

The View from Carnegie Mellon: What We Did and What We're Doing

Jeannette M. Wing

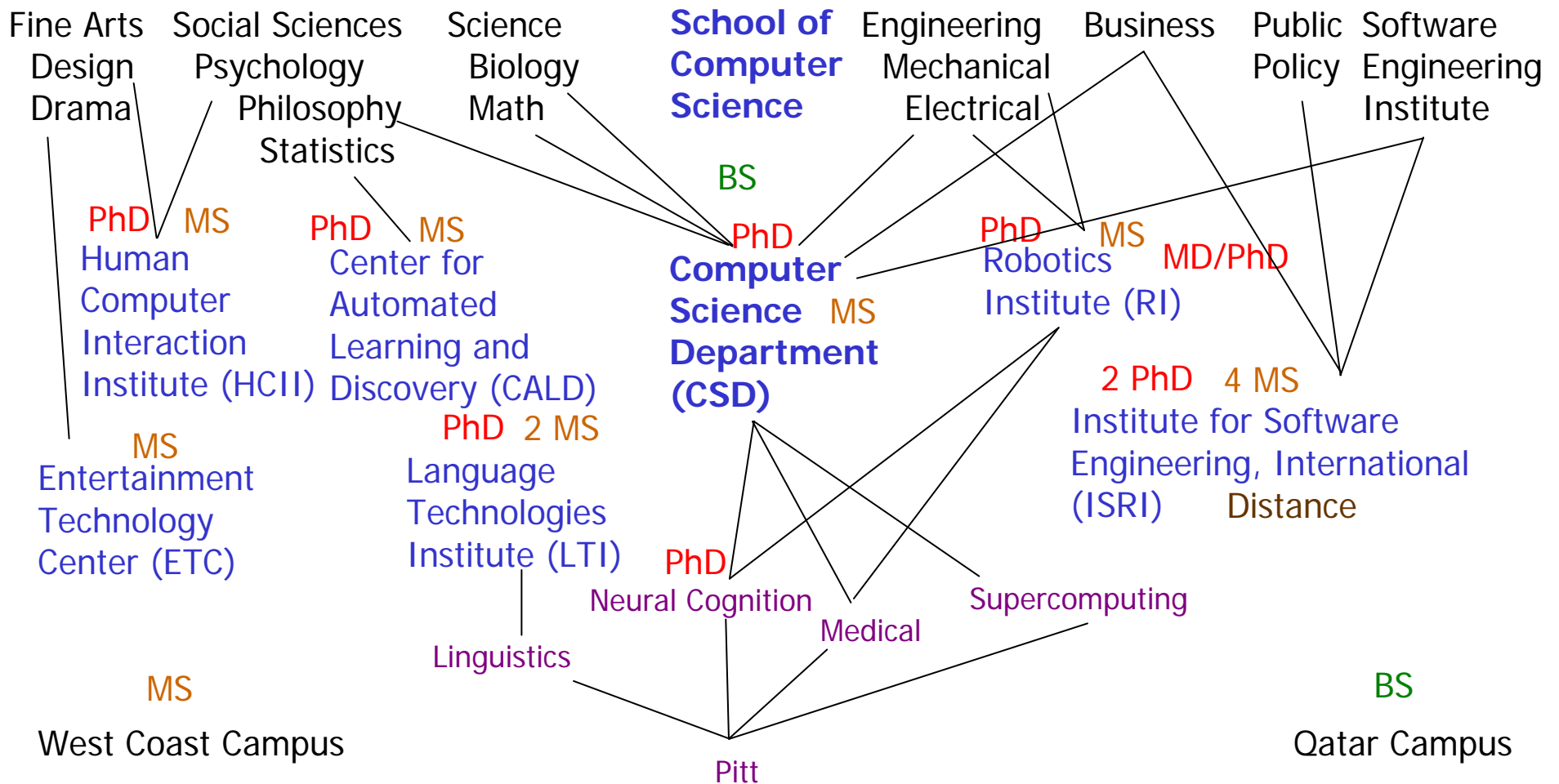
President's Professor of Computer Science
Head, Computer Science Department
Carnegie Mellon University

National Center for Women and Information Technology, Pittsburgh, PA, November 17, 2005

