A vision for the field of system dynamics with some suggestive policies

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Introduction

It is a great honor to stand here and speak as the president of the system dynamics society. Coming from Iran, I would like to start by saying SALAM, meaning peace and health, to you all.

I would like also to express the society's appreciation to Nathan Forrester, James Hines, Roberta Spencer, Vedat G. Diker and all of those who worked hard to make this wonderful conference possible.

Today, I will present a vision for our field and suggest some policies to move toward that vision. I invite you to contemplate about the vision and the policies, and help to polish, modify, and make them shared vision and policies that all of us would like to pursue. I will use some system dynamics in supporting the policies that we could take up. But first I would like to review the solid foundation and potential of our field that make such a vision possible. I will also briefly review the history of the field and where it stands now.

Potential of the field

More than four decades ago system dynamics was founded based on some simple, prevailing, and strong premises that are valid and valuable today even more than before. Let me mention just a few of them:

The world is dynamic and everything is changing over time. Changes are the result of the interaction between elements that constitute systems. To understand changes we should understand the related systems. Elements of systems interact through feedback loops as the building blocks of all dynamic systems. Feedback loops consist of accumulation, or level variables, rate variables that change levels, and information connecting levels to rates. Simultaneous active feedback loops create the dynamics of our concern. The human mind is not capable of perceiving the dynamic consequences of a number of simultaneously active feedback loops. Misconceptions of feedback loops prevail. As a result, decisions usually do not lead to the desired results and have unintended consequences. Mathematical models and simulation are necessary to determine the dynamic consequences of multi-feedback loop systems.

Not only the above simple and strong premises do prevail today, but they are even more profound than they were 40 years ago. The world has become more dynamic and inter-related. Changes are accruing faster. Human activities have become more connected and interacting more intensively with each other and with nature as well. Today we are facing more complex dynamic problems at different levels that remain to be understood and managed than we were facing forty years ago.

Our field has much to offer in deepening our understanding of the dynamic challenges that we are facing. The founder of our field, Jay Forrester, was truly a genius in carefully thinking through and laying down such a solid and long lasting foundation for the field of system dynamics.

With such a foundation and great potential, our field should have an ambitious vision for the next 25 years. I believe our field will grow and such a vision will eventually come true. However, the challenges of our society would be to adopt policies that make the vision happen sooner rather than later. I will propose some policies that can be helpful and I invite you to reflect on them. But first let me review how the field has evolved and where we stand now.

An overview of the past and present standing

System dynamics took off in the sixties and early seventies by focusing on three important and essential sets of problems. These problems included instability and growth of industrial enterprises, growth and decay of central cities, and growth in a world facing a limited carrying capacity. System dynamics studies generated insights that became the center of many intense public and academic discussions. The quality and publicity of the works helped the field to take off and many became interested in studying system dynamics. The first wave of growth in the field started. However, teaching materials and teaching institutions were not sufficient. There were not enough competent system dynamicists to respond to the rising demand for teaching and consulting. Therefore, growth slowed down.

Later, the graduates of the first wave of growth created the second wave in the eighties and early nineties when new user-friendly softwares such as Stella, Vensim, and Powersim were developed, and system thinking by publication of the Fifth Discipline became popular. In other areas such as human decision-making and misconception of feedback loops, group model building, K-12 or pre-college education we made a good progress. We have had good achievements in application, although I believe after the early 70s we have not focused enough on the broad and essential problems that our societies and organizations face. System dynamics has been applied to a wide variety of areas from business to public policy, from dynamics of a cell to economic development and global issues, and from soft problem of organization development to supply chain management.

In spite of all these achievements, we are far from the real potential of our field. Today not many institutions in the world teach system dynamics, not many decision makers are aware of system dynamics or adopt system thinking to manage their organizations. There are not enough competent system dynamicists. In fact, due to the second growth wave, demand for system dynamics modeling has exceeded far beyond the existing competent capacities leading to a lower average work quality. Many of our prominent members are concerned over the low quality work that is being done under the name of system dynamics. They rightly think that would be damaging to the field and may cause a down turn for a while.

