Women in System Dynamics Modeling
Out of the Loop?

Diana M. Fisher
Wilson High School
1151 SW Vermont St.
Portland, Oregon USA
(503) 916-5280 (phone)/(503) 916-2705 fax
dfisher@pps.k12.or.us or dfisher25@verizon.net

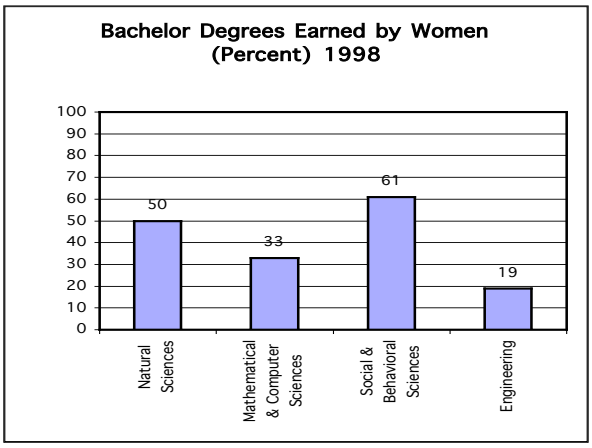
"System dynamics deals with how things change through time, which includes most of what people find important… System dynamics demonstrates how most of our decision making policies are the cause of the problems that we usually blame on others, and how to identify policies we can follow to improve our situation." (Jay Forrester) How can this field be unattractive to women? This paper presents statistics showing the level of representation of women in the sciences in the United States in 1998-1999. It presents some issues women face when trying to participate as a minority in a technical field such as computer science or engineering. A summary of responses from both men and women to a questionnaire that was posted on the System Dynamics Society listserv regarding under-representation of women in the System Dynamics field is compiled. Suggestions for potential action are listed.

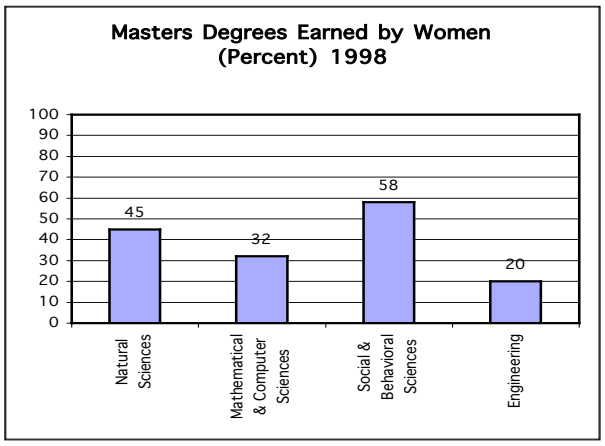
"System dynamics deals with how things change through time, which includes most of what people find important. It uses computer simulation to take the knowledge we already have about details in the world around us and shows why our social and physical systems behave the way they do. System dynamics demonstrates how most of our decision making policies are the cause of the problems that we usually blame on others, and how to identify policies we can follow to improve our situation." (Jay Forrester) How can this field be unattractive to women? The reference to showing "why our social systems … behave the way they do," an area traditionally associated with women's interest, alone should draw women to this field of study. Is it the use of computer simulation that is a barrier? Is it the lack of women mentors to invite, encourage, and support women in the pursuit of this field of study? Is it an environment that is insensitive or unwelcoming to the few women who have tried to enter the field? Whatever the cause, it is important to understand the factors that limit the growth of an important segment of those professionals who need to know the lessons of dynamic system behavior. These lessons must begin early but must continue through all levels of educational training and professional growth.

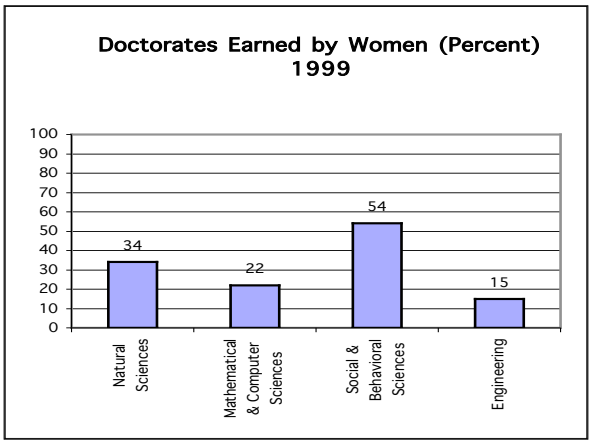
Background on Women in Technological Fields