Carnegie Mellon's Broad View of Computer Science

Pervasive and Interdisciplinary

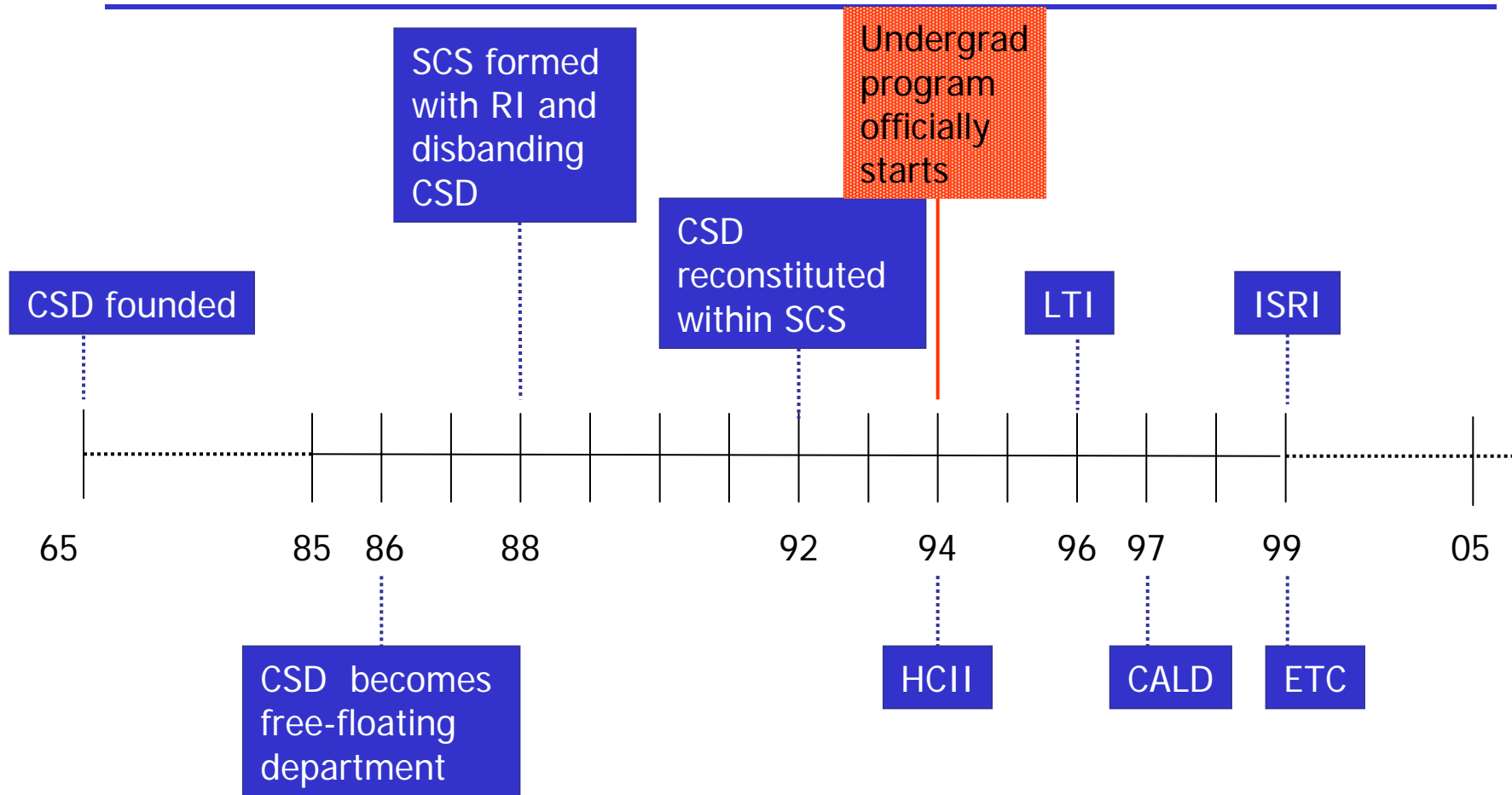
CMU



SCS Numbers at a Glance

- 215 faculty
- 213 courses on the books
- 540 bachelors students
- 235 masters students across 11 programs
- 400 doctoral students across 9 programs

Timeline: 40 years of CS at CMU



Carnegie Mellon's Broad View of Computer Science

- The Computer Science Department is the
 - Home for traditional areas of Computer Science
 - Home for new, emerging areas of Computer Science
- Other units of the School of Computer Science connect Computer Science to other disciplines:
 - Robotics: CS + Mechanical Engineering + Electrical Engineering
 - Language Technologies: CS + Linguistics
 - Human-Computer Interaction: CS + Design + Psychology
 - Automated Learning and Discovery: CS + Statistics
 - Software: CS + Public Policy + Management
 - Entertainment: CS + Drama

Outline

- Then and Now
- What We Did
- What We Did Not Do
- What We Are Doing
- What *You* Can Do
- What We Can All Do!

