

CALIFORNIA INSTITUTE OF TECHNOLOGY  
MINUTES OF THE FACULTY BOARD MEETING

May 19, 1986

3:00 P.M.

Millikan Board Room

Presiding: B.V. McKoy

Present: J.F. Benton, R.D. Blandford, J.E. Bercaw, N.H. Brooks, B.E. Cain, G.R. Cass, J.J. Hopfield, M.B. Kennedy, W.G. Knauss, F.E. Marble, R.A. Marcus, R.J. McEliece, H.D. Politzer, A.H. Zewail

F.C. Anson, M.L. Goldberger, D.M. Grether, P.C. Jennings, G.A. Lorden, J.J. Morgan, R.E. Vogt, P.J. Wyllie

E.M. Searle, W. Whaling

Absent: A.L. Albee, M.R. Hoffmann, L.E. Hood, G.R. Rossman, K.E. Sieh, E.C. Stone, H. Zirin

Invited Guests: E. Antonsson, J. Bower, C. Bures, S. Chan, D. Cohen, A. Duval, P. Feldman, C. Fu, C. Mead, S. Salyards, A. Skjellum, J. Strauss, B. Sturtevant, D. Van Essen

(1) The Minutes of the 21 April 86 Meeting were approved.

(2) There were neither announcements nor questions.

(3) In calling on Professor Sunney Chan for the report of the ad hoc Committee on the Core Curriculum, Faculty Chairman McKoy recalled that he and outgoing Faculty Chairman Cohen had appointed this Committee last summer to make a critical review of the core curriculum, and he thanked Chairman Chan and the members of the Committee for the time and effort spent on this important assignment.

Professor Chan announced that the Committee report is complete except for final reproduction. He distributed to the Board excerpts from the report [see the yellow appendix] containing recommendations for changes in the core curriculum, new courses, reduced requirements, and other initiatives designed to give the student greater freedom to explore his/her own interests.

Professor Chan stated that the Committee endorsed the principles on which Caltech's traditional curriculum is based but believes that certain evolutionary changes are needed to recognize, for example, the blurring of boundaries between disciplines. The Committee believes also that the intensity of our undergraduate program has gone too far. In its recommendations the Committee has aimed for a curriculum with greater breadth, less specialization, fewer requirements, more diversity, less pressure, more time for creative thinking, fewer homework problems, more independent projects.

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Following Professor Chan's presentation Board members had many questions that reflected support for the Committee's goals, but some uncertainty concerning detailed implementation of the recommendations. In particular, the proposal for the new HSS courses was found vague by some, ill-matched to the capabilities of the HSS staff by others, better suited to a two-year program in a balanced university than a one-year course in a technical university. There was also the complaint that the HSS recommendations preempt a similar review being carried out at present within the Division.

Several questioners found fault with the quarter system, asked if the Committee had considered the advantages of adopting a semester schedule. Professor Chan replied that the Committee believed the quarter system so deeply entrenched as to be immutable. President Goldberger asked about the January vacation that is a part of the semester system at MIT and many other schools, a vacation that is said to provide time for the independent study that the Committee seeks to encourage.

SC: "It is an academic farce. We visited MIT during January and could find few people on the campus; everyone leaves town. I think they go skiing."

In response to a question, Professor Chan reported that the Committee does not share the concern felt by some about our mechanisms for getting student feedback into the curriculum; he maintains that we do a much better job now than we did five years ago. The Provost quickly disagreed. He believes that much more can be and should be done, and he is now pressing the Division Chairmen to do it. The discussion made it clear that feedback through an ombudsman is more effective in some Divisions than in others.

Professor Knauss: Rather than drop the number of units required for graduation as a means of easing the pressure, would it not be better to curtail particular courses that produce the pressure. Third term seniors customarily take a very light load because they have already satisfied the graduation requirement. An even lower requirement would mean more and more students will try to earn both the B.S and M.S. degrees in four years.

