DOCUMENT RESUME

ED 083 823 EM 011 546

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TITLE Goals and Objectives for Computing in the Associated Colleges of the St. Lawrence Valley.
INSTITUTION Associated Colleges of the St. Lawrence Valley, Potsdam, N. Y.
REPORT NO ACSLV-WP-2
PUB DATE 1 Aug 73
NOTE 115p.

EDRS PRICE MF-$0.65 HC-$6.58
DESCRIPTORS Computer Oriented Programs; *Computers; *Consortia; *Cooperative Planning; *Cooperative Programs; Higher Education; Interagency Cooperation; Interagency Planning; *Networks; Program Descriptions
IDENTIFIERS ACSLV; *Associated Colleges of the St. Lawrence Valley

ABSTRACT

A forecast of the computing requirements of the Associated Colleges of the St. Lawrence Valley, an analysis of their needs, and specifications for a joint computer system are presented. Problems encountered included the lack of resources and computer sophistication at the member schools and a dearth of experience with long-term computer consortium planning. Among the goals postulated were the following: 1) to increase user services to all groups; 2) to increase access to the computer for instructional purposes; 3) to maximize resource utilization; and 4) to provide the needed hardware and software. A survey yielded the findings that a computer network was required to provide the desired services and that a cooperative, high level planning effort should be undertaken. It was recommended that: 1) The Associated Colleges of the St. Lawrence Valley (ACSLV) should be the administrative agency; 2) the financial stability of the ACSLV should be assured; 3) the necessary hardware should be located at one site; 4) equipment should be obtained on a lease-purchase agreement; and 5) the cost should be distributed according to a formual accepted by all members. (PB)

WORKING PAPER NUMBER TWO:

GOALS AND OBJECTIVES

FOR COMPUTING IN THE

ASSOCIATED COLLEGES OF THE ST. LAWRENCE VALLEY

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August 1, 1973

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GOALS AND OBJECTIVES FOR COMPUTING IN THE ASSOCIATED COLLEGES

I. Introduction

A. Background

Although a committee on computing predated the formation of the Associated Colleges of the St. Lawrence Valley, it was not until January of 1973 that direct progress toward planned cooperation in this field was realized. Among the reasons for this delay were the inadequate reporting of data needed for a comprehensive study, the institution of a statewide network affecting SUNY College at Potsdam, the presence of a self-fulfilling prophecy about the probable success of a joint computer study, the appearance of fiscal cutbacks which limited the interest in planning for any expanded services, the appearance of sporadic on-going changes in institutional computing machinery, and the existence of questions about the long-term viability of the consortium itself. To a large degree, many of the difficulties presented by these factors have either been eliminated or discounted.

In January of 1973, Working Paper #1, "Future Computing In The Associated Colleges," was completed. This document provided a comprehensive inventory of computing machinery and general pattern of operation for each of the four member colleges in the association. The working paper attempted to convey a sense of the problems and benefits attendant to cooperative computing. Several alternative patterns for

cooperative arrangements were discussed. An initial selection of one such pattern was suggested as being more likely than the others. A sample hardware configuration appropriate to the pattern selected was described to illustrate one method by which computing services for all of the colleges could be handled adequately.

Some of the contents of Working Paper #1 are included in this report. However, much of the data contained in that document has not been repeated. It is important to note, however, that the study was sent to each of the campuses for formal review and response. Each campus held a meeting of its computer users group to determine whether further efforts in this direction were feasible. Subsequently, all of the colleges agreed to continue the study at a higher level to determine the feasibility of actually implementing a cooperative system.

The Computer Committee for the consortium scheduled a number of activities to review the goals for computing throughout the colleges. These activities included the following:

1. The convening of a broadly-based computer users' group meeting on each campus. Each of these groups made specific responses to a generalized goals statement for computing within the four colleges. They also provided the Committee with a range of information about their campus's plans for new programs and activities requiring more computing over the planning period.

2. Four individuals attended a week-long institute on computing for college executives sponsored by the International

Business Machines Corporation. Several computing center staff also attended IBM seminars dealing with the System 370 line of computers;

3. William Lyman of Clarkson College of Technology prepared benchmark tests which were run on the major existing computers in an effort to obtain a limited measure of the computing "power" of existing machinery, and to provide a composite picture of the level of computing throughout the consortium;

4. A consultant, Mr. William Dempsey, of SUNY College at Plattsburgh, spent two days with the consortium. During this period, Mr. Dempsey looked into four questions of importance to the Computer Committee:

a. How applicable are the present data systems to the Western Interstate Commission for Higher Education format;

b. Do the projected changes in the data gathering and processing techniques projected for the planning period appear to be efficient and effective;

c. Given the projected development of data management systems at the four campuses, how appropriate will the systems be to future management needs;

d. What are the most constructive patterns of cooperation that would be possible among the four campuses, including joint use of computer software and hardware?

Data from Mr. Dempsey's visit is included in this report;

5. Dr. James Farmer of Systems Research, Inc., acted as a second consultant to the consortium. He spent one day with a fairly large group of representatives from all four campuses. During his visit, the assembled group discussed general principles of computing in higher education, computer network management, and the advantages and disadvantages of various configurations which were technically feasible;

6. This working paper was prepared by the Computer Committee to focus the findings of all of these activities, as well as the data obtained from the readings assembled by the Committee pertinent to our problem.

This phase of the computer study was designed to prepare information pertinent to four objectives. While the previous working paper considered information primarily from the point of view of establishing the feasibility of examining the prospects for consortium computing on a more intensive basis, the second phase from March 1st to May 30th had the following objectives:

1. To forecast computing requirements as accurately as possible for the time period 1975 to 1980;

2. To determine the degree of similarity existing among the future requirements of the four campuses in terms of computing;

3. To prepare a useful basis for possible specification of a joint computer system;

4. To propose recommendations that will permit the highest degree of effective, consortium-wide interaction possible, given the anticipated development of computing on

the separate campuses.

B. Assumptions

In writing this working paper, the Computer Committee has been guided by a number of assumptions which emerged as the result of previous study or which emerged as this phases's activities began to get underway. These assumptions are:

1. For the consortium's computing effort to be successful, the system proposed must be technically, financially, and operationally feasible. Not only must a proposed system represent the optimum utilization of the consortium's total resources but the proposed system must also permit the most effective resource utilization by each campus. That is, each college involved in an eventual proposal must benefit from the changes proposed.

2. The Computer Committee should only consider recommendations sufficient for a joint computing effort, not just for a joint computer. Thus, its recommendations must take into account the impact a joint computing arrangement could have on hardware and software available, on curriculum developments possible, on administrative systems improvements, and on faculty development programs that might be feasible.

3. The proposal recommended to the Board of Trustees should be based on the most likely outcome of the projection of computing requirements over the planning period, as opposed to focusing on the most desirable outcome, or upon the least desirable outcome;

4. The Committee should not maintain any commitment in attitude toward any specific vendor or system configuration. All possible alternatives should be considered with the same degree of objectivity;

5. The Committee should maintain a generally positive orientation toward computing and the need to extend and expand the degree of computing utilized for both administrative and academic purposes;

6. A heavy reliance should be placed upon the professional literature describing the results of installing networks for academic computing purposes. Many concepts which have emerged from the implementation of joint computing systems under funding from the National Science Foundation and other agencies are transferable to our consortium even though no exact counterpart could be identified;

7. It was presumed that each campus is completely willing to give serious consideration to new proposals that relate to that campus' access to computing, and that the proposals need not be restricted to access to on-campus computing.

8. The Committee should rely primarily on the perceptions of institutional personnel as the basis for estimating each college's computing needs. In some instances, where it was felt that institutional information was not complete, or in which campus personnel were not familiar with certain facets of computing, the Computer Committee did insert its own perceptions of future computing needs;

9. Any changes to be recommended for computing hardware are primarily to be made on a future-oriented basis. In many ways this is the most difficult assumption for non-committee members to accept. The future, particularly the distant future, can easily be discounted when confronted with the needs associated with present patterns of operation. Because of progress at each of the campuses, our situation is similar to that described in a recent report by one consultant firm:

> "Ironically, the basic problems currently besetting the management of many computer companies we have studied have their origin in the successes of the past."

That is, many of our operations, systems, and staffing patterns are efficient, given today's requirements. But extended in a straight line, they may not be suitable for the projected future. Still, it is difficult to obtain complete unanimity of opinion as to whether change is in fact necessary.

10. Computer networking is possible. There are many individuals we have spoken with who do not presently believe that it is possible for the four colleges to mount a joint computer effort, even if the economic, technical, and academic requirements can be demonstrated on paper as being met. To some degree, this is a reflection of the statement of Charles Mosmann who recently completed a book on academic computing. He writes, "At universities that have never tried to cooperate, it is a good argument; many administrators and faculty are unaware of the progress made in the past few years...they are worried about problems they have seen in the past."

11. All of the colleges can and are willing to eliminate their commitment to existing hardware now owned, rented, or provided under contract to obtain improved services.

12. A significant retraining and curriculum development effort would be needed to justify a larger system.

13. Each campus must maintain some on-campus administrative data processing personnel.

14. Any system should be justified solely on the basis of four-college service and not on the potential for marketing of service to others.

II. The Problem of Setting Goals and Objectives

Despite the efforts of the Computer Committee to obtain a complete and usable base of information pertaining to computing over the planning period, it is clear that complete confidence in our conclusions is not warranted. While we do believe that these are the best conclusions and projections that could be set, they cannot be considered wholly predictive of future needs. Some of the more important problems the Committee has confronted can be stated fairly briefly:

1. Throughout the four institutions there are relatively few pockets of sophisticated computer utilization. It is difficult for most individuals to predict the precise forms and amounts of computer utilization in their discipline. This is especially true if they are not personally familiar with the kinds of activities that are already in operation, or that are being developed elsewhere. Very few individuals have a clear "fix" on the kind of growth that can be anticipated for their discipline. Even in some areas where we had assumed a high level of expertise, the projection of utilization has been set forward in ambiguous and unclear terms;

2. Despite a rather extensive search for materials on computer planning in the academic environment, there have been virtually none to be found. It appears as though most colleges have continued to operate on a saturation threshold. When their computer and computing staff becomes inadequate, they obtain new machinery and additional staff with additional capabilities, without any firm basis of implementation other than computer center estimates;

3. The Computer Committee has at times found it necessary to compete with short-term proposals being put forward on the acquisition of specific types of hardware to accomplish fairly tangible results. Many individuals who feel committed to obtaining particular kinds of hardware to implement projects now, find it difficult to look for a broader horizon than is immediately visible to them. A publication by EDUCOM states the problem succinctly:

> "If the needs are expressed in terms of specific equipment, rather than required resources as is often the case, the evaluation will be hard to make."

4. The commitment of financial resources to computing is not made a priori. Computer budgets are deservedly derived from the objectives that are being attacked. The level of funding, however, is a distinct limitation to the kinds of services that can be considered. Thus, the Committee had to obtain some degree of consensus on a realistic projection of the foreseeable budget structure for a computer center and did not "blue sky" to include every new function that it felt would be beneficial to the colleges;

5. Very few individuals have had enough background in the operational facts of computing machinery and services and particularly the current capabilities of computer main frames, input/output devices and other types of hardware. This limitation in turn makes it difficult for the Committee to secure complete consensus on the goals and objectives for individual institutions;

6. Since no approximate counterpart to our consortium's effort could be located, it was difficult to draw the same

kind of parallels for one group of colleges that might be possible for a single institution, which could identify a peer college with similar types of students, faculty, computing needs, c

7. Within each institution and throughout the consortium, there is a very wide variety of academic and administrative needs to be met. This report attempts to bring together as many of these needs as possible, but because some needs are relatively insignificant to the large picture it was not possible for all of them to be addressed directly.