Themes

Numbers
Culture

×

Pipeline



Then and Now: 80's – 00's

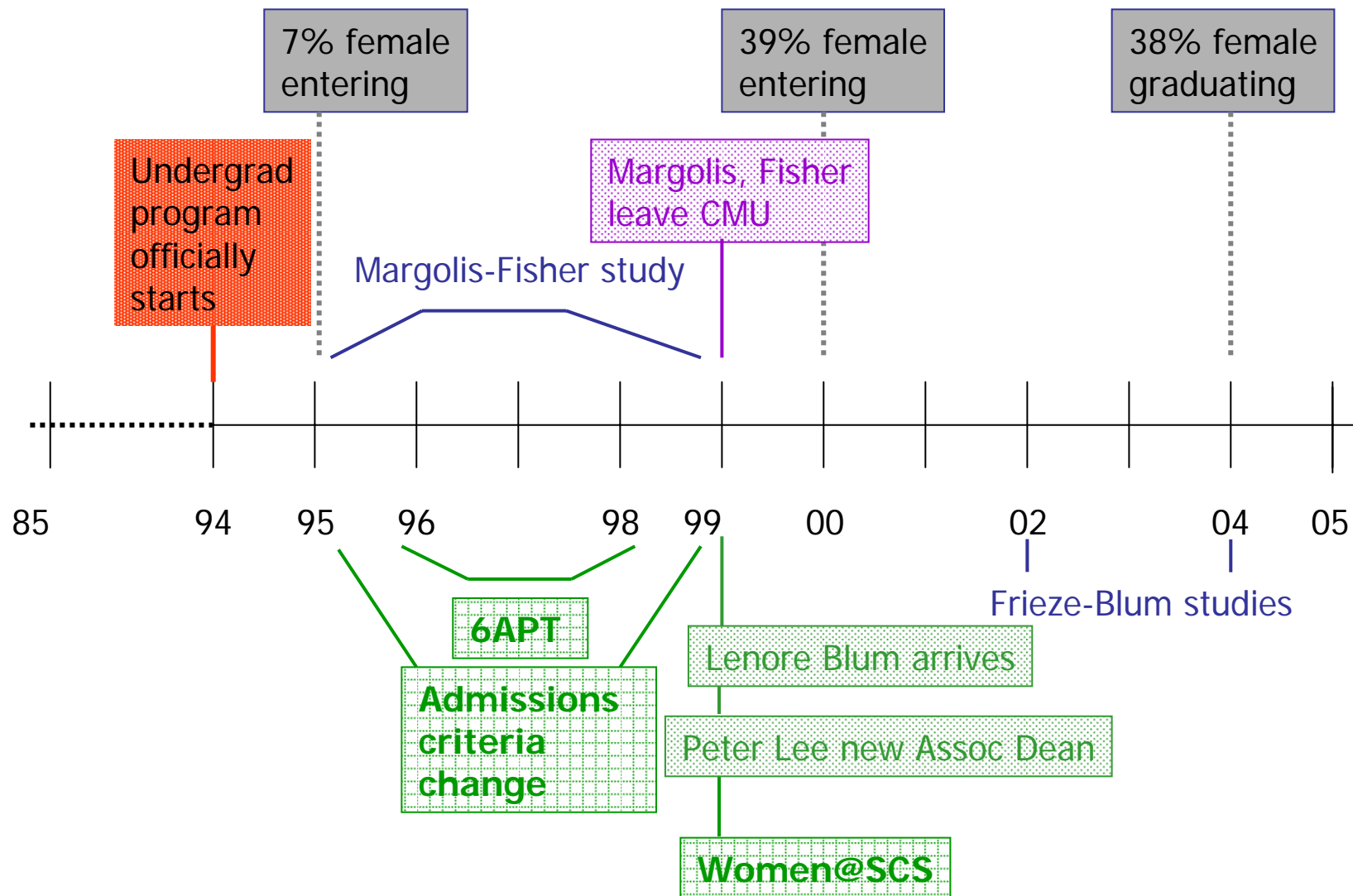
Numbers

Female undergrads	7%	→	33-39%
Female grads	10-12%	→	10-23%
Female CSD/SCS faculty	5%	→	15.4%

Culture

Faculty attention	grad students	→	undergrad and grad students
Faculty attention to gender issues	absent	→	engaged
Undergrad student community	absent	→	Women@SCS

Timeline



Then and Now: Numbers

Year	Applied		Admitted		Enrolled	
	Total	Women	Total	Women	Total	Women
		(% of all applicants)	(% of applied)	(% of female applicants)		(% of total enrolled)
1995	1484	160 (11%)	382 (26%)	54 (34%)	96	7 (7%)
1996	2182	231 (11%)	479 (22%)	87 (37%)	142	23 (16%)
1997	2222	248 (11%)	481 (21%)	87 (35%)	136	18 (13%)
1998	2364	274 (12%)	462 (19%)	96 (35%)	140	27 (19%)
1999	2680	342 (13%)	454 (17%)	122 (36%)	130	50 (38%)
2000	2876	404 (14%)	386 (13%)	158 (39%)	132	51 (39%)
2001	3237	435 (15%)	402 (12%)	157 (36%)	130	47 (36%)



How did this happen?