But, our field, with such a solid foundation and great potential to address so many important dynamic problems surrounding us, should enjoy a higher status. It should be taught and applied much more widely than it is today. Businesses should be more aware

of it and use it more frequently in the boardrooms. There should be more competent system dynamicists teaching, researching and practicing to improve the quality of the decisions that affect our lives. We should set up a vision matching the potential of the field and adopt policies to achieve such a vision sooner rather than later.

A vision

I would like to present a vision for the field in 25 years from now. The vision has the following dimensions:

1. **Education:** System dynamics will be taught widely at different levels from kindergarten to graduate schools. The system dynamics perspective will become an ingredient of educational programs.

2. **Managers and decision makers' mental models:** Leaders, managers and decision-makers in our institutions will think systemic and dynamic, and focus on policy design rather than operational decisions to improve the dynamics of their institutions.

3. **Teaching materials:** We will have a broad and rich base of material to choose from in order to teach system dynamics at different levels. We will have materials that explain the dynamic insights that the field has produced in numerous applications. Dynamic insights generated by system dynamics studies will be integrated into the textbooks of different fields such as economics, management and political sciences.

4. **Consultants:** A large pool of competent system dynamicists will support managers and practitioners of system dynamics in applying it to reach better policies.

5. **Researchers:** Researchers in various research institutes and organizations will be working on important dynamic problems and also on expansion and enrichment of the foundation and methods of system dynamics.

Challenges and policies

To make the vision a reality I would like to suggest some policies. I will use a simple and aggregate system structure to support my suggestions.

Education: Education and teaching, as Jak Vennix concluded last year, is the key to the growth of the field. It is through education that people become familiar with the system dynamics approach and grasp a deep understanding of it. Figure 1 shows an aggregate stock and flow diagram of training and education in system dynamics. I omitted the quality variable in order to make the system simple. The system produces professional system dynamicists and general system thinkers familiar with system dynamics. System thinkers, who are larger in numbers, include college students in other fields, practitioners,

and managers. Graduates from K-12 programs either flow into the pool of system thinkers or flow into higher education programs in system dynamics. It is wise and samrt to expand the teaching of system dynamics at the K-12 level as it generates a large flow to the pool of system thinkers and system dynamics university programs. Professional training too increases the pool of system thinkers. However, it is education programs at the universities that train professional system dynamicists and generate reinforcing loops for the growth of the field. K-12 programs and professional training create the demand for the expansion of university programs. We should accelerate the expansion of our university programs by developing good curriculum and teaching materials, as I will discuss next.

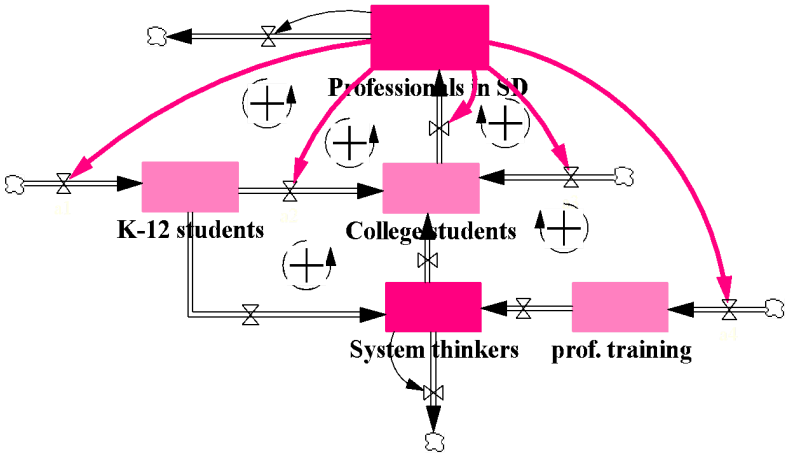

Figure 1: Aggregate stocks and flows of education and training in the system dynamics.

Curriculum development: Strong curriculums enhance the quality and efficiency of educational programs. We have not yet developed a strong and high-quality curriculum for our field. We need to develop the proper curriculum for different levels from k-12 to graduate programs, so teachers and students at different levels can benefit from it and learn system dynamics more effectively and efficiently. As shown in Figure 2, with a solid curriculum, more people will be encouraged to come to the training pools of the field and the quality of the graduates will improve.

