COMPUTER SCIENCE CURRICULUM PROPOSAL

OVERVIEW

In our most recent (2009) CS curriculum revision we:

1. **Added a rotating set of introductory courses** to attract and engage a variety of students. Enrollments in introductory courses have increased significantly since this change, although these courses cover less core CS content than did the previous introductory course.
2. **Formalized the role of laboratories** in introductory courses and in Computer Science II. Students clearly benefit from the extra contact time with faculty, although CS faculty do not receive teaching credit for laboratories, unlike the other science faculty.
3. **Reduced the number of courses required** for the major and minor, to have fewer under-enrolled CS courses and to make it easier to combine CS with other academic programs. However, this weakened the experience students received relative to other programs, and removed the common capstone experience, which the College has since formalized as the Culminating Undergraduate Experience (CUE).
4. **Simplified the prerequisite structure** to make advanced courses more accessible to CS students and other interested students. However, there has been little interest in advanced CS courses from students in other programs, and fewer prerequisites lead to students being inadequately prepared for advanced courses. Thus, material formerly covered in prerequisites is now duplicated between courses, further reducing time for core course content. The earlier decision to discontinue **MTH 215: Discrete Structures** also contributes to this problem.

Thus, changes 1 and 2 have generally had the intended outcomes, while 3 and 4 have had mixed results, and some adverse effects on CS majors and minors. Therefore, we propose the following adjustments:

1. **Restore the number of courses in the CS major** from 10 (2 math, 8 CS) to 12 (2 math, 10 CS), including **CSI 370: CS Seminar** as the Culminating Undergraduate Experience (CUE). This provides appropriate and necessary depth and breadth for CS majors, and is consistent with other programs. The CS minor is unchanged.
2. **Restore selected prerequisites to advanced electives**, to ensure that students are adequately prepared for advanced courses and to reduce content duplicated between courses.

These changes will not have significant staffing implications. Two CS faculty members can continue to offer enough courses for students to complete the major and minor. In the future, we hope to identify suitable adjunct faculty so we are able to offer 7-8 courses each semester (as shown below).

BACKGROUND

As a academic discipline, **CS changes rapidly and can be approached from varied perspectives**.
This is evidenced by a variety of curricular models (see references):

1. The **Computing Accreditation Commission** (CAC), part of the **Accreditation Board for Engineering and Technology, Inc** (ABET), is the accrediting body for undergraduate CS programs.
2. The **ACM/IEEE Joint Task Force on Computing Curricula** develops the most widely used curricular models.
3. The **Liberal Arts Computer Science Consortium** (LACS) consists of CS programs at a set of elite liberal arts colleges, and also publishes model curricula.

At Muhlenberg, our goal is to balance the ACM/IEEE and LACS recommendations, and to be consistent with CS programs at our overlap institutions. CAC/ABET accreditation requires more faculty, technical support, facilities, and coursework than are currently possible at Muhlenberg.

As an academic discipline, **CS also faces unusual challenges**. Most math and science majors had 3 or 4 years of both math and science in high school, while very few CS students had more than 1 year of CS, and many had none, since CS is not a standard element in most high school curricula. The foundations of CS are mostly in discrete mathematics, not calculus or statistics, so that CS programs need separate mathematics courses, or must cover these topics within existing CS courses (as we do at Muhlenberg). Laboratories are common in most science courses, but CS programs often lack the space, staff, and budget for laboratories appropriate to CS courses (at Muhlenberg, CS courses meet 3-4 hours/week, while other science courses often meet 6-7 hours/week).

PROPOSED CS CURRICULA

The proposed CS course offerings are divided into three categories:

- **Introductory Courses** (only one may count as a major or minor requirement)
  - CSI 102: Computer Science I – Intro to Game Programming
  - CSI 104: Computer Science I – Intro to Robotics
  - CSI 106: Computer Science I – Intro to Multimedia Computing
  - (other CSI 1xx courses may be developed and offered as time and interest permit, such as Scientific Computing, or Computing and Cognition)
- **5 Other Required Courses** (prereqs)
  - CSI 111: Computer Science II — CSI 1xx
  - CSI 210: Software Engineering (W) — CSI 111
  - CSI 220: Data Structures and Algorithms — CSI 111
  - CSI 240: Computer Organization — CSI 1xx
  - CSI 370: Computer Science Seminar (W, CUE) — CSI 210, 220. 240
- **Elective Courses** (4 required for major) (prereqs)
  - CSI 305: Database Systems — CSI 220
  - CSI 310: Theory of Programming Languages — CSI 220
  - CSI 326: Artificial Intelligence — CSI 210, 220
  - CSI 345: Internet Programming — CSI 220
  - CSI 350: Operating Systems — CSI 220, 240
  - CSI 355: Computer Networks — CSI 220, 240

MAJOR/MINOR REQUIREMENTS

	Current Minor		Current Major		Revised Major	
description	**#**	**courses**	**#**	**courses**	**#**	**courses**
Mathematics	1	MTH 121	2	MTH 121, MTH 122 or 119	2	MTH 121, MTH 122 or 119
CS required	3	CSI 1xx, 111, CSI 220	4	CSI 1xx, 111, CSI 220, 240	6	CSI 1xx, 111, CSI 210, 220, 240, 370
CS electives	2		4		4	
TOTAL	6		10		12	