8. Very little has been done in the way of long-range planning for computing on any of the four campuses. Each of the institutions has a "planning document" for academic purposes, but special consideration of the role of computing has not been addressed with any high degree of specificity. Neither do the colleges have any prepared guidelines for directing expansion of their own computer services over the long term;

9. In contacting individuals throughout the four colleges, it was apparent that many of the projections made consisted of straight-line extrapolations of existing services which would be expanded or in some fashion, slightly diversified. Although many individuals have had fleeting contact with such concepts as micro-computers, hierarchial computer systems or national computing systems, the Computer Committee was unable to obtain coherent forecasts of hardware and software developments which differed significantly from existing conditions. This situation made it difficult to go beyond developing concepts

related specifically to existing services;

10. A major element that was lacking in this study was the adequate representation of individuals on the campuses who were openly antagonistic or apathetic to the continued growth of computers in either instructional or administrative areas. Since the initiation of new computer services will require institutional consensus as to budget allotments and changes in curricula, the impact of these individuals has to be accounted for. It is difficult to determine at which points the projections and the actions of supporters of computing will be blocked or restrained from being put into effect;

11. The literature which was surveyed on computing throughout the country made very little reference to specific developments that could be anticipated over the planning period. Again, the inability to demonstrate the emergence of new types of computing machinery or to identify the completion of particular kinds of software packages, made it difficult to be completely confident in all conclusions drawn by the Computer Committee.

While the Committee has made some effort to point out the difficulties of drawing projections about the goals and objectives of the four campuses, it hastens to point out that the same difficulty would confront any campus research group attempting to solve the same problem. Indeed, each of the campuses with a computer committee was in a quandry over these same difficulties. The statement of these problems is simply to point out that there is a range of opinion on many topics. We believe that the goals and objectives set forth

here are as accurate as they can be in light of these problems.

III. General Goals

In initiating the search for information pertaining to the projected growth of computing services, the Computer Committee felt it would be necessary to propose general goals for computing throughout the consortium. These goals would then be re-examined in the light of information and reactions elicited from the colleges. At the same time, these goals made it possible to insure that we were giving consideration to all aspects of computing needs within the consortium.

Since statements of goals are necessarily broad, they are also somewhat ambiguous. It was the committee's hope that the study would be able to proceed from the tentative establishment of these broad goals through to the enunciation of more specific objectives. By continually re-examining the accuracy of the goals statements as the study proceeded, it was possible to determine whether the goals were accurately stated. Each campus was asked to review the goals statements and make suggestions for changes. During the study, one additional goal statement was added, and several were slightly reworded. To be sure, the final version does not imply that each of the statements is mutually exclusive.

It is very difficult to establish priorities among the fourteen statements, either for an individual institution or for any individual college. During each campus computer users meeting, the committee requested that each institution select the five goals which seemed to be of greatest importance to that campus. This was done. A notation alongside each

of the goals written below indicates which institutions considered that goal to be a priority. While there was some anticipated diversity in the selections of goals and priorities, there was a higher degree of consistency than might have been expected. There were three goals which none of the institutions selected as a priority; there were two goals which were selected by three or more campuses. Both of the goals which received a priority classification by three or more campuses pertained to the need for increasing either the accessibility for computing services for instructional purposes or an increase in the range of services available to users of computing. This initial selection of priorities did, in fact, reinforce the general conclusion that a greater expansion of computing for instructional purposes, particularly in disciplines or departments not presently involved in computing, was going to be the case over the planning period.

It is important to note that while the committee asked for a "forced choice" selection of priorities by each campus, completely unanimous opinions on these priorities did not exist within each campus. Virtually every goal received a priority rating from some individual within each campus. Therefore, the overlapping of interests throughout the consortium is far greater than might appear to be the case if only the top five group choices are utilized.

It would also be helpful to point out that the users group assembled at each meeting was not wholly representative of the entire institution. If, for instance, more administrators had been present, the results might have been somewhat different

than they were. Similarly, if a larger group of research-oriented faculty were involved, they might have given a different perspective. The final goals are listed below in their approximate order of priority, based upon the numbers of times the goals statement was selected as a campus priority. The final goals statement for computing within the Associated Colleges between 1975/1980 is as follows.

> To increase the range of services available to all users of the computer: staff expertise, languages, software user seminars and documentation.
>
> Clarkson College, St. Lawrence University, State University Agricultural and Technical College, State University College at Potsdam
>
> To increase the accessibility of computing service for instructional purposes: job turn-around time reduction, improved diagnostics, large numbers of terminals, ease of use by novice users, and 24-hour batch-processing service.
>
> Clarkson College, State University Agricultural and Technical College, State University College at Potsdam
>
> To enhance each institution's ability to shape its computing resources according to its unique needs.
>
> St. Lawrence University
> State University College at Potsdam
>
> To handle existing computer needs, and to handle new functions on an optimum cost/benefit basis.
>
> State University College at Potsdam
> State University Agricultural and Technical College
>
> To provide a hardware and software capability sufficient for all major purposes.
>
> Clarkson College
> State University Agricultural and Technical College
>
> To encourage the utilization of computing in disciplines other than those generally allied with computer sciences.
>
> St. Lawrence University
> State University Agricultural and Technical College

To expand the availability of interactive, time-sharing capabilities at each campus.

Clarkson College, St. Lawrence University

To utilize each institution's computing resources in the most efficient and effective manner: staff, facilities, development, training.

St. Lawrence University

To provide appropriate languages, storage capacity and processor speeds capable of satisfactorily supporting anticipated increases in research computation needs.

Clarkson College

To provide computer facilities, staff and services and software which are reasonably current with the state of technology.

State University College at Potsdam

IV. Institutional Patterns

A. Clarkson College of Technology

At the present time Clarkson owns and maintains a medium size IBM System/360 Model 44 computer (128K bytes) equipped with two high speed tape drives (3420, 800/1600 bpi, 120KB) increasing its adaptability for software experimentation and for conversion to a multiprogramming operating system. Peripherals for the 360/44 include a 1403 Model 2 printer, one 2540 card reader (1000 CPM), one card punch (300 CPM), four 2311 disk drives and one 2310 disk drive (23 million bytes). Additional equipment includes ten 029 key punch machines, one 029 interpreting punch machine, and one 514 reproducing punch machine. Software includes:

ALGOL	LETARITR
Assembler G	LISP
ASSIST	PLANTRAN
FACET interpreter	SAMOS
FORTRAN IV G	SNOBOL 3
44 Assembler	SORT 44
GASP	SSP
GPSS	UCLA Biomed Statis. Routines

The pattern of usage for the 360/44 is as follows: research accounts for 24% of the jobs and 42% of the time, administration accounts for 15% of the jobs and 30% of the time, instruction accounts for 45% of the jobs and 10% of the time, while the computer center accounts for 16% of the jobs and time. Although the Computer Center is not an academic department, staff members do teach computer science courses in the mathematics department. All programs are batch-run. The professional computing staff at Clarkson numbers eight.

During 1971-72, a complete PDP-8/E timesharing system (T/S) was purchased and put into operation to give undergraduate students interactive computing, easier access and faster turn-around time for small jobs. Fifteen terminals are provided. Languages present in the system include:

FORTRAN II	MACRO-8
BASIC	PAL-D
ALGOL	FOCAL
PAL-III	

The system is very heavily utilized and is at its maximum terminal capacity.

Clarkson is the institution within the consortium that has experienced the greatest diversity in the use of computing in its existing curriculum. Clarkson utilizes more computing time and larger-size computer programs than does any of the other three colleges. In many ways its expected future for computing represents an expansion and improvement of the services which it has been accustomed to providing. There are a number of changes which are anticipated over the planning period and these will create significant new academic demands on its computing hardware and staff. It is anticipated that the Bachelor of Professional Studies program will enroll a large number of students in computer science. Since this program is designed to enroll many students from two-year colleges who will have had access to computers before they reach Clarkson, this program will constitute a significant growth factor.

Also a new program in Criminal Science is being worked on. It is clear that a program of this nature will have to maintain

a considerable element of computing within its structure since crime control agencies are accelerating their engagement in automated procedures. The School of Management anticipates the initiation of a data processing option. The emerging degree programs in bio-medical engineering and environmental studies also are likely to create a far greater demand for high-level computing services than has been true in the past.

The Social Science curriculum at Clarkson also appears to be taking on a higher orientation toward the quantitative aspects of psychology and sociology. Such work is also being undertaken by both sociology and economics faculty in the area of systems modeling and simulation. The freshman Calculus course recently initiated a requirement for utilizing the PDP 8/E time sharing system. As these students move through additional mathematics courses, their early start in using the computer should show up in heavier use of the computer for other purposes. The Mathematics curriculum generally will expand its computer science options, as will the Mechanical Engineering curriculum. Some new priority is being given to the selection of instructors with backgrounds in computing in several of these fields.

There is a distinct need for more sophisticated hardware capable of supporting computer-aided design in the engineering curriculum. It is also very desirable that a facility such as PLAN be available. PLAN is a problem-solving language which itself is used for developing problem-solving languages.

Increased attention is being given to computer-assisted

instruction. Presently all of the emphasis is being placed on the acquisition of software packages which are obtainable from other sources. Very few faculty have indicated an interest in developing computer-assisted instructional packages. Among the primary functions of CAI that either already have an existing unmet need, or for which a distinct need is developing are the NMR simulation techniques, the PRINCE programs in sociology, and the Integrated Civil Engineering Systems packages (ICES).

Although CAI is fairly difficult to develop, many institutions are using computers for computer-managed instruction which is less complex but directly related to self-paced instructional courses. Some of the courses being implemented at Clarkson probably will begin to involve computer-managed instruction.

Virtually all faculty being hired by Clarkson have some background and experience in computing. Specific mention was made of some increase in the existing level of faculty background in Industrial Management, Mathematics, and the Social Sciences. The feeling was expressed that Clarkson has lost faculty and has not been able to employ some faculty because of the instructional and research limitations of the existing computer.

Nearly all students are now taking at least one course in computer programming so that no new introductory programming courses are anticipated beyond those presently offered. The view was expressed, however, that most students are limited in the amount of access they have to the computer. Therefore,

these courses could be substantially upgraded if more computer time could be provided for them. It appears as though Clarkson is close to being able to assert that all of their students are "computer literate" by the time they graduate.

In reviewing the research demands on the computer, it was found that, with several exceptions, the speed of the existing computer was not a major deterrent to upgraded research projects. However, the computer's core size was a definite limitation. While it is possible for some programs to be rewritten in such a way that they could be run on existing computers, there are many projects that simply could not be made to fit. These projects either were eliminated or farmed out to other computers. It was noted that some doctoral candidates presently are having difficulty fitting their programs to the model 44.

The newer administrative requirements were found to center on the implementation of the management information systems programs being developed by the Western Interstate Commission on Higher Education (WICHE). Clarkson is farther ahead in the use of these materials than is any of the other colleges. Interestingly, since all of the WICHE programs are written in COBOL, Clarkson cannot run these programs directly, but will use the Potsdam computer for this purpose. It was felt that many of the costs associated with on-line direct access systems for many administrative functions were dropping. Increased use of this technique will probably be implemented over the planning period. In particular, the use of cathode-

ray tube/keyboard terminals would be used by the registrars and finance officers. Increased use would be made of integrated systems of administrative files.