What We Did: Getting Them In the Door

1. Admissions Criteria Changes

- Prior programming experience not needed. [Allan Fisher]
- “Look for leaders.” [Raj Reddy]
- Consequence: Increased diversity in *both men and women* in their interests and background.

2. Summer Institute for CS AP Teachers (6APT)

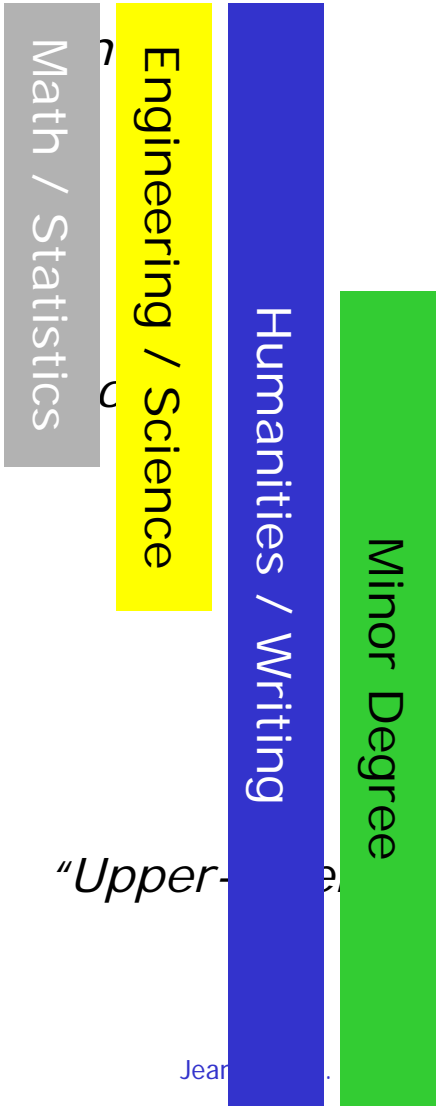
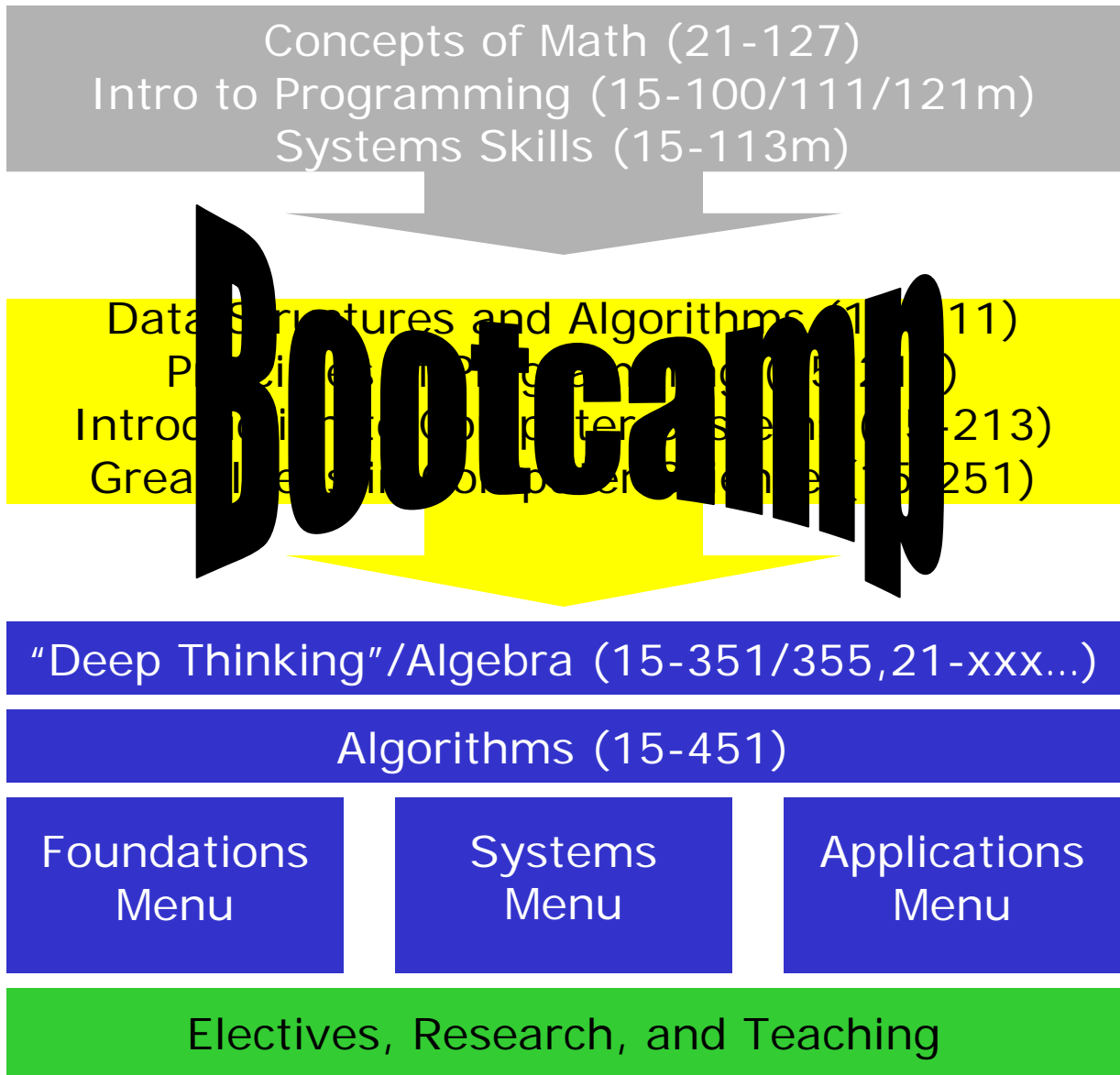
- Opportunistically teach gender-equity skills to 240 high school teachers while they are taught C++ for AP CS.
- Allan Fisher, Jane Margolis, Jo Sanders, Mark Stehlik
- Consequence: 18% of women entering 1999 and 2000 were from the 6APT high schools, as compared to 0% in 1995.

