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INDIANA UNIVERSITY OF PENNSYLVANIA
SENATE CURRICULUM COMMITTEE B-2

NEW COURSE PROPOSAL

Department: Computer Science

Person to contact for further information: John A. Cross, x4478.

Course Affected: CO 355 Computer Graphics

Desired Semester of Change: Fall 1986

Approvals:

Department Curriculum Committee Chairperson: _____

Department Chairperson: _____

College Advisory Committee Chairperson: _____

College Dean: _____

A. DESCRIPTION AND ACADEMIC NEED

A1. Catalog Description (attached)

A2. Course Syllabus (attached)

A3. Need Fulfilled

The field of computer graphics has experienced phenomenal growth in recent years. It is now a very active specialty area within computer science, with more than 20,000 in attendance at the National Computer Graphics Association (NCGA) meetings. Student interest is high, as evidenced by capacity registration each of the three times the "special topics course" has been offered. Employers are showing their interest by spending billions of dollars a year on computer graphics and increasingly by giving our students opportunities to work with computer graphics.

A4. Effect on Other Courses

No change in other courses is foreseen.

A5. Does this course follow traditional offerings in the

department?

The format of this course includes lectures, recitation groups, examinations, projects and written assignments. This is traditional in computer science. Recitation sections in this course will enable the instructor to present hands-on demonstrations and supervised laboratory experiences. This course is seen as an elective offering for upper level computer science majors.

A6. Has this course been offered at IUP on a trial basis?

Yes, it has been offered as a "Special Topics" course three times since Fall, 1982.

A7. Is this a dual level course?

No.

A8. Do other universities offer this course?

Yes, in a variety of forms. Titles such as "Computer Graphics" or "Interactive Computer Graphics" are common. A report listing over 100 U.S. colleges and universities which offer undergraduate courses in computer graphics was distributed at the 1984 ACM meeting of the Special Interest Group on Computer Science Education. (The University of Pittsburgh offers such a course in its undergraduate program.)

A9. Is this course recommended or required by a professional society?

Yes, by the Association for Computing Machinery (ACM) "Curriculum '78". In fact, a special session on undergraduate computer graphics has been a regular feature of the annual meeting of the ACM Special Interest Group on Computer Science Education (SIGCSE) since 1984. The National Computer Graphics Association (NCGA) would certainly recommend it, but they have not yet adopted any curriculum recommendations.

B. Interdisciplinary Implications

B1. Will the course be offered by one instructor or will there be a team?

The course will be offered by one instructor.

B2. Are additional or corollary courses needed?

We will list CO310 and Junior status as prerequisites. CO310 is "Data Structures."

B3. What is the relationship of the content of this course to the content of courses offered by other departments?

Although computer graphics is proving to be useful in many disciplines, such as art, business, geography and medicine, this course is not designed to service these areas. However, students may wish to take this course as part of a minor in Computer Science.

B4. Is this course applicable in a program of the school of continuing education directed at other than fulltime students?

No.

C. Evaluation

C1. What procedures are expected to be used to evaluate student progress?

Students will be evaluated on the basis of written examinations, projects using IUP graphics facilities and written projects.

C2. Variable credit?

No.

D. Implementation.

D1. What resources are needed to teach this course?

This course requires substantial use of graphics hardware and software. This will require significant (and continuing) investment in selecting, purchasing, maintaining and supporting computer systems with graphics capabilities. This will place knowledge and training burdens on faculty and computer center staff as the field grows. Also, this field is changing so rapidly that it is very important for the computer science faculty to be represented at a national computer graphics meeting at least every other year, if not

every year.

At present, our facilities are adequate for no more than 10 students per recitation (2 per workstation), and 30 students per semester. In the past we attempted to demonstrate the functionality and use of graphics hardware and software by occasionally scheduling class meetings in a room with 5 workstations (G-1). The success of the laboratory idea, plus the difficulty associated with having too many students in the lab, make it clear that a weekly laboratory meeting is needed.

D2. How many sections?

One lecture section (2 hours per week) and three recitation sections (1 hour per week). This arrangement for conducting the course is dictated by available facilities.

D3. How often will the course be offered?

Initially, once a year.

D4. How many students will be accommodated?

30 students maximum, due to equipment limitations and the project orientation of the class. The limit of 30 is necessitated by the need for out of class time on the graphics equipment, and out of class interaction with the instructor.

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COURSE SYLLABUS

Course Syllabus: CO 355, Computer Graphics

Date Submitted: January 15, 1986
(Revised: March 17, 1986; April 10, 1986)

Submitted by: John A. Cross

Department: Computer Science

I. Course Identification

CO 355; Computer Graphics; 3 credits; 1 recitation.

II. Catalog Description (attached)

III. Course Objectives

This course is proposed as a 300 level first course in computer graphics for computer science students. It is intended as an elective. Philosophically, the course is designed to provide hands-on experiences in a variety of computer graphics systems and detailed study of basic concepts as they are implemented in a particular system.