There has been a marked change in the influx of students who, when admitted to Clarkson, already had experience with the computer. It was estimated that this percentage approximates 20% of the students, whereas such students were rare five years ago. Most of the students coming from two-year colleges have had programming experience. The students who already have used computing in an instructional environment have often used BASIC and therefore have already obtained skills expected of students completing some of the elementary programming courses.

Attendant to the dropping costs of electronic hand calculators, many students have begun using these devices to replace slide rules. Since many of these calculators have the elementary characteristics of computers, a greater push on the faculty for electronic calculations of all types will be noticed. In addition, these devices seem to be creating an easier transition to the use of larger computers.

The implementation of the PDP-8/E time-sharing system has elicited a high level of enthusiasm from both faculty and students. Design and other severe limitations have been placed on the instructional load that can be assigned to this system. It is now believed that while the concept of time sharing has been proven successful, the present system does not encourage students to move into more sophisticated types of computing. The core size is very limited, and file space is

not available.

The presence of the time-sharing system is creating a demand for higher level programming languages and computer processing capabilities. The transition from time-sharing to batch processing should not be difficult and is likely to mushroom in the future. It was also felt that if a more sophisticated time-sharing system was available, many students would develop and test their programs on this system. Then they could move to batch processing for the actual running of the jobs.

The 360/44 hardware and software were designed for scientific users working primarily in FORTRAN. This makes it an inappropriate machine for utilizing many software programs written elsewhere. Many programs of value to Clarkson already exist and more will be developed in the future. Thus, the existing machine is a "bottle neck" to increased computing.

Although an accurate estimate of the computing budget for Clarkson is not available, largely because of the fact that the System 360 and the PDP-8/E are owned and not charged back to various departments, the percentage of the budget devoted to computing is estimated to be approximately 5% of the total instructional budget. This would be about $100 per student.

The currency of the machinery available was not seen to be a critical factor. Although the Model 44 is considered to be obsolete by many faculty and staff, its major drawback is that it is unable to provide the level of service required. Most faculty felt that the type of software that is available is of greater concern than is the age, or the model of the

computer. It is very difficult to adapt newer software that is now available to run on the 360/44. In a few instances within the college, where computers as a focus of research are involved, the newness of a computer is of some significance. For instance, a computer with advanced large scale integration characteristics superior to those exhibited by the Model 44 is of importance.

It is clear that the amount of funding being derived to support computer time for research projects has dropped over the last several years. From a past peak of about $30,000 of computing time supported in this fashion, only about $6,000 has been paid for from extramural sources in 1972-73, but more research is being done this year. This indicates that future computing is likely to be paid for by institutional resources rather than by outside agencies. Typically, computing time is negotiated away as one of the institutional contributions to a project. Therefore the amount of funding available in the future for research is likely to have very little impact on the level of research computing.

The National Science Foundation is presently supporting the implementation of a national computer network (ARPA). ARPA will provide national access to the computer time and software available at each of these centers. In a related project disciplinary computing centers are being developed in all of the quantitative sciences. It is believed that Clarkson as well as the other colleges could benefit by being able to draw upon this network.

B. St. Lawrence University

An IBM 1401 computer is being phased out as the services available from the St. Lawrence County National Bank are accessed through a remote entry unit, DC1102. Peripheral gear utilized includes a 400 CPM card reader, a 400 LPM printer, and a console printer. Software is limited to COBOL and RPG. The Buroughs 3500 at the bank is well adapted to business and management functions, but is of less value, and has not yet been used for instructional and research purposes. Such uses are contemplated for the future. A professional computer staff of three is now present.

St. Lawrence has been using four teletype terminals connected to a small PDP-8/E unit which it owns. These terminals are heavily utilized to provide BASIC and FORTRAN for students' projects. Three additional terminals are now rented on a 12 month basis with one port access to the Dartmouth time sharing system to make available a wide range of the data banks and program libraries present therewith. This system also stresses the use of BASIC and some packaged programs. There are no credit courses presently offered that are directly concerned with data processing or computer science. Probably less than a dozen credit courses require occasional use of a computer. A number of short term non-credit courses have been provided for students, administrators, and faculty.

The only new major being considered at St. Lawrence that would entail any special computing requirements will be the environmental studies program. The establishment of this major should necessitate a heavier commitment to natural systems analysis. In addition to the types of computing built into the

course work within this major, students may wish to enroll in the environmental studies courses available at Clarkson which will utilize computational technology extensively. Also, computing demands may grow with the increasing facility by which SLU students can enroll in multifield majors and in double majors, particularly if such requirements involve increased cross registration.

Greater emphasis will be placed on the revision of existing curricula than will be shown in the implementation of new degree programs. During the coming semester an operations research course will be offered for the first time, which will include computing requirements. The mathematics department will also be offering courses that in combination will provide a computer science option. The government department is anticipating larger amounts of data-base handling types of computer augmented instruction and will be requiring a course in computer usage. The psychology department has begun to do more in the use of the computer for experimental analysis and a course in econometrics was offered for the first time in the spring of 1973. The physics department is getting a plotting machine for demonstration purposes and the chemistry department is doing more in the way of experimental data analysis. It is anticipated that over the planning period the computer will be used for bio-nuclear and genetic problem solving by the biology department.

Generally, the use of the Dartmouth time-sharing system has led to a much higher level of familiarity with the computer as an instructional tool. However most of this involvement has been focused on data-base handling in which pre-existing programs

and data banks are manipulated rather than as an original problem-solving tool developed by either the student or faculty member. The use of the interterm as a time period for offering short courses with computing components is likely to grow.

Computer systems instruction has not been utilized greatly in any fashion other than in regard to the software packages available through Dartmouth. The most likely prospects for the importation of CAI packages seem to be in the areas of accounting and economics where some interest has been expressed in the TSAR material available through Syracuse University. It is felt that much more can be done in this area but no requests for use of any particular packages has been made, given the existing equipment.

It appears as though new faculty who are hired will be more likely to have some computing background since some priority is being given to this aspect of their training.

It is felt that very few introductory programming courses would be offered at St. Lawrence in any field other than mathematics. This department is planning on offering courses utilizing BASIC. These courses will be "Scientific Programming," and "Computer Science for the Layman." It is expected that short-term courses will continue to be offered as they have been in the past. About 20 faculty are now interested in instructional computing.

Considerable interest was expressed in increased numbers of training programs for staff. In addition to short-term courses, it was felt that efforts should be made to send faculty to locations where the computer programs in their specialty were being put to use. A heavier reliance on staff members teaching

their peers about findings at other locations should be encouraged.

There seemed to be uneven support for the implementation of a "computer literacy" philosophy, which in effect would require students to obtain essential introductory levels of experience with the computer. The 5 year plan does stress an objective to offer each student firsthand experience with the computer. Any developments along this line, though, would appear to confront a sizable negative faculty reaction in some disciplines. This was the conclusion drawn from a questionnaire distributed by the University's own computer committee.

Since sophisticated equipment has not been available until recently, the University has not had any large amount of on-campus experience with computer-oriented research. The Dartmouth terminals have just been extended from a 10 to 12 month basis. It is hoped that their availability over the summer months will permit and encourage some research to be conducted in this mode.

The facility of tying into the Burroughs 3500 at the St. Lawrence National Bank has enabled St. Lawrence to reprogram many of its administrative systems. The computer staff has reduced their programs from 200 which were run on the IBM 1401 to 45 presently in use. It is anticipated that the planning for the university will eventually be conducted on a Planning-Programming-Budgeting System. Such a system would require much heavier computer analysis than is common.

It was observed that many large city and suburban school districts are now making computing available to the students entering St. Lawrence. There has been a definite increase in

the ratio of students with computer backgrounds entering the institution and presently approximates 10 to 20 percent. Many of these students have had experience with computers that go beyond the capabilities of the hardware presently available at St. Lawrence.

The computer users group felt that they had little need to be concerned with hardware capabilities that reflected the contemporary state of the art in computing hardware. A far greater concern was expressed over the availability of software packages and time-sharing terminals that could be easily accessed by students and staff. Thus, the characteristics of newer generation computer systems were not seen to be of importance as an object of research or study, but simply as a facilitator of learning programs.

The overall impression directly conveyed by the campus committee was their difficulty in projecting the growth that was conceivable over the planning period. It was generally agreed that the involvement of St. Lawrence in the use of the computer had been so limited that any new capabilities would demonstrate an exponentially accelerating growth curve. In addition, some dissatisfaction was expressed with the level of sophistication that was possible with the Dartmouth system. Although the Dartmouth terminals provide an easy entry into some types of computing, namely data-base manipulation, it did not provide easy access to more sophisticated types of computing. Some students were spending undue amounts of time trying to program more complicated programs than the equipment or the attendant documentation was able to support. Neither does the

Dartmouth system encourage the use of the computer for stimulating students to prepare methods of solutions to their own problems. Since most of the packages originate with a particular data base and a selected series of manipulations, the students are unable to use this system for programming solutions to problems they may be working with in courses that would utilize languages other than BASIC.

Considerably greater interest was expressed in the use of a computer which could also be made available to local school districts than was expressed by the other campuses. Some student teachers from St. Lawrence had already been bringing some of their classes on to the campus to use the computer terminals, and it was felt that this type of interaction should be encouraged.

In addition the graduate programs in educational administration, educational psychology and counseling would also be excellent vehicles for tying university programs with school district needs.

C. State University College at Potsdam

Potsdam continues to rent an IBM System/360 Model 30 computer (64K bytes) which provides all services for the administration, the computer science department, and faculty involved in research. Peripheral gear includes a 1403 printer, a 2501 card reader, a 1443 punch, two 2415 tape (800 bpi), and three 2319 disk drives, and four 029 key punches. Some unit record equipment including 029 key punches are present. Software available includes:

Assembler F	GPSS
COBOL	PL/1
ANSI COBOL	SAMO/SAMOS
Coursewriter III	SORT
FORTRAN IV F	SSP
GASP	

Potsdam is a heavy computer user primarily as the result of the rapid growth of its computer science department which now is one of the largest departments at the College. This factor alone requires that advanced hardware and software, as well as student access be present. Approximately 32% of the computer time is directed to administration and 61% to instruction purposes. Other departments and research account for the other 7%. Six professionals staff the computer center. A terminal to a large IBM System/370 Model 155 is presently on-campus as a part of an N.S.F. funded project to stimulate classroom computing. The project has stimulated interest in the APL language, although the economic feasibility of continuing the present communications with Binghamton is not yet proven.

The only new degree program with significant computing requirements expected to be instituted during the planning period will be a master of arts in computer science. Such a major would have a very significant impact on the utilization of the computer, both in terms of load and diversity of programming languages and services.

During the past several months a revitalized interest in computing has been demonstrated by a number of existing curricula and individual faculty. In particular, the social science departments have begun to emerge as higher level users than was true

in the past. This is especially true of sociology where it is anticipated that all students majoring in sociology will have had one course in computing before they graduate. In addition, the political science department has begun using some gaming techniques for a course , "Practical Political Science." The geology department is now requiring a course in computing for its majors, and both the chemistry and physics departments are growing in their utilization of the computer.

It is anticipated that within three years a more intensive involvement in computing will be shown by the education department. It was projected that by the end of the planning period, all pre-service graduates in the education program would have completed a course in the use of computers in education. It was expected that teacher education programs would eventually offer a course in computer science instruction for teachers.