What We Did: Getting Out the Door

3. Multiple entry points into 200-level bootcamp
 - Four paths to 15-211, based on programming experience: none, some, a lot

4. Women@SCS: a professional community for students
 - Professional activities
 - Mentoring, tutoring, curriculum advice, curriculum oversight, career counseling, technical seminar series, professional networking, alumni/ae networking
 - Giving back to the community
 - Resurrection of Pittsburgh chapter of Computer Professionals for Social Responsibility (CPSR)
 - Outreach, brochures, roadshows
 - Women@SCS website, SCS website
 - Social activities
 - Dinners, SCS Day (workshops and talent show)

Our Undergraduate Curriculum



women@SCS

School of Computer Science, Carnegie Mellon University

The Women@SCS mission is to create, encourage, and support academic, social, and professional opportunities for women in computer science and to promote the breadth of the field and its diverse community.

Site Highlights

- ◆ Features
- ◆ Interviews
- ◆ In the News
- ◆ FAQ
- ◆ **Ada Website**

Who We Are

- ◆ About Us
- ◆ Contact Us
- ◆ Profiles

What We Do

- ◆ Photo Album
- ◆ Big/Little Sisters
- ◆ Alumnae Link
- ◆ Advice Network
- ◆ Outreach
- ◆ Women@IT
- ◆ SCS Day

Calendar

- ◆ Current Events
- ◆ Event Archive

For Students

- ◆ Jobs
- ◆ Funding
- ◆ Research
- ◆ Academics
- ◆ Undergrad Site

Resources

Women@SCS News

Dr. Telle Whitney to Speak at CMU



Dr. Telle Whitney, President and CEO of the Anita Borg Institute for Women and

Technology, will deliver a speech as part of the University Lecture Series on Wednesday, Nov. 16th at 5:00 pm in Rangos 3. Her speech, entitled "Technology: The Unfulfilled Promise and the Opportunity", will explore technology creation and look at innovative techniques to attract a diverse population to the study of technology.

Events

Big Sister / Little Sister Event



Decorate picture frames at the next Big Sister / Little Sister event on Saturday,

November 12th from 1:00 - 3:00 pm in Wean 4625. Contact Stephanie Rosenthal (srosenth at andrew.cmu.edu) for more information.

Roadshow at W.P.S.D.



The Women@SCS Roadshow recently visited the Western PA School for the Deaf and met with

What We Did: Pay Attention!

- Commit to sustain success
 - Lenore Blum
 - Distinguished Career Professor of Computer Science
 - Faculty advisor to Women@SCS
 - 2004 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM)
 - President Jared Cohon
 - “Diversity” President
 - Allan Fisher initially, then Peter Lee, now Klaus Sutner
 - Associate Dean for Undergraduate Education
 - Carol Frieze
 - Director of Women@SCS
- Raise awareness
 - SCS faculty

What We Did Not Do

- We did **NOT** change admissions standards.
 - The strength of the applicant pool increased through the late 90's through 00's.
 - There has been no decrease in median grades or test scores of those admitted.
- We did **NOT** change the curriculum.
 - We did not “contextualize” the curriculum in any big way.
 - 1-unit 1 semester Immigration Course is good for *both men and women*.
 - We did not make it “female-friendly.”
 - Bootcamp is *for both men and women*.

What does that mean anyway?