Professor Politzer: Third term seniors have been so driven to satisfy requirements that when they finally get a chance to coast, they jump at it. At other schools the minimal requirements are easily met, and good students look around for something else to do. Other schools manage to encourage independent work by the best students by setting minimal graduation requirements.

Dean Lorden: Our graduation requirement of 43 units/term is just the base on top of which many students (and not necessarily the best) pile additional courses. To permit students to take 6 or 7 courses per term encourages superficiality. The Committee's report mentions another factor encouraging superficiality: the never-ending homework. Instructors assign it to get the student's attention, but with five homework sets due every week, there is no time to pursue anything in depth.

President Goldberger: Some schools use the senior thesis as a mechanism for incorporating independent research project into the curriculum. But you should be

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aware that it is very expensive in faculty time and effort.

Several questioners wondered what would happen to the Committee's recommendations and noted that some encroach on Divisional turf while others involve the whole Institute. Chairman McKoy replied that after he had read the full report he would meet with the ad hoc Committee and decide the appropriate destination for the various proposals, whether another faculty committee, a divisional or administrative office or the Faculty Board.

In thanking Professor Chan and the Committee members once again, Chairman McKoy noted that many of the recommendations are timely since they address problems raised at the recent student-faculty conference.

**(4) Professor Hopfield presented a proposal for a new graduate option in Computation and Neural Systems (CNS).** The proposed catalog statement is appended to these minutes [in blue]. Professor Hopfield noted that there are groups in several Divisions working in areas related to CNS:

In Biology, the research of Bower, Julesz, and Van Essen in visual perception and olfaction has strong aspects of the interdisciplinary connections described by the new option, and that of Allman, Konishi, and Lester often extends into this regime. C. Koch will be joining the faculty in the fall as an Assistant Professor in this research area, jointly appointed by Biology and Engineering.

In Engineering, the work of Abu-Mostafa, Barr, Mead, and Psaltis on computer hardware and software is directly related, and that of Kajiya, Posner, and McEliece also has appreciable connection.

In Physics, Fox is involved with the relation between problems and architecture, and Feynman's interest in the "physics of computation" extends into the domain of CNS.

The new option would provide a mechanism to foster interaction between these various groups. It would serve to attract students and new faculty to Caltech, possibly new funds as well. This is a new field that has not been worked elsewhere, but it is one in which there is widespread interest - graduates should have no trouble in finding attractive positions. Caltech's flexible academic organization makes this a particularly favorable location for such a hybrid enterprise to get started. The option will give this activity visibility and an official stamp of approval.

Following Hopfield's presentation, many others spoke in support of the new option including the President ("one of most exciting intellectual developments since I've been at Caltech"), the Provost (at length), the Division Chairmen, and many faculty members. It was noted that this proposal had the overwhelming endorsement of the Graduate Studies Committee. And many at JPL have an interest in CNS and would like to see this activity flourish on the campus. [The Secretary has never before seen this Faculty Board display such unanimity.]

To make a long story short, the Faculty Board voted unanimous approval of the

### Core Courses in Mathematics, Physics and Chemistry

The Committee notes with satisfaction that important progress has been made with respect to the core offerings in mathematics, physics and chemistry in terms of course coordination, teaching quality, feedback and workload. The Committee uncovered only two concerns in its discussions with students: (i) the dovetailing of the mathematics taught in mathematics courses with the mathematics needed in physics and chemistry could use further improvements; and (ii) there was a certain amount of discontent with Ph2abc, centered around both the level and the workload.

- (a) The Committee urges the Faculty teaching the core courses in mathematics, physics and chemistry to make a determined effort to ensure that there is satisfactory coordination between the mathematics taught in the Ma1abc, Ma2abc, and Ph1abc, Ph2abc, Ch1abc.
  
