Resolution # 8

TO: President John E. Van de Wetering

FROM: The Faculty Senate Meeting on: February 17, 1997

RE: I. Formal Resolution (Act of Determination)
   II. Recommendation (Urging the fitness of)
   III. Other (Notice, Request, Report, etc.)
For your information

SUBJ: Resolution on Combined Bachelor's/Master's Degree Program in Computational Science

Signed: [Signature]
(Faculty Senate President)

Date Sent: 2/19/97

TO: The Faculty Senate

FROM: President John E. Van de Wetering

RE: I. Decision and Action Taken on Formal Resolution
   a. Accepted. Effective Date: 3/19/97
   b. Deferred for discussion with the Faculty Senate on
   c. Unacceptable for the reasons contained in the attached explanation

II. III.
   a. Received and acknowledged
   b. Comment:

DISTRIBUTION: (Cover sheet only) Full resolution can be obtained from Faculty Senate upon request

Distribution Date: 2/19/97

[Signature]
(President of the College)
Combined Bachelor's/Master's

Degree Program

in

Computational Science

Submitted to

The Faculty Senate
SUNY College at Brockport

October, 1996
I. Introduction and Rationale:

The Faculty Senate approved on May 9, 1996 a proposal from the School of Letters and Sciences to institute Baccalaureate and Masters Degree Programs in Computational Science at SUNY Brockport. As a follow up to this we propose to offer a combined Bachelor’s/Master’s Degree program in Computational Science. The rationale for offering the combined degree program is much the same as those of the other senate-approved programs in Computational Science. The proposed program seeks to provide a fast track for capable students to obtain a masters degree in five years as opposed to the normal six years. All across the academic spectrum of this country increasing number of institutions are resorting to the combined masters program by carefully pruning and restructuring degree requirements. We believe that such a program will be timely in the context of critical need for application-oriented scientists with skills in high-performance computing. For a more detailed rationale for introducing degree programs in Computational Science we refer you to the "Baccalaureate and Masters Degree Programs in Computational Science" approved on May 9, 1996 by the Faculty Senate.

\^[1\]vide SUNY at Albany Catalog pages 20 and 33. Copies attached.
II. Five-year combined Bachelor's/Master's Degree Program in Computational Science (56 credits)

A. Required courses (47 credits)

Mathematics courses (15 credits):
- Calculus III (MTH 203) 3
- Linear Algebra (MTH 424) 3
- Statistical Methods II (MTH 442) 3
- Numerical Analysis (MTH 471) 3
- Discrete Mathematics II (MTH 481) 3

Computer Science courses (11 credits):
- Fundamentals of Computer Science II (CSC 205) 4
- Advanced Data Structures (CSC 406) 4
- Parallel Computing (CSC 444) 3

Computational Science Courses (21 credits):
- Applied and Computational Mathematics (CPS 404) 3
- Dynamical Systems (PHS 302) 3
- Scientific Visualization (CPS 433) 3
- Computational Methods in Physical Sciences (CPS 604) 3
- Advanced Instrument Interfacing Laboratory I & II (CPS 608, CPS 609 - 1 credit each) 2
- Deterministic Dynamical Systems (CPS 632) 3
- Stochastic Dynamical Systems (CPS 633) 3
- Graduate Seminar (CPS 698) 1

B. Elective Courses (Two courses) 6


C. Computational Project Culminating in a Project Paper, or Practicum, or internship (CPS 700) 3

Prerequisites:
- Calculus I & II (MTH 201 & 202 - 6 credits)
- Discrete Mathematics I (MTH 281 - 3 credits)
- Fundamentals of Computer Science I (CSC 203 - 4 credits)
- College Physics I & II (CPS 201, CPS 202 - 8 credits)
- Probability and Statistics (MTH 346 - 3 credits)
- Instrument Interfacing I & II (PHS 408, PHS 409 - 1 credit each)
- Statistical Methods I (MTH 441 - 3 credits)
A five-year schedule of the combined Bachelor's/Master's Degree Program in Computational Science.