Keys to Our Success

- People make a difference
 - Lenore Blum, Jared Cohon, Allan Fisher, Carol Frieze, Peter Lee, Raj Reddy, Mark Stehlik, Klaus Sutner
- Action, not talk
 - 6APT, Women@SCS
- Commitment, perseverance, vigilance
 - By faculty, by key individuals, by administrators

Gender Studies: Margolis-Fisher

- 1995, 1996, 1997 cohorts (7%, 16%, 13%)
- 230 interviews
- CS culture: hacker, geeky, nerdy
 - computer science \approx computer programming

Findings

- There are gender differences, e.g.,
 - Men tend to view the computer as an object of study in itself. They “dream in code.”
 - Women tend to view the computer as a tool. Their interest is in “computing with a purpose.”
- Community of undergrad women is an unsuccessful intervention strategy.

Gender Studies: Blum-Frieze

- 2002 study: 1998 entering class (19%) interviewed (senior year)
 - “Class in transition”: 33 interviewed: 17 women, 16 men
- 2004 study: 2000 entering class (39%)
 - 44 of senior class interviewed; 136 of other classes surveyed
- CS Culture: more balanced in gender, students with diverse interests
 - computer science \approx a way of thinking and solving problems

Findings:

- Margolis-Fisher gender differences disappeared!
 - Men and women alike like to hack and/or like applications.
 - Most are a little of both.
 - Men and women alike “dream in code” and “compute with a purpose.”
- Women@SCS shows community building has a dramatically positive effect—it is culture-changing!

Why These Differences in Findings?

- Because the numbers changed (near critical mass)
- Because the culture changed
 - Our environment is full of “leaders” and people with diverse interests
 - Students are energetic, enthusiastic, and pro-active

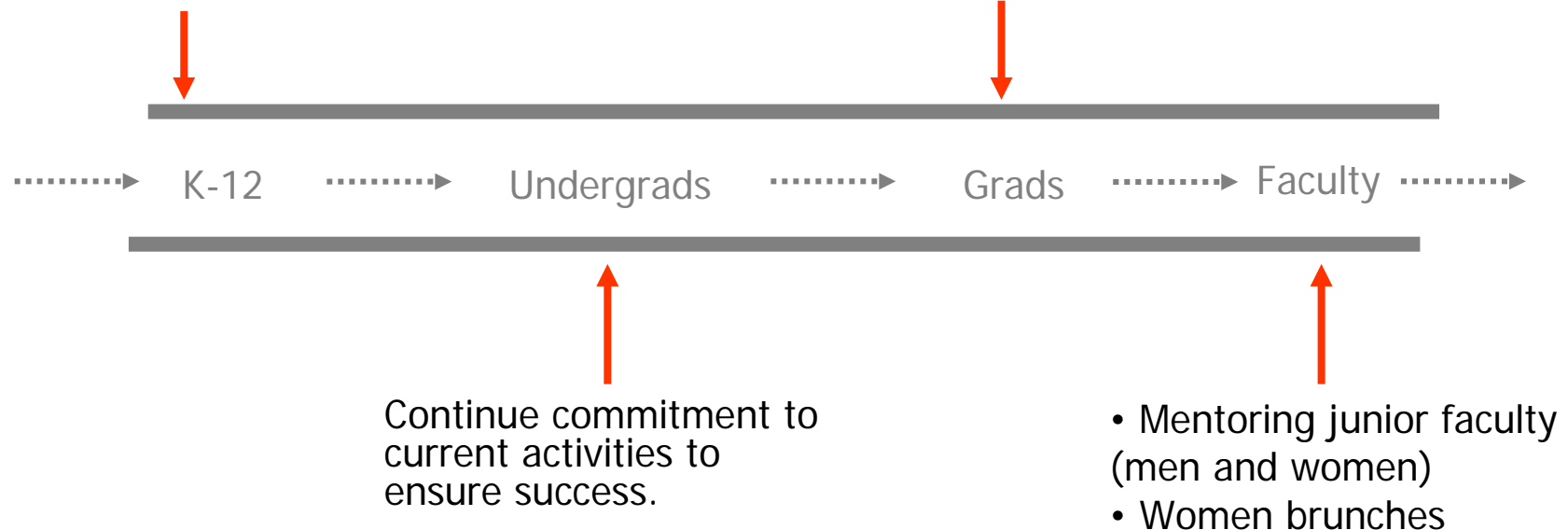
What We're Doing: Other Ends of Pipeline

Outreach:

- *CS4HS: to augment Teacher Training Workshops*
- Andrew's Leap: summer program for local elite HS students
- Pennsylvania Governor's School for the Sciences
- Summer Academy for Mathematics and Science (for underrepresented minorities)
- Women@SCS Roadshows

Pay more attention

- Barbara Lazarus Women@IT (Sloan Foundation) fellowships for women with non-CS backgrounds



What We're Doing: More Generally

Trying to change the public's misperception of Computer Science!