As was true of many of the other colleges, it was difficult to project the utilization of computer-assisted instructional packages since it was unclear as to which faculty would be interested in packaged programs. It seems clear, however, that except for a music theory course that was developed at Potsdam, most CAI packages would be imported from institutions outside of the region. Larger data base packages than those presently available for political science and other social sciences will be necessary.

Specific references were made to the transfer of packages such as the PLATO and TICCIT systems presently being funded by the National Science Foundation to demonstrate the efficiency and cost-effectiveness of CAI techniques.

Considerably more attention is being paid to the retention of new faculty with computing background and experience. The mathematics department has recently hired a new staff member with a background in computers and operations research. The geology, economics and sociology departments are using a strong quantitative background as a major criterion for considering applicants for their positions. All new faculty are queried on their research interests as a part of the interview procedure. An emphasis on research activity generally will be conductive to a higher level of research which uses the computer. Since many of the new faculty hired recently obtained their doctorates, they are quite likely to have had experience with computing techniques in graduate school. Some attention is being given to the selection of a faculty member at Crane who has had experience with computer-generated music.

It was pointed out that many potential faculty who come to the campus have requested tours of the computer center and have asked about particular kinds of software packages that they had used in graduate school. There was reason to believe that the unavailability of some of these packages, such as the materials prepared by the Interuniversity Consortium for Political Research, has deterred the employment of some prospective candidates.

The Computer Science Department is particularly aware of the role the availability of computing hardware and software has on applicants for professional positions. To retain a faculty roster appropriate to a computer science department, the existence of adequate and extensive computing services must

be available. The computer science department is revising some of its offerings to include more service courses for other disciplines than has been true in the past. There will be a greater number of entry points for non-computer science majors to obtain some background in computer science. It is expected that all courses in programming and computer science will be kept within the computer science department, rather than being offered by other departments. It is also expected that the computer science department will offer more mini-courses than they have in the past. These courses will serve faculty needs and will encourage heavier computer utilization in the future. Courses at the graduate level for teachers enrolling in the summer session will also be conducted.

In addition to those whose interest in computing will be generated by mini-courses, there are now estimated to be approximately 12 very active faculty who utilize the computer. Considerably more interest is being expressed in software packages available elsewhere and in the preparation of "in house" packages.

Except for the departments noted above, there does not appear to be any substantial concern for creating a philosophy of computer literacy universally applied to all graduates of SUNY College at Potsdam. There was a high expectation that as a part of the general education of most students they should be made aware of the practical implications computers have for society.

As noted above, all new faculty being hired are being screened for their interest in research and it is anticipated

that the proportion of computer-oriented research projects will increase in the future. As an adjunct to this screening process, a position for a Director of Sponsored Research is being filled this year and should result in a higher level of research activity across the campus.

Although a comprehensive study of the new administrative requirements for the planning period was not available, there were some areas in which increased computer applications were seen to be required. It is hoped that registration can eventually be accomplished through computer usage to reduce the time to 20 minutes per student. In addition, the computer should be used more aggressively in class scheduling, test scheduling, transcript preparation, library record keeping, and admissions processing, institutional research, pre-registration and on-line data processing.

The College has also been experiencing an increased ratio of students who already have had contact with the computer during their highschool experience. It would appear that this ratio is quite close to the national figure of 15%.

D. State University Agricultural and Technical College at Canton

Canton began leasing an IBM System/3 Model 10 (16K bytes) this academic year. Its basic peripherals are limited to one 300 LPM printer, a multifunction card unit, and a 4.9 million byte disk. There are also six data recorders and a card sorter. Software available consists of:

System/3 Assembler	Disk RPG II
ANSI COBOL	Disk SORT
FORTRAN IV	Card Utilities

At the present time, machine usage is 60% administrative and 40% instructional, with negligible amounts of time devoted to research. Some seven courses dealing directly with computer science are offered. Three professionals staff the computer center. The monthly equipment and service costs for the center approximate $3,000 per month.

Over the planning period 1975/80, it is anticipated that there will be a number of new two-year A.S. and A.A.S. curricula instituted that may have some implications for the use of the computer in the academic environment. Although none of these curriculums are specifically directed toward computing per se, it is hard to envision these curricula being offered without some consideration of the role of computing in their implementation. It is important to note that a computer science curriculum that had been carried in the Master Plan in the past is no longer being considered for implementation.

A number of health education programs for medical records technicians, medical assistants, surgical assistants, dental assistants and inhalation therapists are projected for eventual review and implementation. Since hospitals are increasingly deploying computers for business record keeping and patient care, it would be desirable that these curricula provide for some orientation to the computer for their graduates. It could be that such elements if included would provide a distinctiveness to these programs that would be uncommon across the state and nation.

Some consideration is also being given to a program in retail business management. Since a number of commercial computing services are being established in the North Country with capabilities adequate for the small business, the inclusion of some consideration of this growth would be desirable.

A Police Science curriculum is also being considered which must have some computing requirements in light of the accelerated growth of data processing in the field of criminology. It might be noted that both in retail business management and police science, Clarkson College of Technology is also moving forward with programs at the four-year level. It might be possible for both Canton and Clarkson to contribute significantly to both curriculums through computer-based materials jointly developed.

A curriculum in audio-visual technology is being considered at Canton. Since computer terminals are now being installed in virtually all of the major city and suburban school districts - the districts most likely to employ audio-visual technicians, it would be extremely beneficial for such technologists to have had a background in the use of computing in education. The same type of argument is true for industries which are likely to employ audio-visual technologists. Thus, some inclusion of the use of computers in this curriculum would be likely.

It is interesting to note that the data processing curriculum has not been growing in the numbers of students opting for this major. Despite the national predictions for personnel needs

continuing as they have in the past, it would appear that the numbers of two-year and four-year institutions which produce programmers and computer operators has temporarily, at least, caught up with the demand. It also reflects the increasing trend toward on-line data processing conducted by non-computer specialists.

Since the IBM System 3 was installed, an improved version of FORTRAN has been available. This has led to a 100% increase in the use of computers by the engineering technology division. The student population within the General Education Division at the college will continue to stand at about 10% of the general student population in terms of majors. The division will continue to provide electives for all the other majors. It is likely that the needs of these liberal arts courses will reflect the same needs as are experienced by the lower division course offerings at the other three institutions. Primary interest in the division has been shown by the economics faculty who have been working on the utilization of economic systems modeling. The physics faculty has also been utilizing the computer as a part of its individually prescribed instructional packages.

A requirement is now in effect for all business students to have had an introduction to computers. This will affect greatly students who are majoring in business administration, accounting, secretarial science and eventually marketing. The marketing program also is utilizing a decision-making gaming technique.

Potential new foci for computing in the instructional environment could be in the area of remedial instruction. This area lends itself to computer-assisted instruction. Because of

the elementary nature of many forms of remedial forms of instruction, it is most likely that program packages will become available at this level.

The use of the computer will also be encouraged by the independent study options available and through the individual studies program recently initiated.

Canton is moving to a modular form of scheduling courses within its academic calendar. If this calendar revision becomes a significant component of the college's structure, it is likely that the computer will become more intensively used as a scheduling and record-keeping device. Farmer noted that modular scheduling requires a significant (estimated ten-fold) increase in computing capability.

This form of scheduling would also facilitate the development of short-term mini-courses which focus on the computer in various disciplines. At the present time Canton does not have a capacity for handling many forms of computer-assisted instruction or special user-languages. For instance, there have been indications of interest in having COGO available for the civil engineering faculty. It is unlikely that any high level of CAI development will be carried out at Canton. Heavier reliance will be placed on packages of materials available from other sources.

There does not appear to be any particular stress on obtaining faculty with computing experience or background, and no new introductory programming courses are anticipated. The college has been sending some of its faculty to locations where computers are being used in a discipline contained in the Canton program. However, the seeds being sown have not yet

been reaped.

The data processing faculty had proposed a course in FORTRAN programming. However, the course was rejected as a major element in another curriculum. While it is hoped that some reconsideration of this course will be undertaken during the planning period, there is clearly no aggressive effort to include such a requirement in most curriculums.

Although several faculty at Canton have conducted research with the computer as a part of the data-processing element, this research has been run at Clarkson or at Potsdam. It is not anticipated that the level of on-campus research using the computer would increase significantly over the planning period.

Administrative changes over the planning period were difficult to forecast at the present time. Consideration is being given to developing new programs for library record-keeping and for the cataloging of parts and supplies in the college warehouse. There is an active interest in the development of the WICHE simulation models.

V. Conclusions about Comparative Computing Functions.

A. National Center for Higher Education Management

The National Center for Higher Education Management Systems (NCHEMS) has developed reporting and planning systems under heavy funding from several federal funding agencies. Some of these federal agencies have already begun to require the use of these reporting systems. The use of the data gathering and planning will play a more productive role than meeting simple reporting requirements, however. They can and are being used to substantially upgrade the internal management of institutional resources.

On May 14 and 15, 1973, Mr. William Dempsey, the Assistant to the President at the State University College at Plattsburgh, was invited by the computer committee to review the four colleges' ability to utilize the NCHEMS simulation models. Particular attention was given to: (1) the Student Flow Model; (2) the Induced Course Load Matrix (ICLM); and (3) the Resource Requirements Prediction Model (RRPM 1.6).

Table I displays the essential elements needed to utilize these models, and Mr. Dempsey's assessment of whether the individual colleges can meet these requirements. In general, it appears as though the four colleges would be able to meet the basic information requirements. One must hasten to add, however, that while the various categories of information required for the models such as individual student records, staff salaries, and faculty rank distributions are available, it would be particularly difficult to capture this data on an historical basis. St. Lawrence would be most pressed to combine this data.

ICLM AND RRPM 1.6
DATA ELEMENT REQUIREMENTS

	CANTON	CLARKSON	POTSDAM	ST. LAW. B-2500
Ans. COBOL	Y	N	Y	Y
Hardware Requirements ICLM 40K bytes	N	Y	Y	Y
RRPM 1.6 52K bytes	N	Y	Y	Y
1 record per student	Y	Y	Y	Y
Program, Major	Y	Y	D	Y
Student Level	Y	Y	Y	Y
Cost Center (course, Disciplines)	Y	Y	Y	D
Course Level	Y	Y	Y	D
Units Taken-Contact or Credit	Y	Y	Y	D
Student/Term (Student #, SS#)	Y	Y	Y	Y
DATA FOR EACH COST CENTER				
Average Salary for each faculty rank	D	Y	Y	Y
Av. salary for each staff category	D	Y	D	Y
Chairman's FTE & Average salary	Y	Y	Y	D
Average expenditure for each expense category (ie, supplies, travel, equip. etc)	Y	Y	Y	D
DATA FOR EACH INSTRUCTION (COURSE) LEVEL WITHIN EACH COST CENTER				
FTE Faculty	Y	Y	Y	D
Percentage distribution of faculty ranks	Y	Y	Y	Y
Productivity ratios (units produced at this level - FTE faculty at this level) From ICLM output	Y	Y	Y	Y

Y = Yes
N = No
D = Difficult but possible

Canton and Potsdam would have somewhat less difficulty in this respect. Clarkson is farthest ahead and is already test running some of the models.