Fall

YEAR I
(3cr) MTH 201 CALCULUS I (N)
(4cr) PHS 201 COLLEGE PHY. I
(3cr) ELECTIVE (F)
(3cr) ELECTIVE (H)
(3cr) ELECTIVE (P)

YEAR II
(4cr) CSC 203 FUND. COMP. SC. I
(3cr) MTH 281 DISCRE. MATH. I
(3cr) MTH 203 CALCULUS III
(3cr) ELECTIVE (SC)
(3cr) ELECTIVE (F)

YEAR III
(3cr) MTH 441 STAT. METH. I
(3cr) MTH 471 NUM. ANALYSIS
(3cr) UG-MAJOR ELECTIVE
(3cr) ELECTIVE (AI)
(3cr) ELECTIVE

YEAR IV
(4cr) CSC 406 ADV. DATA STRUC.
(3cr) CPS 404 APPLIED & COMP. MATH
(1cr) PHS 408 INSTRU. INTER. I
(3cr) ELECTIVE

YEAR V
(1cr) CPS 606 ADV. INSTRU.
INTERFACING LAB. I
(3cr) CPS 604 COMP. METHODS IN
PHYSICAL SCIENCES
(3cr) CPS 632 DET. DYNAMICAL SYS.
(1cr) CPS 698 GRADUATE SEMINAR

Spring

YEAR I
(3cr) MTH 202 CALCULUS II
(4cr) PHS 202 COLLEGE PHY. II
(3cr) CSC 120 INTRO TO CS (T)
(4cr) ELECTIVE (L)

YEAR II
(4cr) CSC 203 FUND. COMP. SC. II
(3cr) MTH 481 DISCRE. MATH. II
(3cr) ELECTIVE (H)
(3cr) ELECTIVE

YEAR III
(3cr) MTH 442 STAT. METH. II
(3cr) MTH 424 LINEAR ALGEBRA
(4cr) UG-MAJOR ELECTIVE
(3cr) ELECTIVE (W)
(3cr) ELECTIVE

YEAR IV
(3cr) MTH 443 STAT. METH. III
(3cr) MTH 424 LINEAR ALGEBRA
(4cr) UG-MAJOR ELECTIVE
(3cr) ELECTIVE (W)
(3cr) ELECTIVE

YEAR V
(1cr) CPS 609 ADV. INSTRU.
INTERFACING LAB. II
(3cr) CPS 700 PROJECT PAPER
(3cr) CPS 631 STOC. DYN. SYS.
(3cr) Grad-ELECTIVE

TOTAL CREDITS FOR THE 1ST YEAR (14+16) = 30
TOTAL CREDITS AT THE END OF FIRST YEAR = 30

TOTAL CREDITS FOR THE 2ND YEAR (16+16) = 32
TOTAL CREDITS AT THE END OF TWO YEARS = 62

TOTAL CREDITS FOR THE 3RD YEAR (15+16) = 31
TOTAL CREDITS AT THE END OF THREE YEARS= 93

TOTAL CREDITS FOR THE 4TH YEAR (14+16) = 30
TOTAL CREDITS AT THE END OF FOUR YEARS = 123

TOTAL CREDITS FOR THE 5TH YEAR (8+10) = 18
TOTAL CREDITS AT THE END OF FIVE YEARS = 141
III. Admission: Requirements and Procedures

Before applying to the combined program, students must have met the college admissions criteria and been admitted to an undergraduate program. Students may apply for admission to the combined degree program in computational science at the beginning of their junior year or after the successful completion of 54 credits, but no later than the accumulation of 100 credits.

IV. General Requirements for Degree Completion

A minimum of 138 credits, of which at least 30 must be at the graduate level, is required. In qualifying for the B.S., students must meet all requirements for graduation at SUNY Brockport including the major requirements for computational science. (vide Proposal for B.A./B.S. in Computational Science approved by the Faculty Senate on May 9, 1994).