DEPARTMENT POINT OF VIEW

B=Benjamin, K=Kussmaul

Anticipated Typical Course Offerings		
Fall Semester	**Spring Semester**	**Notes**
B: CSI 1xx: Computer Science I K: CSI 1xx: Computer Science I	B: CSI 1xx: Computer Science I K: CSI 1xx: Computer Science I	Intro
K: CSI 111: Computer Science II B: CSI 220: Data Struct. & Algorithms K: CSI 370: CS Seminar (W,CUE)	K: CSI 111: Computer Science II B: CSI 240: Computer Organization	Required
B: 1 elective (rotating)	B: 1 elective (rotating) K: 1 elective (rotating)	Elective
6 courses	**6 courses**	**12 total**
Fall Semester	**Spring Semester**	**Notes**
B: CSI 1xx: Computer Science I	B: CSI 1xx: Computer Science I K: CSI 1xx: Computer Science I	Intro
K: CSI 111: Computer Science II B: CSI 220: Data Struct. & Algorithms K: CSI 370: CS Seminar (W,CUE)	K: CSI 111: Computer Science II K: CSI 210: Software Engineering (W) B: CSI 240: Computer Organization	Required
B: 1 elective (rotating) K: 1 elective (rotating)	B: 1 elective (rotating)	Elective
6 courses	**6 courses**	**12 courses**

Ideal Course Offerings		
Fall Semester	**Spring Semester**	**Notes**
CSI 1xx: Computer Science I (x3)	CSI 1xx: Computer Science I (x3)	Intro
CSI 111: Computer Science II CSI 220: Data Struct. & Algorithms CSI 370: CS Seminar (W,CUE)	CSI 111: Computer Science II CSI 210: Software Engineering (W) CSI 240: Computer Organization	Required
2 electives (rotating each year)	2 electives (rotating each year)	Elective
8 courses	**8 courses**	**16 total**

STUDENT POINT OF VIEW

4 year CS course sequence for CS majors		
Year	**Fall Semester**	**Spring Semester**
1	CSI 1xx: Computer Science I	CSI 111: Computer Science II
2	CSI 220: Data Struct. & Algorithms Mathematics elective	CSI 240: Computer Organization Mathematics elective
3	CS elective	CSI 210: Software Engineering (W) CS elective
4	CS elective CSI 370: CS Seminar (W, CUE)	CS elective
total	**6 courses**	**6 courses**

3 year CS course sequence for CS majors		
Year	**Fall Semester**	**Spring Semester**
1	CSI 1xx: Computer Science I Mathematics elective	CSI 111: Computer Science II Mathematics elective
2	CSI 220: Data Struct. & Algorithms CS elective	CSI 240: Computer Organization CSI 210: Software Engineering (W)
3	CS elective CSI 370: CS Seminar (W, CUE)	CS elective CS elective
total	**6 courses**	**6 courses**

REFERENCES

ACM/IEEE models http://www.computer.org/portal/web/education/Curricula

- Tucker, et al. *Computing Curricula 1991*. ACM and the IEEE Computer Society.
- ACM/IEEE-CS Joint Task Force. *Computing Curricula 2001*. *Journal of Education Resources in Computing* 1(3) 2001.
- ACM/IEEE-CS Interim Review Task Force. *Computer Science Curriculum 2008.*
- ACM/IEEE-CS Joint Task Force. *Computer Science Curricula 2013.* (Strawman draft)

Liberal Arts Computer Science Consortium models http://www.lacs.edu

- Gibbs and Tucker. A model curriculum for a liberal arts degree in computer science. *Communications of the ACM,* 29(3):202-210, 1986.
- Liberal Arts Computer Science Consortium. A 2007 model curriculum for a liberal arts degree in computer science. *Journal of Education Resources in Computing,* 7(2), 2007.
- Walker and Schneider. A revised model curriculum for a liberal arts degree in computer science. *Communications of the ACM,* 39(12):85-95, 1996.

ENROLLMENT HISTORY

Course	Fall 2007	Spr 2008	Fall 2008	Spr 2009	Fall 2009	Spr 2010	Fall 2010	Spr 2011	Fall 2011	Spr 2012	Fall 2012	Spr 2013
CSI 102: Game Programming (2 sections in some terms)		18		15		22		15 10	9 12		19	22
CSI 104: Robotics	6		9				14	15		10		
CSI 106: Media Computing							6	8	11	22	23	18
CSI 110: Computer Science I (2 sections in some terms)	10 10	17	7 8	15	6	9						
Service Subtotal	**26**	**35**	**24**	**30**	**6**	**31**	**20**	**48**	**31**	**32**	**42**	**40**
CSI 111: Computer Science II	7	6		5		5		8	14	9	12	12
CSI 210: Software Engineering	7		5				3			12		
CSI 220: Data Struct. & Alg.		8		5					6		12	
CSI 240: Computer Organization		7		3			3			13		10
Core Subtotal	**14**	**21**	**5**	**13**	**0**	**5**	**6**	**8**	**20**	**34**	**24**	**22**
CSI 305: Database Systems				7								
CSI 310: Prog. Languages	5			8								20
CSI 326: Artificial Intelligence			7								7	
CSI 345: Web Software Dev											10	
CSI 350: Operating Systems		4				4						
CSI 355: Computer Networks					5							9
Elective Subtotal	**5**	**4**	**7**	**15**	**5**	**4**	**0**	**0**	**0**	**0**	**17**	**29**
Total	**45**	**60**	**36**	**58**	**11**	**40**	**26**	**56**	**51**	**66**	**83**	**91**

Notes

prior to 2010 CSI 102,104, etc offered as special topics courses
2009-2010 Clif Kussmaul on sabbatical, David Nelson's final year teaching
2010-2011 first year for current CS curriculum