- Women@SCS Roadshows
- Want to change AP CS exam
- Send this message: Computer Science is for everyone, not just those who want to be computer scientists.

We need
everyone's
help on this.

You can major in computer
science and do anything!

More on this later...

- Spread my vision on Computational Thinking

What *You* Can Do

- Outreach
 - Your local grade schools and high schools: teachers and students
 - Summer and weekend programs
- Diversity In, Diversity Throughout
 - Understand your clientele: Where do they come from and where are they going?
 - Make your program attractive to a diverse set of students, men and women.
 - Present Computer Science for what it is; don't dumb it down.
- *Easy!* Replicate Women@SCS, roadshows
 - <http://women.cs.cmu.edu/>

Reminders

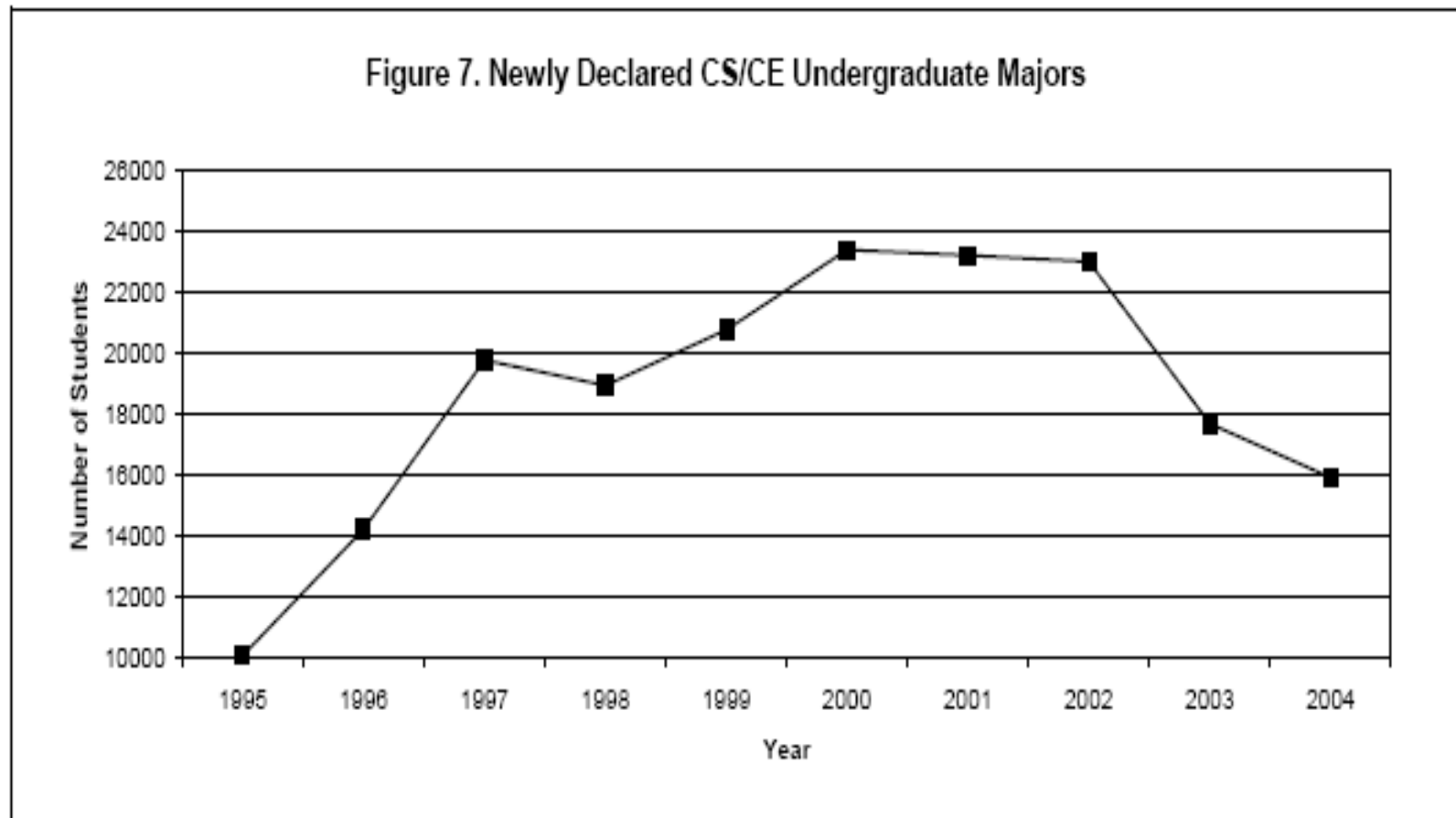
- Don't make women seem different.
- Not all women want to associate with "women's" organizations.
- Respect women for their talent, ability, and achievements.
- Encourage and support girls' and women's interest in science and engineering—in the classroom, in college, in grad school, for their future career.
- Be sensitive
 - To potentially offensive remarks or behavior

But looking ahead, all is not rosy...