In qualifying for the M.S., students must meet all college requirements as outlined in the Graduate Catalog. Up to 12 graduate credits may be applied simultaneously to both the B.S. and M.S. programs. Students are considered as undergraduates until completion of 120 graduation credits and satisfactory completion of all B.S. requirements. Upon meeting B.S. requirements, students are automatically considered as graduate students.

V. Faculty, Facilities, and Students:

The combined masters program does not envisage offering any new courses other than those envisioned in the already approved Baccalaureate and Masters Degree Programs in Computational Science. Hence there is no need for new faculty or facilities. As a matter of fact, we have improved our computing facilities since our last year's proposal on Computational Science by building up 25-unit, networked SUN workstations with visualization and multimedia capabilities. With the introduction of the "technology fee" we are very positive of being current in the area of technology.

The most important aspect of this proposal is the recruitment of students who can successfully master this interdisciplinary and application-oriented subject. The success or failure of this and other programs in Computational Science hinges on the quality of the students we are able to attract and retain. While this is no small challenge, it is a creative challenge that needs to be met squarely. There are positive indicators to the effect that we can target and recruit students having appropriate background. Existence of a large number of
undergraduates in the natural sciences on campus, novelty of
the program, absence of competitive programs from local
institutions are among the reasons for hopes in successful
student recruitment. Further, a combined masters program like
this provides a fast track for capable students to obtain a
masters degree in five years as opposed to the normal six
years. This would be a great incentive to students and parents
alike for obvious reasons.

Reference:
"Baccalaureate and Masters Degree Programs in Computational
Science", by School of Letters and Sciences and approved by
the Faculty Senate on May 9, 1996.
Course Descriptions:

CSC 203 Fundamentals of Computer Science: prerequisites: MTH 122 and CSC 120, or equivalent by permission of instructor. Fundamental computer science concepts and programming in C++. Computing system concepts, problem solving, algorithm design, top-down development, program testing and documentation, data types (built-in and enumerated), data manipulation, sequencing, selection, loops, modules, parameters, arrays, records, sets, strings, files, introduction to sorting and searching techniques and other basic algorithms. Extensive programming and supervised laboratory sessions. 4 credits

CSC 205 Fundamentals of Computer Science: prerequisites: MTH 281 and CSC 203. Abstract data structures and their operations, and software engineering concepts. Topics include: program development (interpreting specifications, top-down development, information hiding, structured testing), implementation of built-in data types and structures, files, pointers, stacks, queues, linked lists, recursion, trees, searching and sorting algorithms, introduction to complexity analysis of algorithms. Extensive programming and supervised laboratory sessions. 4 credits

CSC 406/506 Advanced Data Structures: prerequisites: CSC 205 and MTH 481. Covers the design and analysis of data structures and associated algorithms. Includes these topics: arrays, strings, stacks, linear and generalized lists, multilists, multirings, queues, sets, hashing, trees, graphs, recursion, searching and sorting, and applications such as text processing, polynomials, sparse matrices, storage management, and unlimited-precision arithmetic. Requires extensive programming. 4 credits

CSC 444/544 Introduction to Parallel Computing: Prerequisites: MTH 481 and CSC 406. This course deals with design and analysis of parallel algorithms. Topics include: parallel models of computation, measures of complexity, parallel algorithms for selection, searching, sorting, merging, matrix algorithms, transitive closure, connected components, shortest path, minimum spanning tree and routing algorithms. Hands-on experience in a parallel programming environment. 3 credits

MTH 203 Calculus III: Prerequisite: MTH 202. Infinite series, vectors and 3-space, polar coordinates, functions of several variables, applications of partial derivatives, and multiple integrals. The TI-85 graphics calculator is required for this course. 3 credits

MTH 424 Linear Algebra: Prerequisites: MTH 202 and either MTH 245 or MTH 281. Matrices and determinants and their uses, vector spaces and subspaces, dimension, linear transformations, and Euclidean vector spaces. 3 credits
MTH 442/542 Statistical Methods II: Prerequisite: MTH 441. One- and two-way analysis of variance, multiple regression, experimental design, and linear models. Uses computers for data analysis. 3 credits.