Both Canton and Clarkson are unable to use their own computer systems for running the ICLM and RRPM models. Canton's System 3 does not have adequate core size, and Clarkson's Model 44 does not have a COBOL compiler. Clarkson is going to be utilizing Potsdam's Model 30 for its data processing of these programs.

There does appear to be a sharp interest in having the NCHEMS simulation models in operation at each of the campuses. This is important because the models are only worth implementing if the presidents and other top administrators are interested in utilizing the information and analyses provided.

St. Lawrence University and Clarkson are both including consideration of NCHEMS systems in proposals they have prepared for externally funded planning projects. Both of the SUNY units are likely to be affected by statewide policies that will force information data processing in the WICHE pattern.

Implementation of the WICHE system seems to provide a substantial basis for significant cooperation within the consortium. Among the possibilities which are conceivable are several which are immediately at hand. As noted, SUNY Potsdam has begun running data from Clarkson on its computer. The magnetic tapes obtained from NCHEMS were secured by Clarkson. Since these tapes are in the public domain, it would be possible for Potsdam to utilize them also. By the same token, Canton could utilize

the Burroughs computer which St. Lawrence has access to by using the appropriate magnetic tapes which have been obtained from SUNY Plattsburgh.

Since Clarkson is moving rapidly into the use of simulation models, at the very least each of the colleges should assign someone to work with Gordon Lindsey at Clarkson to establish implementation procedures by which the models could be applied toward each campus's administrative needs. If a higher degree of formality was desired, each campus might appoint two or three representatives to a task force on management information systems. Such a task force could include a diversity in the backgrounds of the representatives. Then each institution could attempt to develop some specialization of this expertise on such matters as financial interpretations, facilities planning, etc.

Mr. Dempsey suggested that the consortium as a unit request consultative assistance from NCHEMS. It was his belief that a consortium effort would be given high support and consideration. Each campus would probably be offered extensive amounts of special consultative help by NCHEMS. It would also be possible to obtain assistance from the N. Y. State Education Department and possibly from the State University of New York through their assignment of personnel to work on regional cooperative projects. Considerable benefits could be obtained from jointly deploying common data element standards, software development standards, and application standards. Farmer has said that packages able to handle all of the colleges' needs would provide an inherent flexibility to them that would normally be absent.

B. Programming Languages

After reviewing the instructional and administrative computer usage at all four institutions, a table listing all of the major programming languages of interest was prepared. This table lists each of the campuses and the demand that campus would place on each language facility made available. The table is reproduced as Table II.

C. Input and Output Devices

As with the programming languages, a tabular display of the committee's conclusions regarding the need for various types of input and output devices is described in Table III.

Both of the tables for input and output devices and programming languages were given to each computer user group for reaction and criticism. At each institution, changes were made to reflect the best estimates of the individuals present.

D. Computer Comparison Tests

A set of eleven FORTRAN programs were prepared for the purpose of comparing the computing power of the existing primary data processing machine at each campus. These programs were not run on any of the minicomputers available due to the size and speed limitations of such machines. FORTRAN was chosen as the only language common to all the computers.

These eleven programs test the basic speed of the machine, the Fortran compiler and the efficiency of the supervisory system. They are not an exhaustive test of a computer system. A large scientific problem was run and camparisons are made with several computers of interest.

TABLE II

MAJOR PROGRAMMING LANGUAGES AND SOFTWARE

	A.[illegible]	C.I.T.	S.L.U.	S.U.C.P.
Fortran	E/M	E/H	D/L	E/H
Cobol	E/M	E/M	E/H	E/L
PL/1	N	D/L	N	E/H
RPG	E/H	D/L	D/L	D/L
Sort/Merge	E/H	E/H	E/H	E/H
Basic	D/L	E/H	E/M	D/M
APL	N	D/M	D/L	E/M
CAI	N	E/M	D/L	E/L
Watfor	E/L	E/H	D/L	E/H
Statistical Lib.	N	E/M	E/L	E/M
Math Lib.	N	E/H	D/L	E/M
Simulation (GPSS, Simscript)	N	D/L	D/H	E/M
Direct Access Files	E/M	E/M	E/H	E/M
Index Sequential	E/H	D/M	D/M	E/H
Sequential Files	E/L	E/H	E/H	E/H
Algol	N	D/L	N	D/L
Assembler	E/M	E/L	N	E/H
PAL '73	D/L	D/L	N	E/H
ICPR	D/L	D/M	D/M	E/M

D - Desirable
E - Essential
N - Non-Essential

H - High volume
M - Moderate
L - Low

TABLE III

INPUT AND OUTPUT DEVICES REQUIRED

	A.T.C.	C.C.T.	S.L.U.	S.U.C.P.
Card Reader	M	H	M	H
Card Punch	L	M	L	L
Printer	M	H	M	H
Disk	M	H	M	H
Tape (magnetic)	L	H	M	H
Keyboard Entry Terminals				
Hard copy	3/6	25/60	7/16	4/20
CRT	0/4	2/6	2/5	2/6
Plotter	0/0	1/2	0/1	1/2

H - High volume

M - Moderate volume

L - Low volume

System	Eleven FORTRAN Jobs, Gross time, sec.	Large FORTRAN Job, minutes
Burroughs B3500	1799*	-------
IBM System/3	appears to be about 1/30 the speed of 360/44	
IBM 360/30	1946	-------
IBM 360/44	244	28:38
IBM 370/145		
IBM 370/155		
Xerox Sigma 6	274	16:30

* Only 10 of the jobs were processed.

E. Major Computing Categories

Harvard University, in a planning effort for itself, utilized six major categories for amalgamating computing user requirements. The study committee will use this format since it is of help in conceptualizing various categories of use.

1. User written program compilations, executions and debuggings.

This category involves only batch processing as interactive computing is treated later (item 6). It focuses on computer activities which involve original computer program development or problem-solving efforts which are initiated by the immediate user. Generally, the category includes relatively unsophisticated users who are likely to require staff assistance, relatively small amounts of computing time, and will experience difficulty in the diagnosis of their computer programs.

2. Packaged Programs.

This category includes the use of previously developed program packages which are placed in a computer library for use by students. A program library may consist of packages developed by consortium faculty or more likely by faculty of major

universities outside of the consortium. Programs such as those that were developed for the Dartmouth system provide better student understanding of specific instructional problems which the package has been designed to obtain. Such packages encourage the intelligent use of computing facilities, and staff, and faculty. Student time is spent in a problem solving mode which effectively individualizes instruction. These packages also permit the introduction of the quantitative aspects of many disciplines without being restricted to science and mathematics majors. These program packages seem to induce a higher level of student motivation than is generally created by other instructional techniques because the computer program is considerably different from many "traditional" instructional patterns. It is important to note that the packaged programs could involve computer-managed instruction, (CMI) as well as computer-assisted instruction. CMI includes testing and evaluation techniques committed to the computer, as well as individually paced instructional programs. Within the consortium, the following conclusions could be drawn:

(a) there will be a very heavy need for importing program packages from other locations because the development costs of such packages are extremely high and the expertise required is considerably greater than most of our faculty possess;

(b) the need for such programs will also increase as newer faculty are retained. These faculty will have had access to the computer programs available at other locations and will seek to utilize these packages for their own instructional purposes. Thus, a sociologist from Syracuse who utilized the

TSAR package would be most effective in utilizing that same system for his own students' conclusions.

(c) The importation of such packages is a difficulty in and of itself. Adaptation of such packages to machines other than the ones they were written for requires heavy computer staff time.

(d) Typically, packages require about 64K bytes for administrative applications and 150-250K bytes for scientific applications. These parameters are chosen by package developers since they match the equipment capabilities of a large number of installations, yet provide for reasonably efficient programs.

3. Large Scientific Production.

This category focuses on research applications created by a fairly sophisticated computer user. The computations included in this category are likely to be batch-processed and are likely to consume high levels of computing time. Higher level computing languages would be required for this purpose.

Among the conclusions drawn by the committee are the following:

(a) Clarkson would have the largest assemblage of individuals likely to draw upon this mode of computing. However, resource sharing in this field is possible since there are a growing number of faculty at St. Lawrence and Potsdam who will require this type of computing;

(b) Potsdam through its anticipated masters program in computer science will also be generating a large number of faculty and students whose computing demands will greatly exceed number of typical computers users.

4. Administrative Computing.

This category of computing does not necessarily require very large core storage capabilities. It does produce a fairly high level of traffic in terms of jobs processed, lines printed, etc. Although there is a heavy emphasis on the use of COBOL for administrative data processing, other languages are required from time to time, and in the case of Clarkson, COBOL has not been utilized at all.

The following conclusions have been drawn from this survey:

(a) the biggest problem in the consortium is the integration of administrative files. Presently most files exist as separate and unrelated entities. Data elements are often duplicated in some files and the maintenance of them has been a significant cost factor;

(b) there is a large current and continuing investment in administrative software. Although there is some individualism in administrative data processing, there is also some commonality in the needs of the four institutions. The adoption of NCHEM standards for data collection and simulation will accentuate a common basis for processing data. Class scheduling techniques, for instance, are part of the administrative system which could be used throughout the consortium;

(c) the bulk of administrative data processing will be concentrated in modifying existing systems to increase their efficiency and capability to meet new work volumes and changing needs;

(d) the development of new administrative data systems will utilize about 20% of existing resources. It is doubtful that there will be any great activity in the importation of administrative data processing systems other than those originating from NCHEMS;

(e) virtually no serious study of the application of on-line data processing terminals has been made at any of the colleges.

5. On-line Data Collection and Process Control.

This type of computing is characterized by terminal-oriented real-time data manipulation systems. Generally such computing does not require high-speed computers or great storage capacity, though there are exceptions to this. The Computer Committee's conclusions pertaining to this type of computing are as follows:

(a) the primary growth of on-line computing will be administrative in nature. Such use will focus on the registrar's office, institutional planning office, library, and the comptroller's office;

(b) there is likely to be some laboratory usage of on-line data processing, particularly for data acquisition at Clarkson. All of the chemistry departments have indicated an interest in data acquisition terminals for their laboratories.

6. On-line Interactive Computing.

This type of computing generally requires easily understood computing languages such as BASIC, APL, etc. Heavy emphasis is placed on the ease of use by the individual involved.

Many program packages similar to those noted under category 2 would be accessed through on-line terminals. Table III noted above gives an estimated picture of the number of computer terminals which are required for academic and administrative purposes combined. If any special computing services are offered to off-campus locations, such as school districts, it is likely to be through on-line keyboard devices such as teletypes or cathode ray tube terminals. These terminals would have access to pre-packaged programs which the user would query and respond to.

F. External Funding Possibilities

It is difficult to project the receipt of significant sources of support for the establishment and maintenance of a consortium computer network through federal or state agencies. At best, perhaps 5% of the total could be supported through computational activities funded under research projects that would require the system's services.

A survey by the Southern Regional Education Board over a five-year period indicated that most federal funding went for equipment and facilities. This component was followed by contributions towards operations, compilations, and computer center development in descending order. The very lowest level of support went to undergraduate instruction, the area of greatest importance to our four campuses.

The National Science Foundation's regional computing program was phased out last year and was replaced by interest in nationwide nets. Since such networks focus on the interfacing of very large computer centers, it is doubtful that our consortium's

computer network would be actively involved in the present effort as anything other than a potential customer for specialized services from other locations. There is some possibility that in the future the National Science Foundation may begin to reinstitute regional computing efforts. If this did come about, some possibility for funding would be possible.

At the present time it would be impossible for the committee to make any predictions about the acquisition of funding from philanthropic institutions or from the State University of New York which is proposing regional computer networks that go beyond the scope of our consortium.