The breadth goal of the course is addressed by experiences with existing computer graphics hardware and software at IUP. Specific activities are suggested in section 5 of this syllabus. The depth goal is addressed in a core of traditional material, including output primitives, standards, 2D and 3D transformations, windowing and clipping, segmentation, curves and hidden lines (c.f. section IV of this proposal or the texts in the bibliography). An introductory assignment in interactive graphics is included because of the importance of fundamental concepts in this area, and the helpful way those concepts interrelate with the other topic areas.

IV. Course Outline:

Topics	Lectures	Labs
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> Graphics at IUP	4	2
> Output primitives	1	1
> Transformations of 2D images	3	2
> Curves	2	1
> Windowing and clipping	3	1
> Segmentation	2	1

> Fundamentals of interactive graphics	3	2
> Three dimensions	3	2
> Hidden surfaces and lines	2	1
> Presentation graphics	3	1
> Exams and major project	2	-
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* Total *	28	14

V. Procedures and Laboratory Plans

Two lecture hours and one small group recitation hour per week will be used to work toward the course objectives. Small group recitations are planned for a hands-on laboratory environment in which there are no more than two students per workstation. Experience gained in offering this course as a special topic supports this approach. Students need to work with graphics concepts in a supervised laboratory setting.

Likely lab activities to address the breadth concerns which are stated in section III, Course Objectives, include:

- presentation graphics (using ISSCO software),
- color graphics using the Tektronix 4105 color terminal,
- CP6 PLOT79 demonstration programs,
- interactive graphics using Macintosh computers for the development of a static image,
- the use of IBM clones, APPLES, and/or the VECTRIX for animation, and
- the Numonics digitizer for graphic input (currently located in G-1).

Lab activities for the fundamentals part of the course include the use of hands-on demonstration software which provides experience in the topic areas listed in the section III, Course Objectives. Experience in our special topics offerings of this course has shown that this kind of activity help students gain an understanding of the geometry inherent in these fundamentals, together with an appreciation for what the parameters are and what they do. The interactive graphics objective should really benefit from a lab activity. The feel of timing, pointing, and working with constraining interfaces is something that can be greatly enhanced by supplementing a lecture with hands-on experiences.

VI. Text

There are currently a number of new texts being published. The attached bibliography lists a number of them. We have tried Foley and van Dam and Harrington. At this time, the most appropriate choice appears to be a new book:

Hearn, Donald, and Pauline Baker. Computer Graphics. Englewood Cliffs, New Jersey: Prentice-Hall (1986). Reading, Massachusetts: Addison-Wesley Publishing Company, 1985.

VII. Additional Readings

No additional required student purchases are planned. Extensive bibliographies are available from ACM SIGGRAPH and within the IUP Computer Science Department. Students will be expected to read serial literature and/or proceedings of national meetings.

VIII. Evaluation

Evaluation in the special topics offerings of this course included the following items. The items that are really essential are the short programming projects and the exams. The others can be used or not as they fit a particular situation.

- (1) Two exams (a mid-term and a final)
- (2) Short programming projects
- (3) A major written project, with some implementation
- (4) Checkpoints for the major project, such as a problem definition or a software system design.
- (5) Quizzes

IX. Other Course Requirements

A scholarly research paper is not appropriate, but a literature search and a major project are viable options. A visit to a particularly interesting computer graphics facility might be worthwhile, but no specific field trip requirements are planned. Videocassettes and slides which are currently available in Stapleton Library are adequate at this point.

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CATALOG DESCRIPTION

CO 355 Computer Graphics

2c-1d-3sh

Prerequisites: CO 310 and Junior status.

The use of computer graphics hardware and software. An overview of current applications and experience with representative software will introduce current practice. Foundations in the primitives, geometry and algorithms of passive computer graphics are the principal focus of the course. A brief introduction to interactive computer graphics will be included.

BIBLIOGRAPHY

ACM SIGGRAPH, "Status Report of the Graphics Standard Committee, Computer Graphics 13(3), August 1979.

Angell, Ian O. A Practical Introduction to Computer Graphics. John Wiley & Sons, New York, 1981.

First published in Great Britain, this is a short and very mathematical introduction to how to do graphics. Its principle features are some good projects in the back, FORTRAN algorithms (most books use PASCAL), and a lot of help with the mathematics and geometry.

Barnett & Barnett, Personal Graphics for Profit and Pleasure on the APPLE IIE. Little, Brown, Publishing Company, New York, 1983.

Beebe, N., "A User's Guide to <PLOT 79>". Available through IUP Computer Science Department, copyright 1979.

Carlbon, I., and Paciorek, J. "Geometric Projection and Viewing Transformations," Computing Surveys, 1 (4), 465-502, 1978.

This article has been used as a handout to enhance student understanding of the basic ideas of 3D viewing. It is highly recommended, and it should have value for years to come.

Chambers, J., and W. Cleveland, B. Kleiner, P. Tukey, Graphical Methods for Data Analysis. Duxbury Press, Boston, 1983.

Creative Computing, Special Issue on Graphics, July, 1982.

Foley, J.F. and A. Van dam, Fundamentals of Interactive Computer Graphics, Addison-Wesley Publishing Company, MA, 1982.