MTH 471/571 Numerical Analysis: Prerequisites: MTH 201 and CSC 203. Provides a survey of methods used to numerically approximate the solutions of a variety of mathematical problems. Covers the generation and propagation of round-off errors, convergence criteria, and efficiency of computation. Includes these topics: roots of non-linear equations, polynomial approximations, and an introduction to numerical differentiation and integration. 3 credits.

MTH 481/581 Discrete Mathematics II: Prerequisites: MTH 201 and MTH 281. A second course in discrete mathematics. Includes these topics: complexity of algorithms, recurrence relations, inclusion-exclusion principle, partial order and equivalence relations, graph theory, trees, Boolean algebra, grammars, formal languages, and finite-state machines. 3 credits.

PHS 201 College Physics I with Laboratory: Corequisite: MTH 201. This course deals with the fundamentals of mechanics and thermodynamics, including kinematics, Newton’s Laws, energy, rotational motion, kinetic theory of gases, and the first and second law of thermodynamics. Three hours of laboratory per week. 4 credits.

PHS 202 College Physics II with Laboratory: Prerequisite: PHS 201. Corequisite: MTH 202. This course deals with the fundamentals of electricity, magnetism, optics and sound, including the electric field, electric potential, electrical circuits, the magnetic field, Maxwell’s equations, and wave propagation. Three hours of laboratory per week. 4 credits.

CPS 404/504 Applied and Computational Mathematics: Prerequisite: MTH 202. This course will provide the mathematical skills for the development of efficient computational methods for several topics including: Elementary numerical methods and their computer implementation; Linear and nonlinear equations; Ordinary differential equations; Initial and boundary value problems; Modeling of data; Statistical distributions; Generation of random numbers, discrete-event simulations, and statistical analysis of the output of simulations; Introduction to stochastic processes; Markov decision chains and applications from transportation, inventory control, and health care; Discrete Fourier transform and its application to digital signal processing. 3 credits.

PHS 302 Dynamical Systems: Prerequisite: CPS 404. An introduction to dynamical systems. Topics include: conservation laws; phase space; Lagrange’s and Hamilton’s formulation of dynamics. Application include linear and non-linear oscillators, perturbation...
theory, and coupled oscillators. Chaotic dynamics is studied in computational problems; appropriate programming language such as C, C++, and software packages such as Mathematica will be used for problem solving and for determining equations of motion. A solid understanding of differential equations is essential. 3 credits.

*PHS 408/508 Instrument Interfacing Laboratory I: Corequisite: CPS 404. This course provides theoretical and practical knowledge of instrument interfacing techniques. Students will conduct experiments using modern instrument interfacing techniques to collect data. Includes experiments such as A/D - D/A feedback control; A/D workstation and temperature measurement; measurement of D/A Resolution; IEEE interfacing using a digital multimeter, and IEEE interfacing using a digital electrometer. 1 credit. Three hours of laboratory per week. [cross-listed with CHM 408]*

*PHS 409/509 Instrument Interfacing Laboratory II: Prerequisites: CPS 406. This course provides theoretical and practical knowledge of instrument interfacing techniques. Students will conduct experiments using modern instrument interfacing techniques to collect data. Includes experiments such as measurement of chemical luminescence; digital acquisition of spectrophotometer and gas chromatography data, digital acquisition of analog CCD (video) signal; Fourier transform infrared spectrometry; modern autosampling technology and robotics. 1 credit. Three hours of laboratory per week. [cross-listed with CHM 409]*