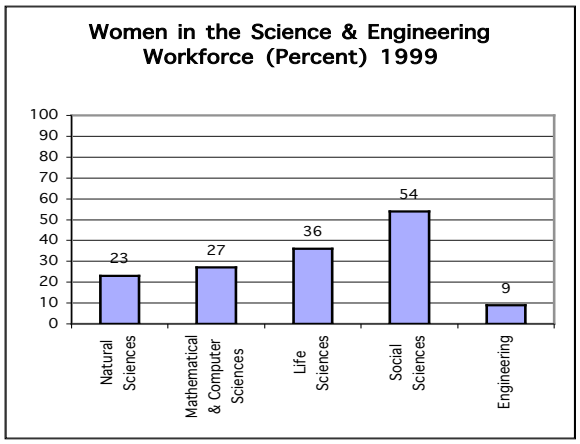
In order to gain some insight into the under-representation of women in technical fields a brief review of statistics for women in science and engineering and review of some literature regarding women in computer science and engineering provide some salient points.

Statistics:

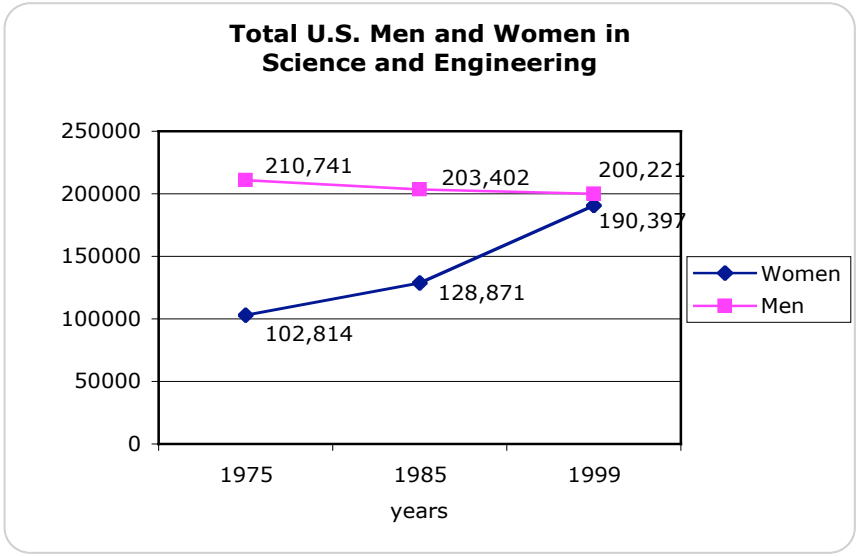






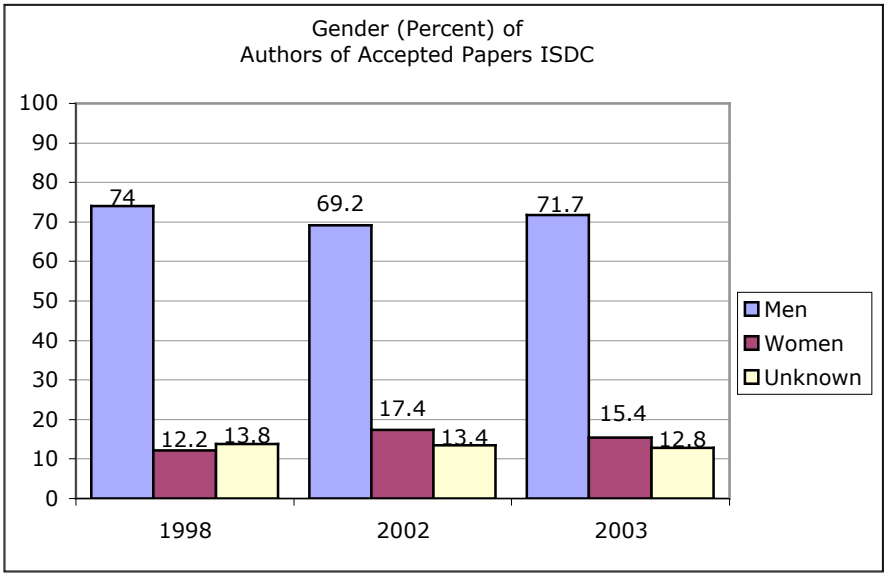


All charts (above) compiled using National Science Foundation statistics by the Association for Women in Science.