G. Potential Sale of Services

Within the four campuses there appears to be very little interest in establishing a computing system which was capable of making services available to other agencies on anything other than an ad hoc basis. Only St. Lawrence expressed much interest in this possibility.

The problems of offering computing services are quite significant. If, for instance, an approach was made to school districts to obtain computing from a college network, it could easily require an initially higher level of computer than would be the case if anything more than modest interest was expressed. The computer would reach its capacity faster than it would on college service alone. Thus, it would be conceivable that while additional services sold off-campus would use some excess capacity, it would also force the faster, full utilization of the computer than might otherwise be the case.

In addition, non-college users are likely to be far less sophisticated than those on campus. If any special packages were required, there would be a greater need for special documentation, circuit riders, and the like. Most of the computing needs off campus would be likely to center on the same peak periods that the colleges would have. Thus, there would be little to be gained in the flattening of computer loads.

The committee did feel that if services can be sold on an ad hoc basis without any commitment to long-term access, this would be a desirable supplementary asset.

A major effort would have to be made, however, to be sure the consortium computer did not conflict with commercial interests in the region. Court cases presently in process have placed several non-profit computing centers in difficult situations as a result of suits brought by commercial firms.

H. Combined Enrollments

Table IV outlines the projected enrollment growth of the four institutions; both undergraduate and graduate projections are included.

While St. Lawrence University's enrollment is expected to stay potentially the same as it is at the present time, each of the other institutions have projected an increased student population. Of these projections, the most significant changes would appear to be the growth of graduate students at Clarkson and SUNY Potsdam. Since the graduate program at Potsdam will include students recruited for the to-be-established master of arts in computer science, this will represent a fairly substantial

TABLE IV

Enrollment Projections

UNDERGRADUATE/GRADUATE

	SUNY ATC	St. Lawrence	SUNY Potsdam	Clarkson	Total	% Increase over 72/73
1971/72	1968	2201	3980/100	2183/215	10332/316	----
1972/73	1990	2197	3991/ 66	2164/192	10342/258	----
1973/74	2145	2178	4050/125	2165/200	10538/200	1.9/26
1974/75	2228	2110	4160/125	2280/250	10778/375	4.2/45
1975/76	2306	2083	4460/125	2360/300	11209/425	8.4/65
1976/77	2386	2067	4710/125	2440/350	11603/475	12.2/84
1977/78	2466	2061	4710/125	2625/400	11862/525	14.7/103
1978/79	2547	2061	4710/125	2810/450	12128/575	17.3/123
1979/80	2627	2064	4710/125	2995/500	12396/625	19.7/142

increase in computing.

In a similar fashion, an even more accelerated growth projection for graduate students at Clarkson will greatly expand the volume of computing being run by this type of student.

The overall increase of approximately 2,000 students at the undergraduate level between 1973 and 1980 will produce a modest increase in computing in and of itself. However, this growth will not be as signigicant as the projected graduate increase.

I. Combined Computing Budgets

In a study done of computing in small colleges by EDUCOM, it was determined that most institutions were required to invest eighty to ninety percent of the costs for computing from their own budgets. Very few small colleges would be able to secure large grants for underwriting the costs of computing. This would appear to be true for our four institutions as well. It would seem from the computer study that considerably less than ten percent of the support for the combined computing operations are obtained through anything other than internal budget allocations.

The Association for Computing Machinery estimated that a small college spends between 1.8 and 2.5% of its total institutional budget for computing services. At the same time, this amount seems to be increasing. An often-quoted growth factor is 8% per year. This figure is arrived at in a 1971 study by EDUCOM. Howard Bowen, in a study for the Carnegie Commission, suggested the figure of 7.5% as being more accurate. While the statewide

study in Illinois projected that the growth rate for computing budgets for the public colleges would not exceed the rate of inflation, it did note that there were many compuses that had "to catch up", and consequently would be required to spend considerably more money than is the case in institutions which are farther ahead in utilizing computers.

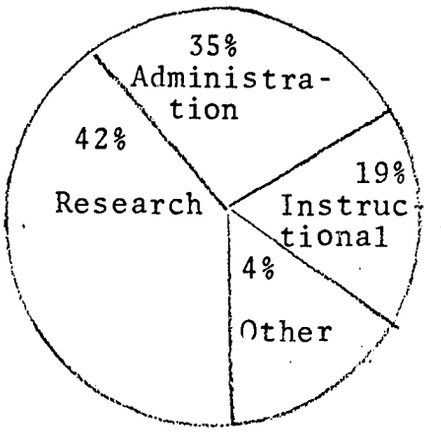
Within the Associated Colleges, it would appear that the rate of growth should be projected at an increase of about 8% per year on the basis of the anticipated and desired new services which are to be provided. Except for Clarkson in several key areas, each of the institutions is behind in the state of the art in instructional computing, particularly in many disciplines not traditionally related to computers.

The statewide study in Illinois determined that there was an approximately one to one ratio of expenditures for hardware and expenditures for personnel services. Within the Associated Colleges it would appear that this ratio is approximately the same when all the computing budgets are combined. However, there is a considerable variation in this respect between campuses. This ratio can be contrasted with approximately $100 for hardware expenditures vs $187 for personnel expenditures in industry. This ratio was reported by McKinsey & Company, a well-known consulting firm. There is a striking discrepancy between the two ratios since it is generally conceded that institutions of higher education require a much greater range of computer services, documentation, staff assistance, etc., than do industrial organizations. Table VI displays the approximate percentages of the computing budgets which are expended on administrative,

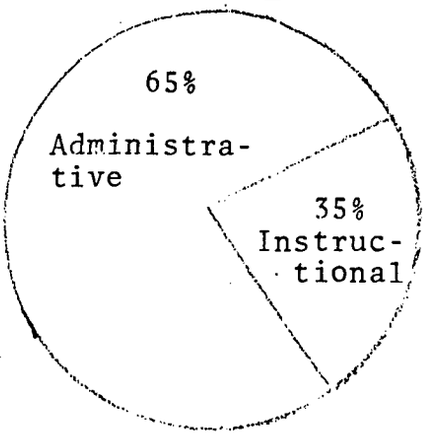
TABLE VI

COMPUTING EXPENDITURES

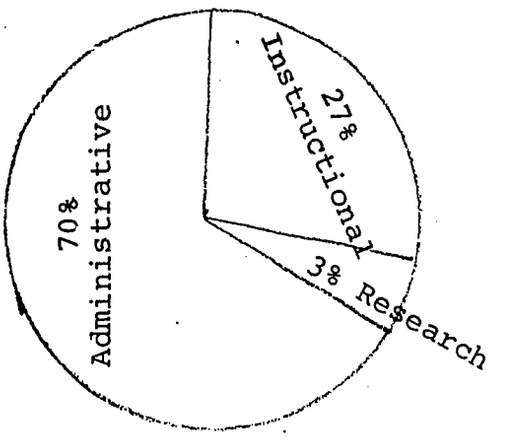
Clarkson College of Technology



State University Agricultural and Technical College



St. Lawrence University



State University College at Potsdam

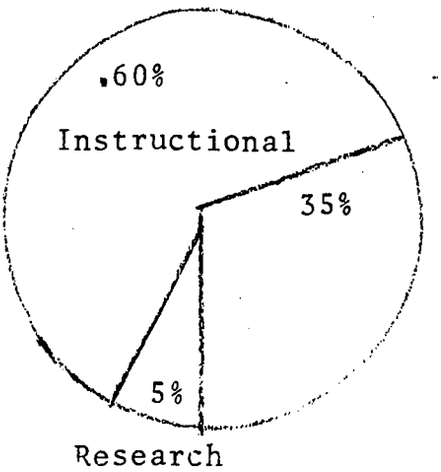


TABLE VII

Computing Budgets 1973-74

	Canton	Clarkson	Potsdam	St. Lawrence
Personnel	53,500	105,000	198,000*	70,300
Hardware and Proprietary	44,000	162,000**	130,000	89,200
Other	2,400	11,400	25,000	12,700
Total expenditure	99,900	278,400	353,000	172,200
Increase over 1972-73	13%	1%	3.5%	Decrease .023

* includes teaching faculty in computer science

** does not include mini-computer costs, but includes rental equivalent of Model 44

instructional, research, and other services. Since the table is presented as the percentage of the total campus computing function, the pie graphs are somewhat misleading. There is a great diversity in the size of the budgets at each campus, thus a small percentage of costs going for administration at one campus may exceed the total amount devoted to administration by a campus with a larger percentage devoted to this purpose.

It is helpful to point out, however, that James Farmer has indicated that a general rule of thumb is that 30% of a campus's computing budget is devoted to administration, 30% to research, and 40% to instruction. Each of our colleges varies considerably in this respect.

McKinsey Consultants in their study of the potential for computers in industry noted that while 35% of a computing budget went for the cost of equipment, 30% went for the operation of the computer and 15% went toward the maintenance of existing programs which were being updated. Only 20% of the computing budget was going toward the development and implementation of new programs.

Presuming that a similar breakdown would be descriptive of an institution of higher education, this would indicate that there is little flexibility within existing budgets to mount a concerted effort toward increasing either the number of administrative data-processing programs, or academic programs. Again, this would indicate that a substantial increase in computing budgets would be required to continue the extension of computing into new areas.

The only other alternative would be the possibility of

combining budgets in such a way that the savings realized could be funnelled into these new areas of program development.

A problem of some significance was identified by the Committee as being common throughout the four institutions. Each of the campuses treats its own computing center or other dedicated systems as "free resources." That is, no meaningful charges are made to various departments on campus to support the computing services. In many instances the use of the computer by researchers is provided them without charge to any unit within the college. While this budgeting technique is perfectly adequate for many individual institutional operations, were a consortium computer installed, a fairly stringent budgeting system would have to be adopted that would display these costs as originating within the academic and administrative areas supported.

It should be noted that while this would present a conceptual problem, the Triangle University Computing Center in North Carolina, has simply operated on a basis whereby the three participating institutions are charged a prorated share of the computing costs and then each institution reimburses the center through its own unique internal budgeting procedures.

J. Training and Educational Computing Uses

A high degree of variability exists in the total computing needs of the consortium. Computers are used for 1) training technicians, 2) educating systems analysts, 3) training computer designers, 4) providing insight into computers as a part of a liberal education, 5) experimenting with computer-assisted

instruction, 6) providing computing as a supportive tool for faculty and student research and instruction, and 7) offering administrative data processing and simulation. Computers handling all needs satisfactorily will be difficult to locate.

K. Intercampus Growth Factors

Over the last year a number of changes have begun to present themselves which will expand the use of the computer in ways other than those which would be associated with any one campus. These uses would include the following at a minimum:

....Cross registration is increasing and will involve more students taking computer-oriented course work on campuses other than their own;

....Faculty taking advantage of cross-registration will enroll in courses dealing with computing;

....Faculty interested in research have begun using the Clarkson computer more actively than they have in the past;

....Clarkson is using the Potsdam computer for running COBOL programs;

....There is a fairly heavy formal and informal movement of students using the Clarkson and Potsdam computers and allied services, particularly the keypunching laboratories, during peak periods;

....The increased numbers of contacts between academic departments should lead to a more rapid dissemination of computing programs utilized on one of the campuses. It is projected that these kinds of contacts will accelerate considerably over the

planning period.