As shown in Figure 3, curriculum development is a function of the number of active professionals and the pool of our accumulated knowledge. Curriculum development generates reinforcing loops, some of which are shown in Figure 3. We should spend more resources on curriculum development. Thanks to Jack Pugh's initiative and Pal Davidson's and the curriculum committee's efforts, initial steps have been taken and some progress has been made. We should look forward to the committee's proposal for proper curriculums for different levels of training and also help them in the big task that they have started.

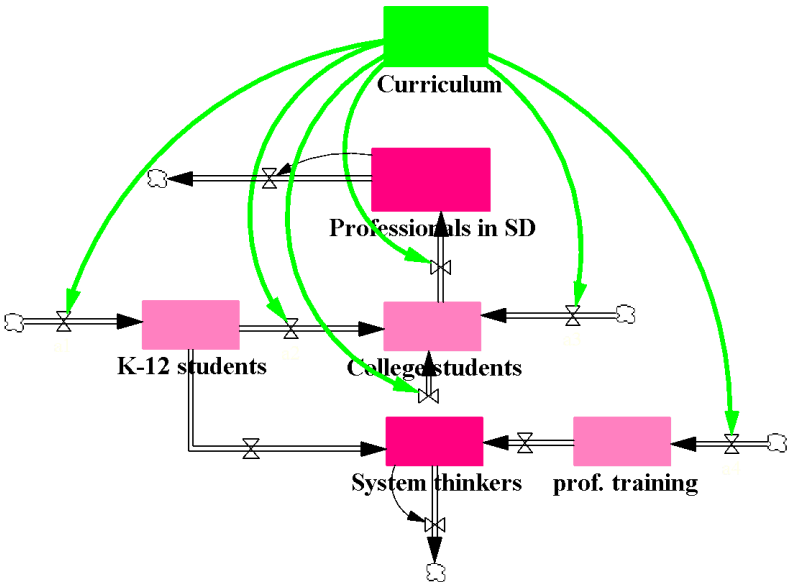

Figure 2: Curriculum and its impact on flows of students through the education processes.

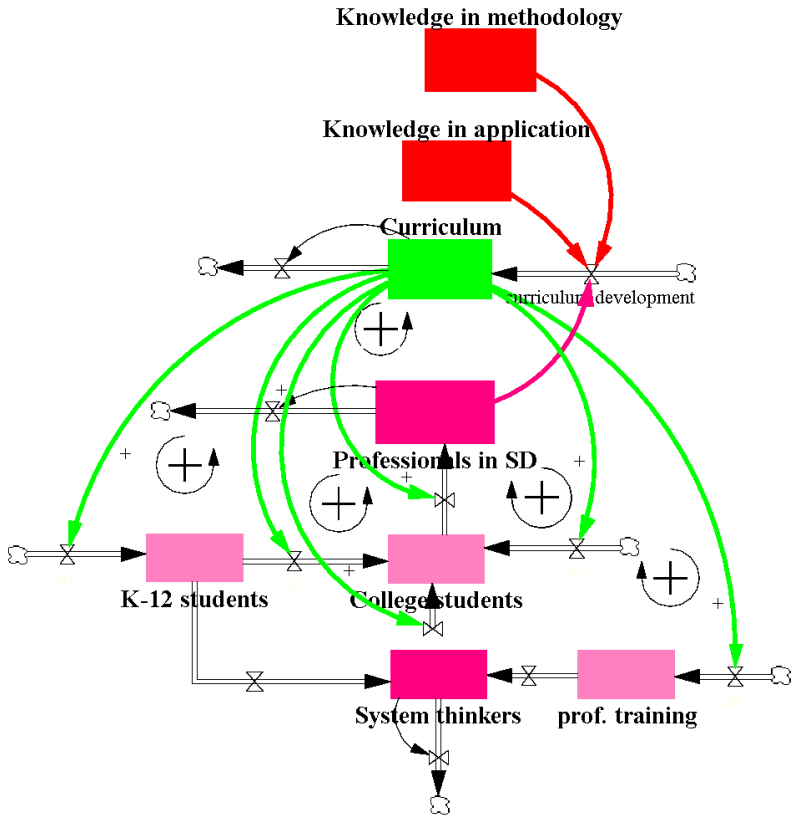

Figure 3: curriculum development depends on the pool of knowledge and professionals.