National Science Board's Science and Engineering Indicators 2002
(Total includes natural science, biology and agriculture, computer science, psychology, engineering, and other science fields)

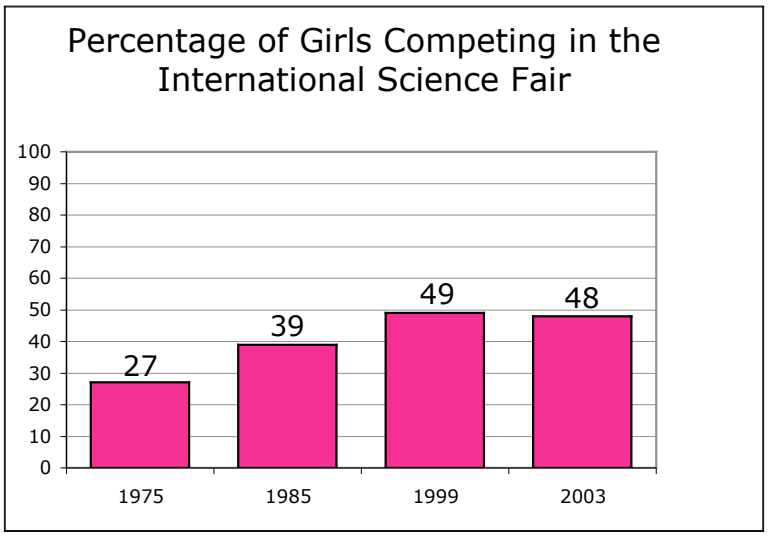
In addition to the statistics that indicate the percentage of women in the fields of science in the United States, it is interesting to note within the System Dynamics Society the percentage of accepted papers which are authored or co-authored by women.



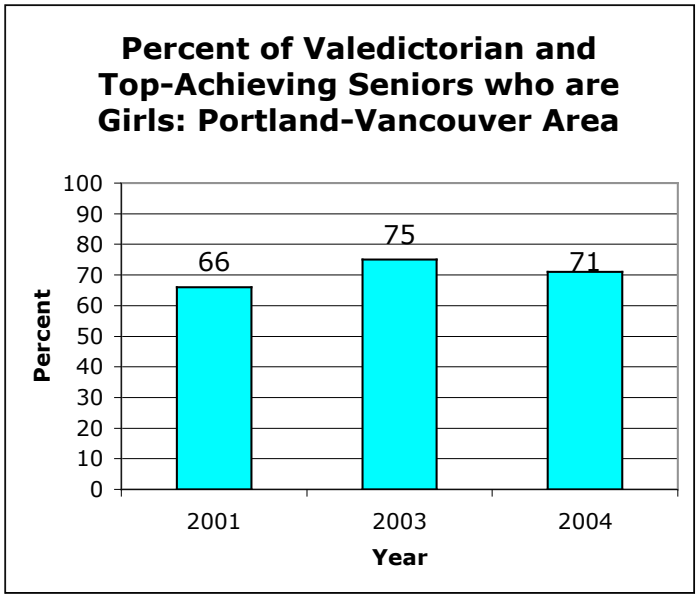
Numbers compiled from the ISDC CDs containing accepted papers for the years 1998, 2002, 2003. In 1998, 2002, and 2003 there were, respectively, 181, 484, and 467 authors of accepted papers.

As a final note, there are some recent statistics regarding the state of affairs for girls in the area of science and scholarship.

One article that appeared in the Oregonian newspaper in April of 2004 indicated girls at the high school level (ages 14-18) are succeeding in science internationally as evidenced by their rate of participation in the international science fair. The article stated that girls are receiving top awards at the same rate as boys.



Another article appeared in the Oregonian in June 2004 stating girls outperform boys in being recognized as valedictorians and top scholars in the Portland, Oregon and Vancouver, Washington region of the United States. The article mentions that "hundreds of area girls in the Class of 2004 earned A's in the hardest courses their schools offer." It goes on, "For generations, researchers say, girls have posted higher grade-point averages than boys. But only in the past decade have they accomplished that while taking as many tough math and science courses as boys."



Issues:

First, many articles suggested that adolescence (ages roughly 11 to 18) marks a segment of a person's life full of anxiety and discovery. Studies suggest that girls begin to lack confidence and sense of competence during this time. "Studies have shown that self-confidence hinges on four different components: performance and accomplishments, observing and learning from others, freedom from anxiety concerning work and conduct in a particular field, and persuasion and support from others." (Gürer) Research indicates that girls attribute their failure to their ability and their success to outside factors, while for boys it is just the opposite. (Margolis, p 114) Girls' lack of confidence seems to persist even in upper level math and science courses although the difference in numbers of girls and boys in the classes and their performance is nearly equal. "Although this enrollment and success gap has been nearly erased, girls still underestimate their math abilities, while boys overestimate theirs. (Margolis, p38) This lack of confidence on the part of women seems to continue far into college. (Camp) "Women's loss of self confidence is especially severe in historically male-dominated fields." (Margolis, p81)