L. Major Areas for Expansion

In reviewing some of the areas in which expanded computer needs will be felt most drastically, the committee located several areas where each of the institutions would begin to have a problem if it relied on its own resources.

The most significant of these areas was that of staffing. It would appear that if any one of the colleges wished to exert its efforts towards the kind of expansion outlined in their institutional profiles, the cost of personnel would rise quite sharply. It is doubtful if any one of the institutions can make an effort given its present staff.

Clarkson is likely to feel a critical pinch on its computer services in terms of the core size of its computer, and to some extent in the speed of its computer. It is also likely to be unable to handle the volume of work anticipated.

Canton will also find core size to be a significantly limiting factor. For instance, NCHEMS simulation packages cannot be run on the System 3 and neither can many of the administrative data-processing programs which will be required in the future. Although Canton could continue its present operations with the existing system, it will find its future options for computer applications severely limited.

St. Lawrence will have moderate to high volume usage of greater numbers of languages than are presently available to it. For data-bases other than those presently available through Dartmouth, and for special statistical and mathematical packages

there will be a problem. While St. Lawrence's facilities are satisfactory for present purposes, a significant increase in the number of terminals to Dartmouth or the acquisition of additional mini-computing systems would be both expensive and likely to result in an incomplete, long-term satisfaction of the needs expressed during the study.

Potsdam will find a critical need for an increase in its computers' core size and for a higher language versatility. It will also find a high need for additional data banks, additional software packages, and will find it difficult to handle the volume of work projected.

One of the most significant needs at each of the campuses is the inability of the present equipment to grow in terms of the provision for sophisticated time-sharing services. The minicomputer at Clarkson is already used to capacity and is highly inappropriate for many sophisticated users.

M. Computer Centers

Several areas of commonality can be found to describe the operation of the four computer installations.

1. Each center is staffed for computer operations, systems design and programming. Three of the four also prepare all administrative data.

2. The computers are run in a "closed shop" fashion, that is, the users submit jobs for processing and return later to pick up the results. CATC is a part-time exception since they require some students to learn equipment operational procedures.

3. Although computer centers most frequently answer to the chief administrative officer of the institution, such is not the case for any of the local centers. Two of them report to academic channels at the Dean-level and the other two report to financial officers at the equivalent level.

4. While three of the computer center directors are involved with some teaching, only one has an academic rank. He has had industrial computing experience. These backgrounds tend to assure equitable treatment to both academic and administrative customers of the computers.

5. The bulk of the computing load is handled by batch-processing. The exceptions are the PDP-8/E machines at CCT and SLU, and the Dartmouth terminal at St. Lawrence.

6. Remote batch and remote job entry processing are found only at St. Lawrence where they are successfully making use of the Lawban computer for administrative data processing.

7. Each of the four centers has grown independently over a number of years to serve the immediate needs of the institution. Communication between the centers has existed for the solution of short-term problems, but no substantial effort has been expended for a true sharing of computer resources.

8. None of the institutions has formally planned for the long range growth of computer resources.

9. The demand for computer services has grown at a rapid pace for the past several years and will continue to grow throughout the planning period.

10. All computer users desire rapid response, i.e., short turn-around times. No rationale can prevail against this desire; the impossible task of keeping all of the users happy places the center management under strong pressure to continually upgrade services and shorten turn-around time. A 5-10 second response time is about the maximum for terminals before users become uncomfortable, and 30 minutes to 2 hours is about the maximum for batch processing to maintain continuous student interest.

11. Bona fide priority schemes seem to be lacking. This results in the establishment of policies by the computer center director, reflecting his personal evaluation of institutional goals or perhaps yielding to a group of influential users who may be self-serving.

12. The computers are generally regarded as a free resource This results in the computer center directors defending the total budget but none of the users justifying their own expenditures.

VI. Conclusions About the Potentials for Cooperative Computing

A. It is technically feasible to implement a cooperative computing effort centering on the joint use of a commonly utilized hardware network.

During the course of this study, it became evident that there were many combinations of computing hardware that could be assembled to meet all or some of the requirements anticipated over the planning period. Any number of alternatives could be given serious consideration. Later in this report a review of some of the primary alternatives is given.

B. There are areas of potentially significant savings in activities for computing of all types.

Although the forms of cooperation which are possible are closely dependent upon the nature of the configuration eventually established, it is possible to note those areas in which more efficient operations would be realized if a consortium effort were made. The degree to which these savings can be realized will be directly related to the level of the expenditures for higher levels of computing services at the four institutions.

The Computer Committee is well aware of the fact that the cost of education is continuing to rise, and the Committee is not prepared to recommend proposals which significantly accelerate the rate of this climb. Since this study is dealing with recommendations pertinent to the satisfactory handling of the anticipated needs of the four campuses over a five-year period - which does not begin for another year and a half - we are framing all of our proposals in the hope that these efforts

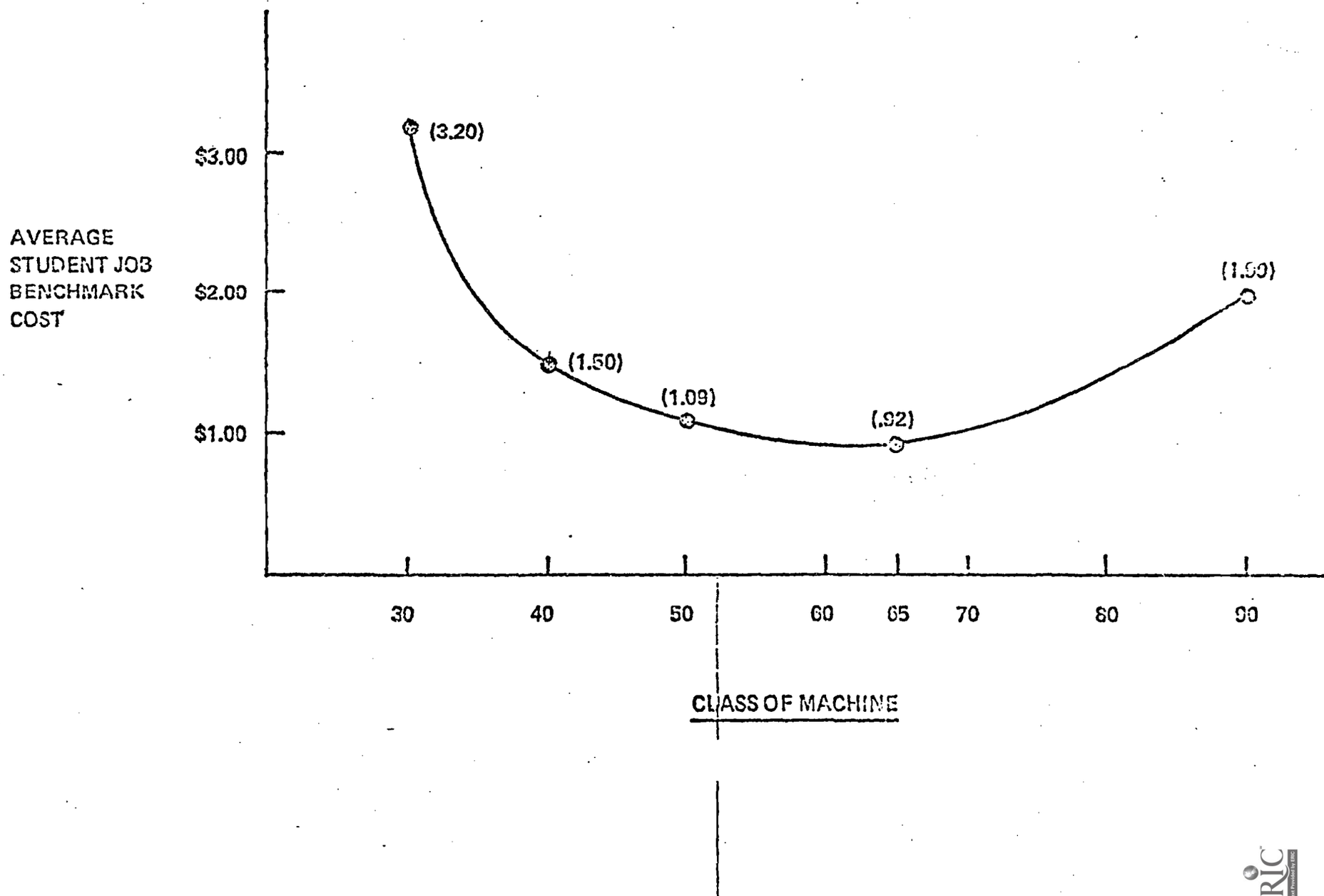
will lead to reduced unit costs for computing. That is, while the cost for computing would of necessity be rising, the expenditures per computational function will be lower than they would have been if individual efforts were made by the separate campuses.

Here are some of the areas where more efficient operations could be produced:

1. Hardware utilization. The costs for computing power have been dropping significantly over the past decade. In 1960, for every dollar committed toward the purchase of a computer, 7,000 characters of storage were available. In 1973, one dollar would purchase one hundred thousand characters of storage. This is a significant drop, and similar projections are made for the future. Thus, it becomes feasible for a group of colleges to secure a computer with far greater power than might have been the case in 1960. A general postulate, Grosch's Law, estimates that for 40% more cost one can obtain twice the computing power. While this is subject to debate, it does seem to hold true generally.

Farmer, however, has indicated that his studies show that there is an efficiency curve for computers. (See Table VII) This curve indicates that the very small computers are relatively inefficient by comparison to the middle range computers, and the most powerful computers are also similarly inefficient. In the case of the smaller computer, the inefficiency is due to the hardware's inability to rapidly process computer programs, and to the difficulty in programming smaller machines satisfactorily.

TABLE VII


AVERAGE STUDENT JOB BENCHMARK COST
$3.00
$2.00
$1.00
(3.20)
(1.50)
(1.09)
(.92)
(1.99)
30
40
50
60
65
70
80
90
CLASS OF MACHINE

The larger machines become inefficient because of overhead costs and because much of the computing power is unutilized for long periods of time.