This is a recommended text for the course. It is an updated, streamlined, version of the Newman and Sproulls classic. It attempts to be a tutorial and a reference, and it appears to be that. The professional relationship between Van Dam and Newman and Sproulls is apparent from many parts of the text and jointly authored articles referred to in the bibliography. PASCAL is used for all programming examples. On the negative side, some users have complained of its overemphasis of interactive graphics.

Giloi, W., Interactive Computer Graphics. Prentice-Hall, Inc., Englewood Cliffs, NJ, 1978.

IEEE Transactions on Consumer Electronics, Special Issue on TELETEXT and VIEWDATA, July, 1979.

Harrington, S., Computer Graphics. McGraw-Hill, Inc., New York, 1983.

This book was used in a special topics graphics course in Fall, 1985. It seems to work reasonably well, and it is a popular textbook, but it is cookbookish and low-level. Other people who used it spoke up at the 1985 ACM SIGCSE and stated that the book got people started, and the instructor had no trouble getting into all sorts of interesting things beyond the text.

ISSCO, "Choosing the Right Chart". San Diego, California 92121-1698: Integrated Software Systems Corporation (ISSCO), 1983.

Hearn, Donald and Baker, Pauline. Computer Graphics. Englewood Cliffs, New Jersey: Prentice-Hall, 1986.

As of March, 1986, this is the book of choice.

IUP Computer Center, "User's Guide to Graphics Systems Software". IUP Computer Center, Release B00, April, 1982.

IUP Computer Center, various CALFORM manuals and guides, maintained by IUP Computer Center.

Jarvis, R.A. "A Computer Vision and Robotics Laboratory," IEEE Computer, June 1982, Volume 15, No. 6, pp. 8-22.

Mehlmann, Marilyn. When People Use Computers, Prentice-Hall, Englewood Cliffs, NJ, 1981.

A brief, readable book on the design of human-computer interfaces.

Mufti, A., Elementary Computer Graphics. Reston Publishing Company, Reston, VA 22090, 1983.

All programming examples are in FORTRAN.

Myers, R.E. Microcomputer Graphics for the APPLE Computer (there is also an IBM edition). Reading, MA: Addison-Wesley Publishing Company, 1982.

Written by an IUP graduate, this is a popular low-level book. It was recommended by speakers and exhibitors at our 1983 Computer Art Exhibition.

Newman, W.M. and R.F. Sproull, Principles of Interactive Computer Graphics, 2nd ed., McGraw-Hill, New York, 1979.

The classic text for a course in how to do computer graphics. This book is used in the PITT Computer Science Graphics course. It is a very helpful reference for a teacher or programmer, and it has good exercises.

NCGA, "Proceedings of the Second Annual Conference (1981)" and "Proceedings of the Fourth Annual Conference (1983)". National Computer Graphics Association, Washington, D.C.

This has quickly become the largest computer graphics conference in the world (over 20,000 in 1982 and 1983). The 1981 proceedings often extensive coverage at a reasonable level of reading difficulty. The 1983 proceedings are more state-of-the-art with many fascinating color prints.

Park, Chan S. Interactive Microcomputer Graphics. Reading, Massachusetts: Addison-Wesley, 1985.

This book is a viable candidate for a class text. However, it uses IBM PC BASIC throughout, which restricts its applicability to an IBM PC (or clone) focussed course. This also limits algorithm expression and module interfacing.

Rogers, D. and J. Adams, Mathematical Elements for Computer Graphics. New York: McGraw-Hill Book Company, 1976.

This book is very similar to Angell (1981). However, BASIC is the language used in all the examples. The approach to implementing the basic manipulations is very different. (I find Angell's approach to be easier and more versatile.)

Rogers, David F. Procedural Elements for Computer Graphics. New York: McGraw-Hill, 1985.

This is a big step up over the BASIC edition. The use of PASCAL helps a great deal, and it graphically illustrates the benefits to be gained from choosing PASCAL over BASIC to publish algorithms.

Ryan, D., Computer Graphics Problems Manual. Brooks/Cole Engineering Division, Monterey, California, 1983.

Ryan, D., Computer Programming for Graphical Displays. Brooks/Cole Engineering Division, Monterey, California, 1983.

Scott, J.E. Introduction to Interactive Computer Graphics, John Wiley & Sons, New York, 1982.

The philosophy expressed in the preface appears to be better than what actually happens in the book. The discussion of hardware could be very helpful. Detail is lacking in many areas of computer graphics. There are no exercises or suggested projects. This could be a helpful source book for a broad, easy view of the concepts and terminology of computer graphics.

Sproull, R., Sutherland, W., and Ullner M. Device-Independent Graphics. New York: McGraw-Hill, 1985.

These are the biggest names in the field of applied computer graphics at the time of their publication of this inexpensive-looking two-tone spiral-bound book. It is definitely a respectable choice, but the emphasis on device independence leaves a lot of work to be done before students get to doing interesting graphics.

VECTRIX User's Manual. Greensboro, NC: Vectrix Corporation, 1983.

Williams, K. Kernaghan, B., & Kernaghan, L. APPLE II Computer Graphics. Bowie, MD: Robert J. Brady Co., 1983.

A fairly low-level and superficial book. Unsuitable for undergraduate computer science classes.