Second, females are not attracted to the singular focus many men show early in computer science. They want more of an interdisciplinary approach. A study conducted by Margolis and (A.) Fisher found that 44% of women interviewed, compared to 9% of men found their interest in computer science was connected to how computing applied to other disciplines. (Margolis,

p53) "Studies have shown that women are more interested in attaining a sense of 'interconnectedness.' That is, their interest is captured by learning how something is relevant to society and to their own lives." (Treu) Authors Teague and Cuny concur. Cuny documents that women interested in computer science are often interested in its application to education, music, art, medicine and other areas involving social issues. Teague concludes, from interviewing 15 participants of her study that "being able to see the practical application of computing in the workplace … is a significant factor helping women decide computing is a career that will suit them."

Third, poor pedagogy tends to have a more deleterious effect on women and minorities than on the dominant group. "… female students in technical disciplines, perhaps partly because of their 'outsider-ness,' are especially vulnerable to poor teaching, inhospitable teaching environments (such as large classes), and unhelpful faculty." (Margolis, p83) Cohoon reports that "quality teaching can help overcome the disproportionately negative effect of otherwise unfavorable environments." She cites that retention of women in computer science departments increases for those courses where the instructors are interested in teaching and feel they play a part in their students' success.

Fourth, supportive relationships are essential for women. "Women may be more sensitive than men to social feedback and more responsive to encouragement, personal recognition, and individual invitations from faculty." (Cuny) Following directly from the issue of poor leaning environments it has been noted that positive teacher – student relationships play a significant role in building self-confidence for women. (Margolis, p89) Women find teachers a source of strength when isolated from family. Teague sites studies in addition to her own survey that indicated "the importance of encouragement and support from family, friends and/or teachers" in attracting women to computer science. "Another major problem facing women in the process of becoming computer scientists is a shortage of mentors." (Pearl) "… role models are important even to pre-college women. Without sufficient role models, high school girls may end their mathematics and science training prematurely…" (Pearl)

Fifth, due to family constraints, women may not be able to follow the traditional paths to study that are open to men. This can be due to distance needed to travel, relocation to the university they want to attend, or the need to wait until their children are a certain age before having the time to devote to university studies. "… flexible hours are especially needed in academia where the time a woman is seeking tenure is also the time she is contemplating having children." (Gürer) "Since schools are often ill equipped to deal with pregnancy, temporary leaves of absence are commonly encouraged to become permanent." (Gürer) "…girls place more value than boys on the importance of making occupational sacrifices for one's family…"(Margolis, p71) "The model for an academic career was developed during a time in which faculty positions were primarily occupied by men who had wives to tend to their home responsibilities. We call this the helpmate-in-the-background model. …(this) model is most obviously inappropriate for women … (women) do not typically have helpmates of their own. … The model of a helpmate-in-the-background should be as untenable for men in today's society as it is for women." (Pearl)

Sixth, there is prejudice on the part of some of the students and some teachers in the majority group. "There is a natural tendency, often subconscious, for faculty to want to recruit students

much like themselves, putting a premium on white males with strong technical backgrounds." (Cuny) "…in many cases men and women alike discriminate against female computer scientists in subtle ways that the perpetrators themselves many not even recognize. (Such) acts on a constant basis may be more harmful … since they add up to a feeling of constant harassment. What makes it even more difficult is women feel they cannot complain … because people will see them as overly sensitive or as not being a team player" (Gürer) Pearl also sites the serious ill effects of cumulative, subtle discrimination. She goes on to quote an MIT report: "Overtly disparaging remarks about women, as well as more subtle differential behaviors, can have a critical and lasting effect. When they occur frequently - especially when they involve 'gatekeepers' who teach required courses, act as advisors, or serve a chairs of departments - such behaviors can have a profound negative impact on women's academic career development by … causing students to switch majors or subspecialties within majors…dampening career aspirations; and undermining confidence" (Pearl)

Seventh, transitioning from other departments into a technical area requires multiple entry points. "Because women are more likely to be late adopters of computing and because they are more likely to interrupt their education for family reasons, women are disproportionately represented among reentry students. …(Reentry students) often have a greater level of maturity, focus, independence, and commitment … They are more likely to bring a range of experiences to their work." (Cuny) "Women often develop an interest in computing at a later age than men resulting in their having less computing experience than men at college age. … if selection criteria favor students who already have extensive computing experience they are likely to disadvantage women." (Cohoon) "An introductory curriculum that helps overcome differences in student backgrounds and experience can be an effective way to welcome women into a program. Offer multiple course sections when possible or incorporate pedagogical strategies that take into account the extent of beginning students' prior experience." (Cohoon)

The information from the research referenced above can be very helpful. Yet the discipline of system dynamics does not seem as if it should be as much a leap for women as computer science. The application of system dynamics methodology has direct connection to many areas of traditional interest to women in the social sciences. Certainly women must have a reasonable comfort level with computers, but most students in school today are expected to use the computer regularly for their studies. The current SD software reduces the need for extensive background in mathematics. There is a need to learn the feedback mechanisms and to learn to design model diagrams that address a particular problem one wishes to study. This material is not trivial to absorb. But the breadth of the potential audience for SD is significantly larger than that for highly technical fields like computer science or engineering. So why is SD not reaching this broader audience, which comprise many more women?

