian students.

The Ph D program, also highly international with students from all corners of the globe, currently hosts 16 candidates enrolled. During the past twelve years 15 PhD degrees has been awarded, 12 of them during the last five years.

During my visit, I interviewed 3 first year master students, 4 second year students, and 2 PhD students who also served as teaching assistants. There was a unanimous opinion about the high quality of the program. They also expressed that the courses required a lot of work, but that sufficient attention from assistants and faculty was offered. Students are very involved in their learning and are challenged. Feedback is provided in both directions; from faculty to students and from students to faculty. Scholarship, creativity, curricular and instructional innovation are valued and supported. Several students expressed their concern for how hard the faculty worked and how they were always responding to questions around the hours.

The quality of the students in the System Dynamics Program, as I have experienced it from discussions and from reviewing assignments and theses is very high. As indicated above, the fraction of foreign students is high and most of these students come from well recognized academic institutions at which they have been informed about and prepared for the program in Bergen. This speaks for the quality reputation the program and its faculty enjoy internationally. The rigorous admission standard has paid off and contributes to the remarkably high student throughput and their grades.

## **Trends in student enrolment**

The long run trend in enrolment has been slightly upwards. This trend should be expected to continue and possibly to accelerate. The number of quota students is outside of the group's control and is most likely to remain fairly constant. Enrolment from developing countries could increase a lot due to the collaboration with the Millennium Institute and the interest shown by UNDP (see below). The enrolment of European and Norwegian students is likely to increase due to word of mouth effects.

## **Section IV**

### **The Faculty**

The System Dynamics master program was initially developed by Professor Pål Davidsen, a former student at UiB who returned to Bergen after having spent time at MIT as a visiting Scholar with Jay Forrester, the founder of System Dynamics. Initially the program was hosted by the Department of Information Sciences, but is now part of the Department of Geography within the Faculty of Social Sciences.

Currently the faculty consists of three tenured members: Professor Pål Davidsen, Professor Erling Moxnes, and Associate professor David Wheat. The faculty also includes s Senior Research fellow: Dr. Birgit Kopainski. The faculty enjoys a strong global reputation and are considered to be in the forefront of innovative research in the field.

Professor Pål Davidsen was recently the president of the System Dynamics Society, the recognized international (academic) society in this field. He has served as the Conference programme Chair twice. He is frequently lecturing at foreign universities and consulted by public organizations and scholarly work is very well known and often referred to. He currently serves as the Society's VP of Publications. He received the Distinguished Service Award in 2014.

Professor Erling Moxnes articles in the top scientific journals (such as Management Science) are also well known and often cited. He has received the prestigious Jay W. Forrester Award for the best publication over the last 5 years. He has served as the president of the System Dynamics Society and is currently Head of the Society's Award committee.

Professor David Wheat has an impressive record as consultant in both the public and private sector and his recent research work on the use of system dynamics in economics education is of high standard. He is currently the President of the Economics Chapter, a special interest group, of the System Dynamics Society. His approach to teaching Economics through the use of System Dynamics is unique and has attracted interest internationally. He has won the prestigious Donna Meadows prize in System Dynamics teaching

Dr. Birgit Kopainski's research uses simulation models to study dynamic decision making in food systems. She has worked in several sub-Saharan African countries and teaches both in Bergen and at ETH Zurich.

The faculty is continuously working to develop and institutionalize a plan that integrates the group's vision and goals with its resources and the university. Comparing numbers such as students per faculty, thesis students per faculty, PhD students per faculty with other disciplines both at UiB and elsewhere, it is obvious that the workload is heavy, as is demonstrated below, and that the faculty lack resources, mainly in terms of more faculty members, but also in administrative support. The fact that the faculty still is proliferate when it comes to international publishing and outreach is impressive.