Development of teaching materials: Teaching materials affect both admission rates and the quality and quantity of graduation rates at different levels, as shown in Figure 4.

Quality teaching materials attract more people to learn the subject and also increase the teaching capacity, as more teachers would have the resources necessary to properly teach system dynamics.

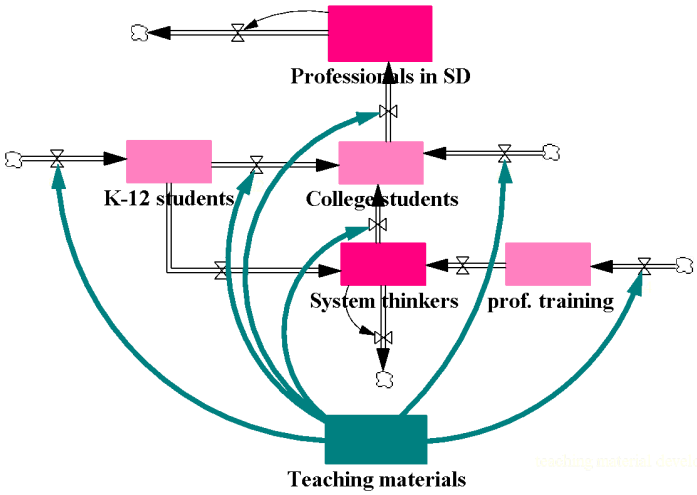

Figure 4: Teaching materials affect admission and graduation rate.

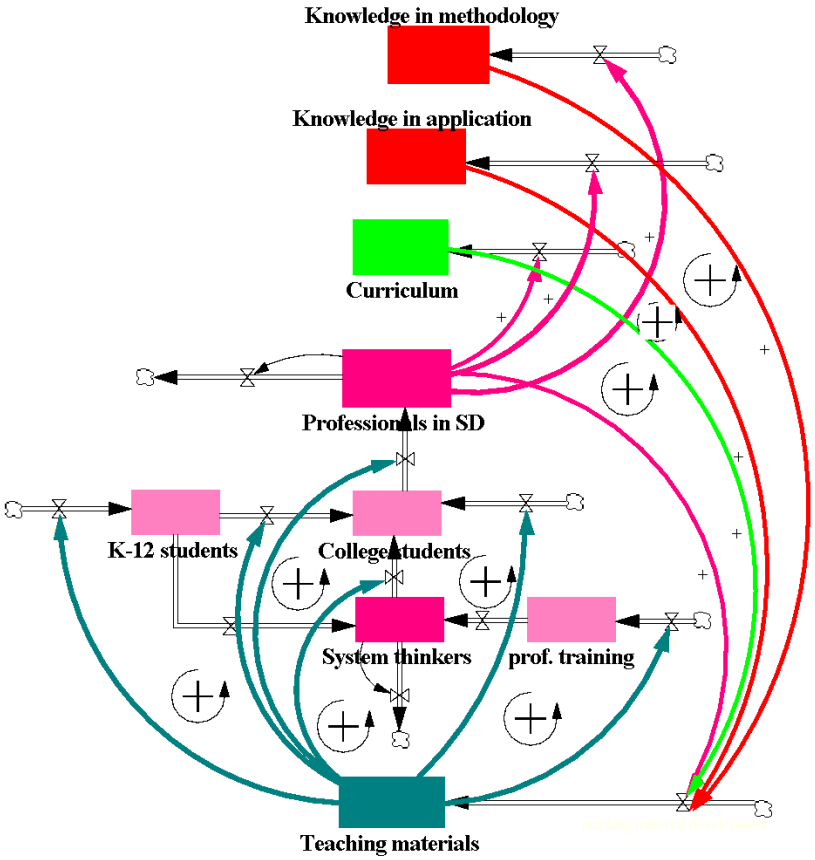

Figure 5: Development of teaching materials generates reinforcing loops for growth.

We do not have enough good teaching materials. We need materials on

methodological issues as well as materials to teach dynamic issues and insights in different application areas such as economics and business. In order to do this, we would obviously need good connection to the literature of the application areas. I believe these kinds of materials would connect us to the mainstream activities in other fields.