Let's turn to the results of the questions posed to the System Dynamics Society to see if there are reasons, other than those listed above, that can be brought to the fore.

Survey Results from System Dynamics Society Listserv

In an effort to better understand why there is an under-representation by women in the system dynamics community of learners and professionals a list of questions was posted to the system

dynamics listserv to illicit responses from all members. The responses are separated into "Women's Perceptions of the Problem" and "Men's Perceptions of the Problem."

The questions posed were:
0.1 Please identify yourself as female ____ or male ____
0.2 Are you trained, either formally or informally, in system dynamics modeling? _____
1. Why do you think learning to create and analyze dynamic systems models is important?
2. What attracted you to this study?
3. What makes this field attractive to women? (Or what do you think might make this field attractive to women?)
4. Why do you think more women are not pursuing this field of study?
5. What are some (or what do you think are some) of the most difficult problems women encounter in their study (either topics or pressures)?
6. Do you think women will use what they learn in SD modeling and apply it to their careers? Would your answer be different for men? If different for men, how would it be different?
7. Should the System Dynamics Society be worried about the low levels of women professionals in the field? If not, why not? If so, what could/should the society do about it?

Note: n = the number of total respondents of a given gender. Also, if a number follows a comment and is placed in parentheses it indicates the number of respondents that made essentially that same comment. If there were responses that could be grouped, collective wording of the response may be reconfigured to include the main ideas. Singleton responses incorporate wording used by the respondent as much as possible in spite of the fact that those responses are not placed in quotations.

<u>The responses given by women</u>: (n = 9)
All women respondents indicated they were trained, either formally or informally, in system dynamics modeling.

1. Why do you think learning to create and analyze dynamic systems models is important?

   Women thought it was important to understand reality and enhance knowledge that would transfer to other disciplines. (4) They thought modeling would help them make good decisions and develop their reasoning skills.(4) Modeling allowed them new ways to look at old problems.(2) "People simply cannot cognitively understand complex systems that are dynamic, rich in feedback, and have time delays, without creating models," was a final response.

2. What attracted you to this study?

   Modeling provided the ability to formally create their vision of the world. (2) The concept of insights, dynamics, visual representation and collective mental models was attractive. (3) It was a fun, intuitive and exciting way to look at the world. Models can solve problems that represent systems with a lot of nonlinearities. (2) The holistic approach was very attractive. Studying problems whose "impacts are distant in time and space and the unintended consequences of our actions" resonated with one respondent.

3. What makes this field attractive to women? (Or what do you think might make this field attractive to women?)

   Some women felt the attraction to the field of system dynamics was not a gender issue. (2) Those who saw a potential difference mentioned that women do not like simple linear causal thinking, that women like to share insights and that women like detail.(2) Also, SD modeling gives women a formal way to think about things, it gives consultants a "tangible decision making tool" that is not "soft or spongy." One response indicated that the SD " field is hard and it is easier for women to succeed in hard fields." (2) Other respondents mentioned that there are not many people/consultants/researchers who are adept at SD modeling; that the current software enhances communication about feedback and relationships between variables; and that complicated mathematics is not a barrier (with the new software). Finally, one woman found that SD modeling gives system thinkers a language to express themselves and a means to communicate with the folks who only use numbers.

4. Why do you think more women are not pursuing this field of study?

   Women felt that the newly emerging field was not well known (5) and since the field was "coined" by men women were even less aware of the field early-on. (2) Since the emergence of the field occurred in technical areas that already under-represent women there is an inherited problem of under-representation. (5) One respondent suggested that there is a lack of encouragement (for women) to be involved in science and model building. Another respondent went further to suggest that there are "provisos" against women doing such research. "Some men cannot accept women as equal researchers or colleagues."(2) Lastly, one woman said the SD field needs more educators across the learning spectrum.

5. What are some (or what do you think are some) of the most difficult problems women encounter in their study (either topics or pressures)?