- (b) The Committee wishes to encourage the physics Faculty to reduce some of the pressure on students taking Ph2abc. Homework assignments should be reduced to one per week and no assignment should be made during mid-term week. In addition, the amount of material in the course should be prudently reduced. In particular, some less emphasis on waves in Ph2a would permit more time to be devoted to quantum mechanics. This should be done without increasing the ground to be covered in the latter subject.

## Humanities and Social Sciences

The Committee believes that the principal problem with the core courses in H/SS, and in particular the introductory courses, is that they are being conceived within frames of reference which are too specialized. The present approach is not only not in the best interests of the students, but goes against the basic educational philosophy of the Institute at large, which is committed to general educational goals, in the sciences, as well as in the areas of human and social studies.

(a) The Committee, therefore, recommends that the students' first-year program be 27 required units of general education courses in human culture and society. These courses should be integrated and interdisciplinary. A menu of four or five sets of such courses should be constructed, and entering students would submit a choice of their preferences and be assigned according to availability. These courses would bring the students to an interdisciplinary examination of some salient epoch or set of problems in human culture and society. They would not be "Humanities" or "Social Science" courses as such, but a coherent set of general education courses that might well be called "Human Culture and Society".

(b) The Committee, therefore, recommends the following scheme as a model for a 108 unit core program in H/SS:

If these recommendations are adopted, a possible course of study for the freshman and sophomore years may be as follows:

Proposed First Year Course, all options

<u>Course</u>	<u>Units per term</u>		
	1st	2nd	3rd
Ma1abc	9	9	9
Ph1abc	9	9	9
Ch1ab (or 2ab or 41ab)	9	9	
Introductory Humanities and Social Sciences	9	9	9
Introductory Laboratory			6
Science/Engineering Electives	6	6	6-9
P.E.	<u>3</u>	<u>3</u>	<u>3</u>
	45	45	42-45

Proposed Core Courses During Sophomore Year

<u>Course</u>	<u>Units per term</u>		
	1st	2nd	3rd
Ma2abc	9	9	9a
Ph2abc (Ph12abc)	9	9	9b
Humanities/Social Sciences	9	9	9
Introductory Laboratory Courses	6		

<sup>a</sup> Ma2c may be substituted by Ma100a, Ph20, etc.

<sup>b</sup> Ph2c may be substituted by APh17a, ChE63a, Ch21b or Ch24a

implementation. With the proposed "Across-the-Curriculum Adjunct Writing Program", writing will be handled by experts trained specifically for this purpose. The professors in H/SS will then be able to devote their energies totally to the teaching of the core subject matter.

- (e) The Committee recommends a small but important change which relates to foreign language courses. At present, students taking foreign languages can only receive humanities concentration credit for either the fifth or sixth term of such work. The Committee believes that students should be encouraged to take as much work in foreign languages as possible and that, therefore, they should receive concentration credit for two terms instead of one.

#### Computing Requirement

The Committee notes that not all students come to Caltech with a proficiency in computer programming, and that many of the computing science courses that are presently used to satisfy the computing requirement (CS10 (9 units), E1a (3 units), E1b (3 units), AMa98c (3 units), Ma4a (6 units), Ma4b (6 units), CS112 (9 units), Ph20 (3 units), Ph21 (3 units), Ph22 (3 units), Ph76 (6 units)) do not make allowance for the students' deficiency in this area.

The Committee wishes to recommend that the present computing requirement be replaced by a computing proficiency, to be satisfied along the same lines as the "Across-the-Curriculum Adjunct Writing Program". The Committee feels that the teaching of computer programming can be integrated across the curriculum, and urges Geoffrey Fox, Dean of Computing, to come up with a mechanism to facilitate this integration. The Committee would like to call attention to the pool of talent among our undergraduate students which might be tapped for this purpose.