Now and Tomorrow: Numbers

Year	Applied		Admitted		Enrolled	
	Total	Women	Total	Women	Total	Women
		(% of all applicants)	(% of applied)	(% of female applicants)		(% of total enrolled)
1995	1484	160 (11%)	382 (26%)	54 (34%)	96	7 (7%)
1996	2182	231 (11%)	479 (22%)	87 (37%)	142	23 (16%)
1997	2222	248 (11%)	481 (21%)	87 (35%)	136	18 (13%)
1998	2364	274 (12%)	462 (19%)	96 (35%)	140	27 (19%)
1999	2680	342 (13%)	454 (17%)	122 (36%)	130	50 (38%)
2000	2876	404 (14%)	386 (13%)	158 (39%)	132	51 (39%)
2001	3237	435 (15%)	402 (12%)	157 (36%)	130	47 (36%)
2002	2328	285	379	113	133	33 (25%)
2003	2066	257	385	128	136	42 (31%)
2004	1872	190	393	100	130	29 (22%)
2005	1734	200	384	107	140	33 (24%)

Declining Interest in Computer Science By All



From Taulbee Survey 2004

What We're Doing: More Generally

Trying to change the public's misperception of Computer Science!

- Women@SCS Roadshows
- Want to change AP CS exam
- Send this message: Computer Science is for everyone, not just those who want to be computer scientists.

We need everyone's help on this.

You can major in computer science and do anything!

More on this now...

- Spread my vision on Computational Thinking
 - <http://www.cs.cmu.edu/~wing/>

My Grand Vision for the Field

- **Computational thinking** will be a fundamental skill used by everyone in the world by the middle of the 21st Century.
 - Just like reading, writing, and arithmetic.
 - Imagine every child knowing how to think like a computer scientist!
 - Incestuous: Computing and computers will enable the spread of computational thinking.

Examples of Computational Thinking

- How difficult is this problem and how best can I solve it?
 - Theoretical computer science gives precise meaning to these and related questions and their answers.
- C.T. is thinking recursively.
- C.T. is reformulating a seemingly difficult problem into one which we know how to solve.
 - Reduction, embedding, transformation, simulation
- C.T. is choosing an appropriate representation or modeling the relevant aspects of a problem to make it tractable.
- C.T. is using abstraction and decomposition in tackling a large complex task.
- C.T. is judging a system's design for its simplicity and elegance.
- C.T. is type checking, as a generalization of dimensional analysis.
- C.T. is prevention, detection, and recovery from worst-case scenarios through redundancy, damage containment, and error correction.
- C.T. is modularizing something in anticipation of multiple users and prefetching and caching in anticipation of future use.
- C.T. is calling gridlock deadlock and avoiding race conditions when synchronizing meetings.
- C.T. is using the difficulty of solving hard AI problems to foil computing agents.
- C.T. is taking an approach to solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science.

Please tell me your favorite examples of computational thinking!

Evidence of Computational Thinking's Influence

- Computational thinking, in particular, machine learning has revolutionized **Statistics**
 - Statistics departments in the US are hiring computer scientists
 - Schools of computer science in the US are starting or embracing existing Statistics departments
- Computational thinking is CMU's current big bet in **Biology**
 - Algorithms and data structures, computational abstractions and methods will inform biology.
- Computational thinking is CMU's next big bet in
 - **Game Theory**
 - Electronic marketplaces, multi-agent systems, security, and networking
 - **Nanocomputing**
 - Molecular-scale computing based on reconfigurable fabric makes the chemistry easier.

Analogy

The **boldness** of my vision: Computational thinking is not just for other scientists, it's for *everyone*.

- Ubiquitous computing was yesterday's dream, today's reality
- Computational thinking is today's dream, tomorrow's reality

Computational Thinking

- Conceptualizing, not programming
 - Computer science is not just computer programming
- Fundamental, not rote skill
 - A skill every human being needs to know to function in modern society
 - Rote: mechanical. Need to solve the AI Grand Challenge of making computers “think” like humans. Save that for the second half of this century!
- Ideas, not artifacts
 - It’s not just the software and hardware that touch our daily lives, it will be the computational concepts we use to approach living.
- It’s for everyone
 - C.T. will be a reality when it is so integral to human endeavors that it disappears as an explicit philosophy.

What We Can All Do Together

Join us at Carnegie Mellon and spread our vision for the
21st Century:

Make computational thinking commonplace!