   One woman stated that "some people will probably say a difficulty is the quantitative nature of the field. But that's insulting to women. It's not that numerically demanding." Another woman said that SD needs to be taught more "sympathetically," especially for those who have difficulty with the technical parts of SD. Other responses mentioned time constraints for women with family responsibilities and classical prejudice women experience in every field of professional life. One respondent said formal SD training (which she considered necessary in most cases) is usually done by classically trained engineers, mathematicians or IT students and "women studying formal (SD) techniques need to be capable of adapting and embracing the engineering/math disciplines," and an inability to "close any mathematical/programming gaps can hinder learning and implementation success." She indicated that there were few women SD educators at the university level. Three women mentioned that women are not perceived as important persons, that they are not taken seriously. Finally, one woman mentioned that it is difficult to find a job where SD skills can be used.

6. Do you think women will use what they learn in SD modeling and apply it to their careers? Would your answer be different for men? If different for men, how would it be different?

   All the women thought women would apply the SD they learned in their careers. Five women saw no difference in application between men and women. Some others thought women would communicate more insights while men might focus more on the technical aspects of modeling or that women might spend more time creating mental models and men might spend more time using SD in their organizations. One woman found SD to be a "game changer," making her more aware of relationships between variables and using her knowledge of archetypes to help improve her communication and make better decisions.

7. Should the System Dynamics Society be worried about the low levels of women professionals in the field? If not, why not? If so, what could/should the society do about it?

   Most women felt that the SD society should be concerned about the low-level of participation by women because the society would "loose a lot of smart people" and because women have different backgrounds from men. But some women mentioned that it is not just a problem for SD, that many technical fields have women under-represented.

   As for possible courses of action: A few women said the SD society should encourage as pluralistic a model of participation as possible, appreciating diversity. The society should make sure its documents, references, and activities are gender neutral. Another response indicated whatever helps recruit women in other under-resented sciences should be applied to SD (2) General encouragement should be made to support women in their study of math and science at all levels of schooling, set the mindset "it's cool to be smart, stop worrying about a man being intimidated." It was suggested by multiple respondents that the SD Society should increase its focus groups to include one just for women and others that incorporate more diverse topics that might be more inclusive.(3) One respondent did not support focus groups just for women. It was suggested that the "SD Society should aggressively support the K12 student pipeline which has a more favorable female/male mix. Getting females exposed to SD when they are young … has long-term impact." Finally, it was suggested that the SD society should perform selective recruitment activities at universities that offer SD/ST coursework.

<u>The responses given by men</u>: (n=25)
All men respondents indicated they were trained, either formally or informally, in system dynamics modeling.

1. Why do you think learning to create and analyze dynamic systems models is important?

   Overwhelmingly men felt that modeling allowed them to understand causes of the most important problems they wanted to study and provided them an option to achieve better solutions or make better decisions. (17) Men also felt creating and analyzing systems models helps them create the future they would like to see. (3) Some commented that it helped them understand counter-intuitive feedback loops. (2) Also mentioned was the fact that some problems require SD modeling to do any useful analysis.

2. What attracted you to this study?

   The logic, simplicity, and soundness of the theoretical framework was attractive. (4) Modeling is a useful tool for business/management. (3) Some men were already in engineering and had exposure to feedback systems. (2) Others liked the wide range of applications, the dynamic, holistic approach, the ability to portray real-life problems and issues. Also mentioned was that modeling was a rigorous, adventurous discipline and that the early practitioners worked on important problems in creative ways. Being on the cutting edge of something important was attractive. Some happened upon modeling by mistake while doing other research. Disenchantment with static models or static thinking in their own discipline prompted a search for a more useful tool.

3. What makes this field attractive to women? (Or what do you think might make this field attractive to women?)

   Many men felt that attraction to the field of system dynamics was not a gender related issue, that both men and women are attracted for many of the same reasons. (13) Those who tried to identify characteristics of SD that they thought women might find attractive mentioned: men and women want to satisfy intellectual curiosity and have an opportunity to do some good in the world (3); that systems thinking and system dynamics are synthesis-based problem solving approaches and women seem to use synthesis more instinctively (3); that women desire to unravel dynamic complexity (2). Some men mentioned qualities they thought women possessed that made women especially adept at systems thinking and dynamic modeling such as: women are more attracted by concrete applications, women are more intuitive systems thinkers, women are interested in tools for developing and sharing understanding. Perhaps that fact that the current software negates the need to have a master's degree in mathematics was mentioned as possibly increasing the attractiveness of the field. Both men and women would be attracted to SD because the field offers many opportunities. Also mentioned for both men and women was an approach to understanding the world based on Human Dynamics. This respondent suggested that different facets of system dynamics appealed to people falling into the mentally-centered (well-structured), physically-centered (clear purpose and interconnections), and emotionally-centered (connection to the value of human beings) categories.