The development of teaching materials, as shown in Figure 5, generates reinforcing loops for the growth of the field. We can do several things to strengthen these loops. First we need to encourage and value the development of teaching materials and textbooks more than we have in the past. We should offer special recognition and awards to those who write new and excellent textbooks. In addition, we can share our teaching materials through the society's website while still honoring the copyright and proper citations for the sources that we use. Course descriptions, exercises, reading lists, draft papers, and many other items can be shared on the web.

Focus of the research and accumulation of knowledge: Teaching materials are based on research results. Research activities focus on either the methodology or application of the field. All areas of research concerning methodology are important. Problem definition and conceptualization, parameter estimation, model analysis, validation, implementation, and development of effective learning environment are all vital to the development of the field.

However, for the research concerning applications, we should be careful to work on important dynamic problems that are worth spending our scarce resources on. These problems should be ones that are of most concerns to the real world so that the outcome and insights we generate could make a greater impacts.

Additionally, as George Richardson once said, we should accumulate our findings and build upon previous work more than before. As shown in Figure 6, the accumulation of knowledge will help us develop teaching materials and extend our research and therefore reinforce growth.

There are several ways to facilitate the accumulation of knowledge. First, through the society's website, we can make the working papers of our members accessible to others. These papers would be organized according to their topics. As Yaman Barlas once emphasized, we should try to generate more publishable papers and publish them, especially in the society's journal. Moreover, in addition to the current general mailing list, we should form discussion groups who are interested in specific area. I think those of us who are working in specific application or methodological areas should have our own discussion groups monitored by a leading active member in that area. This will increase the creation and accumulation of knowledge. Furthermore, we should organize the sessions of our conferences around some fixed methodological and application issues. Of course we can always have some flexible sessions as well. But the structure of fixed and repetitive sessions in our annual conferences would be helpful to the accumulation and formation of research groups to work on the areas that we need to advance most.

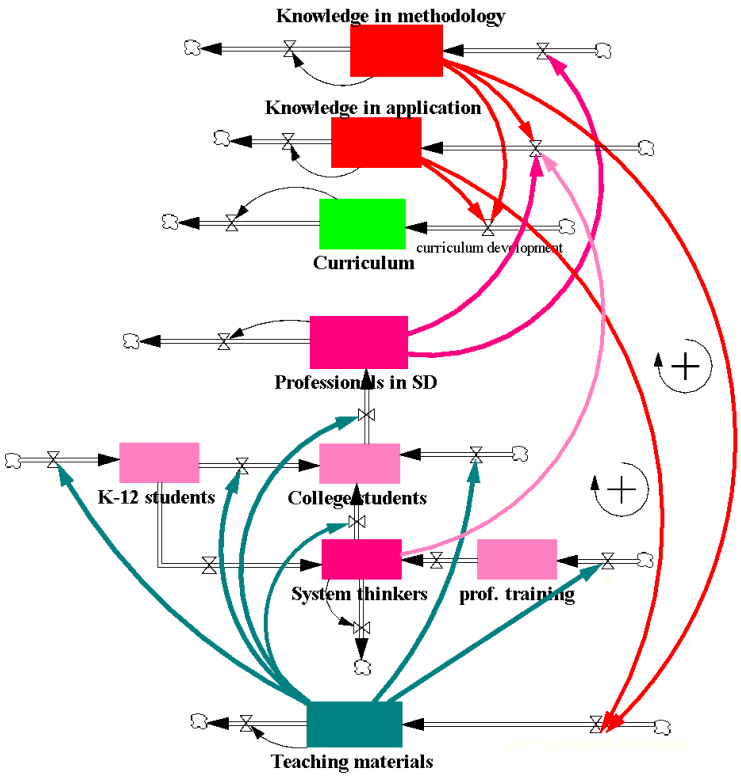

Figure 6: Accumulation of knowledge creates reinforcing loops.