## Overall Curriculum

The Committee is of the opinion that the overall curriculum presently is too intense. Caltech students spend too much time with their noses to the grindstone, and many do not find time to follow-up on things or pursue their intellectual interests. This workload stifles intellectual curiosity and even burns the students out. More importantly, the process goes counter to the educational goals of the Institute. Students should be allowed more time to think and do independent work. The Committee, therefore, recommends some loosening up of the curriculum along the following lines to ease the intensity, to broaden the students' scientific base, and to allow time for independent work that will be conducive to the students growth as creative scientists or engineers.

- (a) To ease the intensity, the Committee recommends:
  - (i) reducing the number of core courses taken per term by freshmen and sophomores from the present number of 5 to 4;
  - (ii) creating some flexibility in the core and the schedule of courses for the freshmen and sophomore years to allow time for more sampling and enrichment in the sciences, e.g. astronomy, biology, geological sciences, materials science, computer science, information science, etc. Toward this end, the Committee recommends to the Faculty that biologists, and other students in options which deem it appropriate, be allowed to consider substitutes for Ph2c (statistical physics). Possible substitute courses include Ch24ab, Ch21abc, ChE63abc, APh/Me17, etc. Along the same vein, the Committee recommends that similar substitutions be considered by the Mathematics Faculty for Ma2c (e.g. Ma100a, Ph20, CS10, etc.);
  - (iii) rename the "Freshman Laboratory" "Introductory Laboratory" to be taken any time during freshman and sophomore year, and to reduce the



requirement from the current 15 units to 12 units, i.e., Ch3a plus one other solid laboratory course;

- (iv) overloading by freshmen and sophomores be discouraged. The Committee recommends that students require specific approval of the Dean of Students to carry a load in excess of 51 units;
  - (v) no homework assignments should be due during mid-term periods;
  - (vi) the Institute consider shortening the school year.
- (b) To broaden the scientific base of the education, the Committee wishes to encourage all options to offer introductory courses in their respective fields to create opportunities for sampling and enrichment by freshmen and sophomores. These introductory courses should be introductory. The Committee recommends consolidating the present Ch1abc (18 units) into two terms of Ch1ab (18 units) to be offered during the fall and winter terms of the freshman year to specifically create a slot for a 9 unit introductory course in Biology.
- (c) to encourage and create time for independent work, such as undergraduate research, engineering design, engineering building projects, other project-oriented work, and participation in Honor Programs in Humanities, Social Sciences, or interdisciplinary work in Mathematics, Computer Sciences, Sciences and Engineering, the Committee recommends:
- (i) that the minimum unit requirement for graduation with the B.S. degree be decreased from 516 to 480 units;
  - (ii) that the Faculty consider making independent work, such as outlined above, be one of the criteria for graduation with Honors.

1.	<u>Introductory H/SS: Human Culture and Society</u> (Interdisciplinary courses in integrated sequences. Several sets of such courses should be fashioned; the emphasis should be general education -- an introduction to essential texts and issues.)	27 units
2.	<u>18 Unit Concentration in Humanities</u> (Literature, History, Philosophy, 5th and 6th terms of Language.)	18 units
3.	<u>18 Unit Concentration in Social Sciences</u> (Economics, Political Science, Psychology, Law, Anthropology.)	18 units
4.	<u>Required Elective Units in Humanities and Social Sciences</u>	45 units
	Total	108 units

If this model of the 108 unit core program is adopted by H/SS Division and approved by the Faculty, the H/SS part of the core will be greatly streamlined. The present requirements, according to the students, are too complex and intricate for simple comprehension: there is too much "fine-print" now, which is the cause of much confusion and misunderstanding.

- (c) In addition, the Committee endorses the recommendation of the Humanities Faculty that an Honors Program be instituted in Humanities and/or H/SS. This program would have its own special courses requirements within the general scheme outlined above. The Committee understands that the Honors Program would also require its students to take a number of elective units above the normal 45.
- (d) The Committee also strongly endorses the Humanities Faculty recommendation that an Across-the-Curriculum Adjunct Writing Program be instituted along with a Writing Center. The Committee understands that this writing program has been approved by the Faculty and that it now only awaits