4. Why do you think more women are not pursuing this field of study?

   Some men wanted statistics that showed that the under-representation of women in SD was out of proportion to the under-representation of women in the technical areas in which it is taught. (5) (This data is important and should be collected.) Although other men indicated they did not know why more women were not pursuing SD (3) many had hypotheses about the cause of the imbalance in representation. Some men felt that the preponderance of men in the field dissuaded women from considering the field because they would have to expend extra effort to break through real or imagined barriers in the workplace, that women would find the field less collegial, or that women would not have role models. (5) Other men mentioned that at certain universities in the past the system dynamics department seemed to

be a men's club and that a great majority of the faculty and students still are men. (4) Another respondent mentioned that men hog the field and behave non-systemically. A few mentioned that because SD is taught within or connected to engineering or operations research that SD inherits the same low-level of representation by women. (3) Four men indicated a possible time lag in the growth of women in the field due to the fact that not many are being exposed to SD ideas. Family expectations or time constraints weigh more heavily on women. (3) Academia is not very friendly to women who wish to have both careers and children. For those men and women who have less technical backgrounds, the "mathematical nature of doing good work in system dynamics" is a huge barrier.(2) On counterpoint, another respondent stated that the math involved in SD is no more difficult that statistics and that there are lots of women in statistics. Finally, it was mentioned that the SD society seems more interested in the SD process and women may be more interested in SD applied to problems that are important to them.(3)

5. What are some (or what do you think are some) of the most difficult problems women encounter in their study (either topics or pressures)?

   Many men suggested that it was better to ask women this question. (8). One respondent had many possible suggestions (some of which were mentioned by other men) including: lack of role models (4), lack of a support network, subtle discrimination (in appointments, committee assignments and informal networks), conflict between tenure and biological clock and inadequate accommodations for this by universities, gender inequity in society (expectations of women as primary caregivers of children, etc.)(3). Also voiced was there should be no problems for women because they were just as good as men at SD. (2) It was difficult to group the rest of the responses. Those responses included: the antagonistic culture of one university seemed to be a very unattractive atmosphere for women, females have difficulty gaining acceptance as consultants, and there are more incentives for women to stay in main-stream science and engineering than to venture into SD. Finally, one man suggested that, since men think differently than women, some men perceive women's models and results differently than they view men's models and results. This perception is a problem (for women) in male dominated groups.

6. Do you think women will use what they learn in SD modeling and apply it to their careers? Would your answer be different for men? If different for men, how would it be different?

   Almost all the men felt that both men and women would apply SD in their careers (19) because SD becomes part of one's mindset. Another response indicated that both (men and women) would apply SD but that applying SD took persons who had courage and determination. (2) Women will apply SD more, said one man, because they study reality more, have the time and patience and pay more attention to detail, while men may be better at creating the right model, so a team approach including men and women would be useful. Since the more obvious applications of SD are in areas were men dominate, they have more chance to apply SD, was another response. One male consultant indicated that female clients tend to ask him about how to optimize the system being studied, while male clients tend to ask about how to make a profit from the system. He said, "Women are using their extra knowledge! They consolidate their role in the organization." A final response

indicated that women might tend to educate others in SD as opposed to just playing with models and new software.

7. Should the System Dynamics Society be worried about the low levels of women professionals in the field? If not, why not? If so, what could/should the society do about it?

   Yes, the SD Society needs to be worried. (8) Responses included: the society needs diversity for credibility and there is a need for more talented people; women add another perspective (3); it may tell us why the field is inaccessible to the rest of the world; the popularity of SD is artificially constrained; the potential intimidation factor for women by the men's club aspect of the SD field is a concern; we have tried to include more women and have failed and I don't know why. One response indicated that the concern should be for engineering as a whole and not just SD, unless the data suggests otherwise.

   Maybe the SDS needs to be worried. (6) We need to know why there is a low level of participation by women. (6)

   No, the SD society does not need to be worried. (5) Let nature takes its course and keep opportunities open. Unless there is bias, said another respondent, we should just try to interest everyone. There are not even very many men in the field so just teach everyone.

   Finally, one man said, before worrying about women worry about the quality of the SD courses in general. Another respondent said the SD Society should worry about the "low levels of professional in the field period, … but having more women would be a good thing."