Quality of system dynamics work:

Finally let me touch on the issue of work quality in our field. While it may be very difficult to do much about it, the quality issue affects the growth of our society. As shown in Figure 7, when the pool of system thinkers increases, the demand for system dynamics modeling also grows and it grows faster than the pool of professional system dynamicists does; it takes more time and efforts to train professional system dynamicists than system thinkers. As a result, the workload of system dynamicists mounts and the quality of work drops. The low quality will be perceived and will negatively affect the growth of the field. We may experience some periods of downturn in our growth path unless we get help from soft system analysts during the periods that we face high demand.

Soft system analysis is not system dynamics, as it does not involve mathematical modeling and simulation to understand and analyze the dynamics of systems. Yet it is an extensive step forward from linear and non-systemic thinking. Most system thinkers can do soft system analysis. We should encourage it to be done but under the name of soft system analysis and not system dynamics. Soft system analysis would be the first step toward appreciation of system dynamics applications while it can take off some of the extra load from the field of system dynamics when heavy workload lowers work quality. As soft system analysis efforts pick a part of the demand for system analysis work and create a lag in the growth of demand for system dynamics work, university programs

would have time to train more system dynamicists to respond to the rising demand and as a result the quality of system dynamics work can be maintained at a higher level.

Dear fellow members, system dynamics has a great potential to contribute much more to our understanding of this dynamic world than it is doing today. Let us move on and bring that potential to the service of human societies.

At the end, with respect and honor, I would like to bring up the memory of one of our prominent members, Dana Meadows, who is not with us any more. She was a bright lady who was fully engaged in applying system dynamics and system thinking to create a better world to live in. She was a great teacher who not only taught her students and attracted great people to this field but also had the dedication to enlighten the general public by system insights. Let us all wish her peace and blessing, and keep her memory alive with honor and respect.

Thanks for your kind attention. Have a great conference.

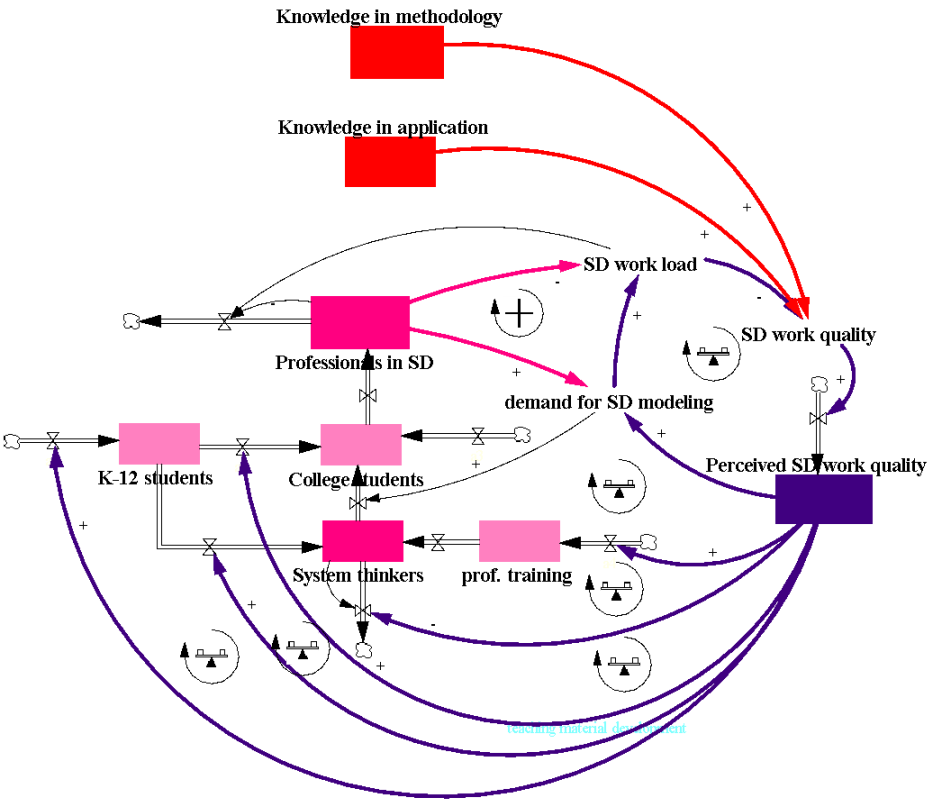

Figure 7: Some balancing loops that could create downturn in our growth path.