*CPS 433/533 Scientific Visualization: Prerequisites: MTH 424 and CSC 205. This course provides concepts and techniques for visualization and its implementation. Specifically, use of visualization tools in mathematical simulation modeling such as data entry and data integrity, code debugging and code performance analysis, interpretation and display of final results will be emphasized. Hands-on experience with visualization software packages in X-Windows environment will be provided. Students may be required to develop a new visualization software designed to aid in the analysis of a chosen problem. Knowledge of programming in a high-level language is essential. 3 credits.*

*CPS 604 Computational Methods in Physical Sciences: Prerequisite: CPS 404. Topics covered will include: Partial differential equations and its applications to fluid mechanics, ecology, and biophysics; Numerical solutions of elliptic, parabolic and hyperbolic partial differential equations; Random processes and partial differential equations; Time series analysis: autocorrelation function, cross correlation function, power spectrum, cross spectrum, and input-output relations; State-space concepts and equations; Spatial Pattern Formation: cellular automata and neural networks. 3 credits.*
CPS 608 Advanced Instrument Interfacing Laboratory I: Corequisite: CPS 604. This course provides theoretical and practical knowledge of instrument interfacing techniques. Students will conduct experiments using modern instrument interfacing techniques to collect data. These experiments include: RC, LC, and operational amplifying; A/D control of robotics via TTL logic/serial Port; pulsed instrument control and triggering with TTL logic; IEEE interfacing of a digital oscilloscope. 1 credit. Three hours of laboratory per week.

CPS 609 Advanced Instrument Interfacing II: Corequisite: CPS 633. This course provides theoretical and practical knowledge of instrument interfacing techniques. Students will conduct experiments using modern instrument interfacing techniques to collect data. These experiments include: Pulsed laser spectroscopy; Fourier analyzer; lock-in amplifier and phase sensitive detection; Fourier transform nuclear magnetic resonance spectrometry; and atomic emission spectroscopy. 1 credit. Three hours of laboratory per week.

CPS 632 Deterministic Dynamical Systems: Prerequisites: CPS 404 and MTH 424. This course will provide the mathematical and computational skills to model and analyze deterministic dynamical systems relevant to topics in the underlying disciplines. The course will have three components: lecture/discussion (50%), exercise/discussion on notebook modules on the internet (25%), and student project drawn from the student’s field of specialization. The lecture part will include:
- ODE: Linear systems (classification of phase portraits), Non-linear systems (linearization at a fixed point, stability at a fixed point, global phase portraits, limit points and limit cycles), and matrix method.
- Vector fields: solution curve, flow, orbits, and phase portraits. Some specific topics included are: fixed points, closed orbits, Poincare maps, families of systems and bifurcations.
- Sample list of models to be discussed: Oscillator, coupled oscillators, forced harmonic oscillator, competing species, volterra-lotha, van der pol oscillator logistic map (bifurcation), Duffing equation, etc. 3 credits.

CPS 633 Stochastic Dynamical Systems: Prerequisites: CPS 404, MTH 424 and MTH 346. This course will provide mathematical and computational skills to model and analyze a variety of stochastic dynamical systems relevant to the topics in the underlying disciplines. The systems will range from one-dimensional discrete time transformation through continuous time systems described by partial differential equations.
- The course will have three components: lecture/discussion (50%), exercise/discussion on notebook modules on the internet (25%), and student project drawn from the student’s field of specialization.

iv
The lecture component will include topics from advanced calculus, differential equations, ergodic theory, probability theory, Markov processes, stochastic integrals, and stochastic differential equations. 3 credits.

CPS 698 Graduate Seminar: This course will provide a forum for the review and discussion of new discoveries and ideas in computational science. The subject matter will consist of information of topical interest obtained from recent issues of computational science journals. Research carried out by students and/or faculty may also be described and discussed. 1 credit.

CPS 700 Project paper: A capstone project oriented course involving a computationally-oriented problem culminating in a project paper, or practicum, or internship. 3 credits.