   As for courses of action: encourage women; clarify professional use of SD; train more people in organizations to engage in SD; discuss SD's shortcomings (sometimes); stop criticizing other fields (like conventional Economics); find bridges between static and dynamic thinking. Some responses indicated that perhaps more SD programs should be housed in other disciplines (like social sciences), since there are more women in social science(4). It was suggested that women should form social networks and get together at conferences to discuss common interests and problems – an SD women's caucus. One response indicated that the SD society needs to pay attention to getting representation from women in the leadership of the society and that is done to some extent. As a final response one man had many suggestions: "The Society could help to establish a research field with several institutions (universities) who are dealing with System Dynamics, aimed at bringing together female researchers/teachers to establish an "old girls' network." Furthermore, what has proven successful in other fields of society are quotas for women (i.e. every second year a woman has to be president of the Society; certain percentage of female contributions to the System Dynamics Review, etc.) Maybe the society could sponsor a female researcher/teacher once a year (i.e. with a prize or the possibility to research and teach at a renowned System Dynamics institution)."

Suggestions that may help improve the number of women pursuing SD

1. Unfortunate as it may seem, it is none-the-less important to take into account that many girls and women have less confidence in their ability to pursue study outside the traditional avenues women follow. It is necessary, therefore, to be sensitive to phrasing criticism in front of groups and even in private. This should be an awareness that all teachers have for all students, male or female. But harsh criticism seems especially destructive to females.

2. The SD curriculum could be broadened to include problems that include a more interdisciplinary application. Not only does this address issues that may be more inviting and interesting to women, expanding the problem applications will also give others outside the field more examples of how SD can be useful in their disciplines and may spur interest in learning more about the field.

3. Emphasis on the best pedagogy at the entry stages of SD study is essential not just for women but to create a climate that has the best chance of catching fire in the minds of all students. Also there is a serious need to increase the number of women who teach system dynamics methodology. Women do teach differently. They choose different approaches from men in both problems to study and sequence of and structure of methodology.

4. Awareness of subtle prejudice (in class: calling on males more, interrupting females, lab environments which are unfriendly or require aggressiveness on the part of the students who need to share insufficient resources – in academia: in appointments, committee assignments and informal networks). The cumulative effect of subtle prejudice is very detrimental for all minorities trying to become part of an organization.

5. Willingness on the part of the teacher to develop positive/supportive relationships with the students, especially the women students help women feel included. Women need encouragement. In their homes they get it from their parents, in school they can get it from their peers and teachers. But when they are cast into an environment, away from their previous support groups, and are in a significant minority, the teacher becomes a very important lifeline. This is especially true in the entry level courses, before women have had an opportunity to create new support structures.

6. Development of multiple entry points for women to enter the SD field from another field of study or later in their lives has the potential to recapture talented women. Multiple entry points may require the design of courses to introduce SD in stages while improving some technical or mathematical background that may be missing or dormant for those women who have been out of school or for those people who want to transfer from other disciplines. It may require introductory summer courses for pre-college teachers who want to increase their skills in modeling(since this is the ONLY time they have to take classes). Pre-college teachers offer a unique leverage point for increasing the number of students interested in pursuing SD and it stimulates students to take their SD lessons into their chosen field of study, further seeding the field in multiple locations.

7. Go where the women are and teach them in their traditional disciplines. This approach includes providing workshops in other disciplines whose practitioners would benefit from the SD methodology and identifying and mentoring those women who seem interested and

adept at SD modeling. Then provide intellectual/moral support for these women as they try to spread the SD approach in their discipline. This suggestion also has significant potential for increasing not only the number of women in SD but for increasing the number of people using SD in general.

Conclusion

"To bring women in is not just to rectify an inequity … it means to change the whole conversation." (Carol Gilligan)

The tools and techniques of the system dynamics methodology allow practitioners to address problems of great import. The field of system dynamics has significant potential for allowing us to "create our vision of the world." The mathematics involved is not a true barrier to assimilating the methodology, given the elegantly designed software available to practitioners. It is imperative that professionals who must make important decisions have the most appropriate and current tools. We should all be concerned about the slow growth of the SD society and of the spread of this method of analysis. Women need to be a big part of the group to whom the SD society should address its message. There are some avenues open to those who are interested in increasing the number of women in the SD pipeline. It should also be noted that there are men in the System Dynamics Society who are working diligently to increase the representation of women in the society (although this effort is not as wide spread as needed to produce significant change). If women won't come to the SD field through engineering then there need to be SD modelers who will go to them. Teachers from social science, biology, environmental science, medicine, economics, health, mathematics, and many other fields should be cultivated to include the SD methodology in their instruction. Pre-college teachers should be mentored by the SD society to provide appropriate SD/ST instruction to students at the youngest level at which it is appropriate. Each member of the society, if he or she feels that SD methodology is important, must accept responsibility to provide some means to share the message and increase the practitioners, even if it means just teaching one person. Of course, we all need to teach our own children.

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