Faculty	Full year equiv/employee
<i>Syst. Dynamics</i>	23
<i>Sociology</i>	13
<i>Adm. Org</i>	20
<i>Comp. Pol.</i>	21
<i>Econ.</i>	22
<i>Info media</i>	16
<i>Soc. Antr.</i>	12
<i>Geography</i>	16

**Table:** Workload by SV faculties

One concern, besides the current workload, is the need to recruit new young faculty to sustain the program in the long run and to facilitate expansion with a new undergraduate program.

### **Faculty Collaborations**

Besides the joint programs on teaching, the faculty has developed collaboration with several reputable international organizations. Among these are:

#### *Millennium Institute, Washington*

MI is an independent and non-partisan nonprofit organization founded in 1983 to inspire global action on sustainability issues. MI was founded at a time when the concept "sustainability" was not yet widely used in the development community. The Dynamics group is assisting the institute to realize its vision by enabling decision makers to use system dynamics thinking and tools to analyze and understand the interconnectedness between economic, social, environmental factors, and issues of peace and security. Annually 15 students are trained for planning ministries

#### *United Nations Environment Programme (UNEP)*

- Member of reference group, organizer of methodology workshop;
- Collaboration (through MI) on green economies;
- Collaboration on Green Economy Report
- Prospect student interns for national sector modeling

#### *University of North Dakota*

Study of social, economic and environmental consequences of oil boom.  
Student/faculty exchange

#### *Ukraine Ministry of Education*

Economic education and development of MOOCs

*Norwegian Centre for International University Collaboration (SIU)*  
Financing of collaborations with Ukraine and University of North Dakota

*European Economic Area (EEA) projects*  
Three projects on sustainability and resilience with Latvia Academy of Science

*ISM University of Management and Economics, Vilnius*  
Annually three weeks of guest lectures

*Landstingsförbundet / Sverige*  
Modeling patient and resource administration

#### Several national collaborations and activities:

Academic collaboration with several Norwegian institutions, such as the Naval Academy and the University of Ålesund

Application collaboration in health care with Haukeland Sykehus and Karolinska

Development and commercialization collaboration with Powersim Software (policy optimization under uncertainty)

## **SECTION V**

### **CONCLUSIONS AND RECOMMENDATIONS**

Long-term policy impact analysis and planning, which is what the System Dynamics programs at University of Bergen train the students to do, is becoming more important than ever. It is, e.g., the aspiration of the EU Commission that the policy impact analysis shall become a major political tool in European policy making. It shall not only produce a better knowledge base for decision-making, but add value by supporting the major aim of creating better regulation and improved internal communication in the Union. To ensure that assessment activities also serve communicative purposes, consultations are made an integral part of the IA procedures so as to make decision-makers and the public aware of likely policy impacts and serves as a communication tool, with high explanatory power, - a call for transparency and effective knowledge transfer.

The SD program in Bergen is without doubt one of the most reputable in the world. It is interdisciplinary and offers an integrative approach; a main emphasis in Horizon 2020, The EU Framework Programme for Research and Innovation. It is unique in that it offers a complete advanced degree while most other universities only offer one or a number of courses in the methodology. The university has an opportunity to use the SD faculty to further its ambition of being a leading institution for interdisciplinary education and research.

To sustain the program for the future and to be able to educate more students, the program will time need more faculty 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 a number of faculties. This would facilitate the recruitment of graduate students from Bergen and also initiate interesting collaboration between disciplines.

It is essential that the faculty is given the opportunity to continue international collaborations and time to do research. Besides new faculty positions resources should be made available to make this possible. It is also essential to recruit new young faculty to sustain the program.

The faculty should also be encouraged to continue the development of new technology based learning methods such as distance learning and MOOC.

## **Appendices**

Visiting schedule

Reports of enrolment and study results

Recent Modeling Projects in SD304 (System Dynamics Modeling Process)

Master and PhD student roster

Workload tables

Erasmus+ – Quality Review Report assessment 2014 for Erasmus Mundus Master Courses (EMMCs)

### Other documents taken part of:

Program descriptions

Bachelor i Integrert Samfunnsplanlegging - PM

Programbeskrivelse: Bachelor i Integrert Samfunnsplanlegging

Several Master theses