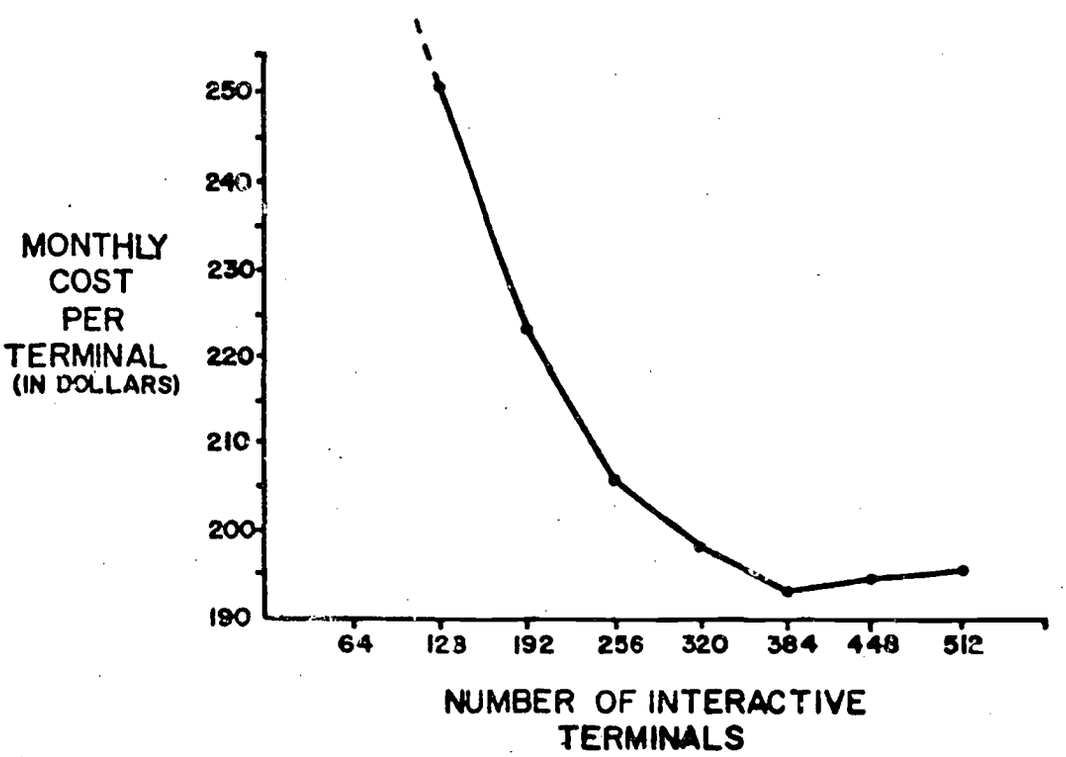
A study by Littrell found that as far as hardware systems were concerned, there was little economy of scale in business and commercial applications because there was a low ratio of computations to the input and output units. For many business application, multiple files are utilized and the requirements for large storage cores are not necessary. Scientific applications do provide for significant economies of scale since the speed and core size of the computer attain greater significance. It is important that the conclusions noted by Littrell are strictly directed toward hardware evaluation, not toward software savings that might result from cooperative ventures.

The Illinois Statewide Plan for Computing reported that the per unit cost of interactive terminals handled through a general purpose computer becomes more efficient as the number of terminals are increased (See Table VIII). It would appear from this study that among the four colleges there is a need for a base number of individual computer terminals that can put the cost per terminal at a reasonable level. Any additional terminals would further serve to make the interactive computing mode of utilization more efficient.

Another advantage to a large computer system is the ability to provide specialized hardware needing large core capability and high speed. Bulk on-line storage for saving data bases, computer graphics materials, and plotting machines for example, will require these computer characteristics. The cost per unit of computer "power" decreases markedly after a threshold limit

TABLE VIII

Computer Cost per Terminal
for an Interactive Instructional Network



has been passed. None of the member colleges would approach that limit on their own.

2. Software utilization. Hardware costs per unit of computing power are dropping, but costs for personnel and software has been increasing. There are possibilities for joint development and utilization of software in fields where there are overlapping academic and administrative requirements. For instance, the geology department at St. Lawrence and Potsdam could draw on the same computer exercises if they had comparable access to terminals with suitable programs. The production of computer packages would be more efficient as would efforts at documenting these programs make them more easily usable.

There would be a better utilization of computer packages which could be obtained from outside of the consortium. Each college has a heavier demand for resources available outside of the system than for specially, self-prepared packages. This is an important point. It is expensive and time-consuming to search for programs outside the region. Much future software will be proprietary. Thus, there will be an increasing value to having a single center. Farmer estimated a savings of $2,000 to $4,000 per month by 1975 for each college. There is no way by which information secured by one campus can routinely be passed on to another. Given the wide disparity of computing services provided, it is difficult to mount a concentrated effort to secure public libraries for our own use.

Computing on our campuses is, as one author described it, "a cottage industry," in which truly sophisticated and usable program packages are not being secured or well utilized.

McClure in reviewing some of the economies of terminal oriented systems indicated that the cost for software should be subjected to a higher level of administrative scrutiny than it has received in the past. About 40% of the computing budget is tied up in applications development and this is where the greatest level of savings can be effected. Thus, savings would be possible by improving the quality of software being developed and by a better evaluation of the need for some of the programs which perhaps should be foregone in the light of other priorities.

On the presumption that the four colleges could make available among themselves a higher speed, larger core computer, several of the colleges which now are hardware limited would have more options open than would otherwise be true.

3. Personnel utilization. In a report issued by the Rand Corporation, an efficiency curve similar to that produced by Farmer was shown to govern the efficiency of personnel time on computers. That is, personnel on relatively small machines were using their time inefficiently for less productive tasks than was true of medium-sized machines. Again, on the larger machines a higher quality of staff was required to maintain the more sophisticated machinery and more time was put in on keeping the equipment running than was true of medium-sized computers. This would again indicate that personnel in

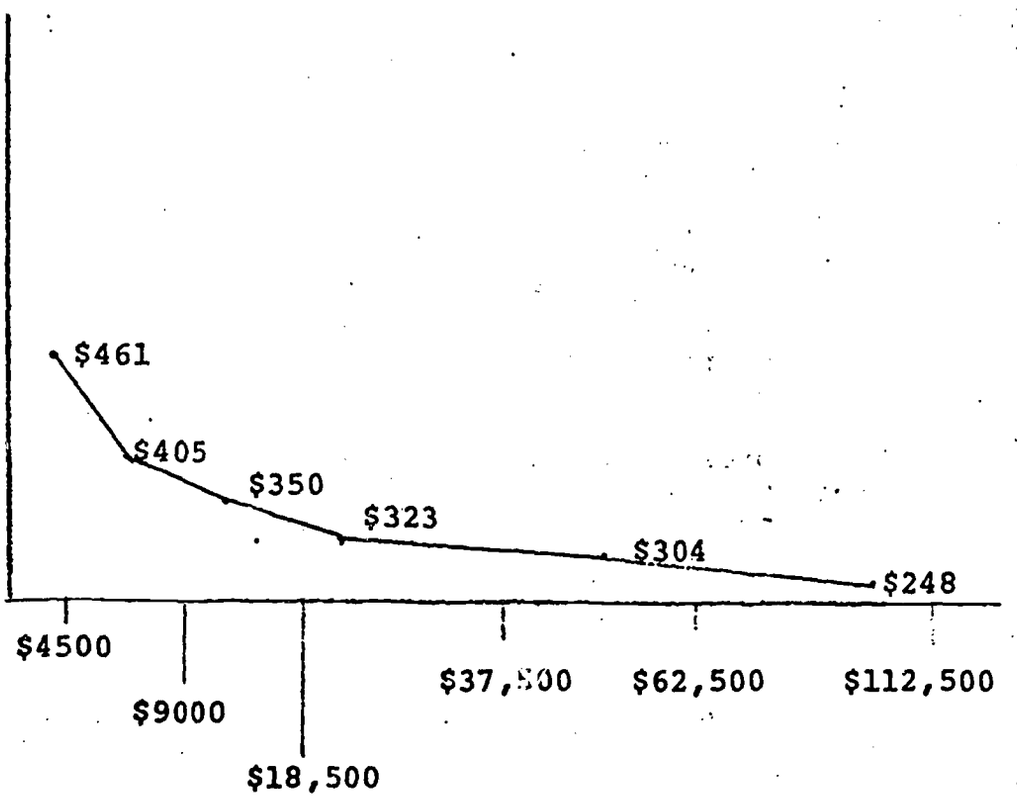
computer areas would be better utilized if a combined effort was possible.

A recent study of computer networks showed a slightly different conclusion. Solomon (see Table IX) found that the personnel costs were decreased when compared to the rental costs of a computer.

4. Training. At the present time there is virtually no on-going coherent training program for either professional computer staff or for faculty and administrators within the consortium. Most training programs are extremely short-term and little in the way of cumulative impact has been realized as a result of this. If a cooperative computing arrangement were implemented, it would be possible for some intensive training programs to be instituted for specific target groups. For instance, while it would not be possible to develop much enthusiasm among other campuses' chemistry faculty to learn about software packages based at Clarkson, when these materials are unavailable on their own campuses' machines, it would be possible to cultivate this interest if they all had access to the same machinery and software. This would also provide the "critical mass" to encourage individual faculty on one campus to maintain their interest in this form of instruction.

5. Acquisition of Expertise. By combining resources for computing, it would be possible to implement a noticeably more powerful computer network that would require a higher level of staff training than is presently given. The staff managing such a network would be available to personnel at

TABLE IX



Average Weekly Personnel Costs

Per $1000 Machine Rental[5]

[5]Martin B. Solomon, Jr., "Economies of Scale and Computer Personnels," Datamation, 16, No. 3 (March, 1970), 107-110.

all four campuses. Similarly each campus could specialize and concentrate on the development of expertise in a manner that could lead to a real sharing of strengths. Such a network would permit the recruitment of a higher level of faculty and computer staff than might be the case with individual machines.

6. Budgetary control. One of the most significant findings of this study is that in many instances there is little information on the actual utilization of the computer. Smaller machines like the PDP/8E systems at Clarkson and St. Lawrence are unable to provide monitoring information about their operations. Thus, it is virtually impossible to know how the machines are being used, what they are being used for, etc. At none of the institutions is there an effective plan for computing over the long term, nor is there any substantive effort underway to bring about such a plan for computing.

By combining and focusing the interests at all four colleges in a single network, far better control over these expenses would be possible and a clear direction set for the future. In short, by concentrating computer resources in a major effort, the consortium can move to what has been termed by an EDUCOM report, as a "fourth generation management system" for computing. The characteristics of the fourth generation management system include competent management, long-range decisions, control centers, reduced, but high quality personnel, evaluation of all functions and accounting for all computing resources.

7. Interfacing with Computers Outside the Region. It is estimated that by 1977, a standard interface mechanism will be available to permit the interaction of general purpose computers. At about the same time documentation for a standarized system of protocol procedures would facilitate the exchange of information between separated systems.

At the present time each of the so-called Interface Message Processors (IMPS) that permit intercomputer communication for the ARPA network cost approximately $56,000. Since there is a very high level of interest in obtaining the resources of such groups as the Interuniversity Consortium for Political Research and in using the special computing services of the disciplinary centers established through ARPA, the need for such an interface should evolve rapidly. Were each campus to obtain such a device for its own computer, a rather substantial form of duplication would be present. This type of needless expenditure could be eliminated through a single interface with such a system. This advantage is highlighted by the Illinois study of computing which concluded that:

> A significant trend in computer development is directed towards systems linking a number of computers, with large scale power at some central point, through a communications network operating with a series of terminals at user locations. The advantages to remote users achieved by this approach are:
>
> (a) the availability of a large computer which provides speed and storage capability which might be unavailable locally,
>
> (b) the support of large data files and data banks which might be impossible locally,

(c) the support of a wider range of programming languages than might be possible locally,

(d) the possibility of the sharing of a program library among all users, and

(e) cost reductions due to economies of scale available on the larger remote computer.

8. Richer software. By combining resources it will be possible for the campuses to afford some types of software that would not have been warranted by the small number of people utilizing these materials on any one campus. For instance, civil engineering programming in COGO probably would be too expensive and too powerful to run on the Canton computer, but if it were available for Clarkson's civil engineering faculty, it would also be available to Canton. Clarkson presently does not have a COBOL compiler which is the preferred language for most business applications. Consequently it has had to use

FORTRAN for this purpose. This makes it difficult for Clarkson to utilize many of the publicly available business libraries, such as the WICHE simulation system. Similar areas of difficulty can be recounted for all of the campuses.

9. Integrated computer files. At the present time many of the accounting and other record keeping systems maintained by the campuses are relatively self-contained. It is difficult to have information from various files manipulated concurrently through integrated systems. Thus, there is much redundant record keeping and much management information which could be made available but which cannot be brought together without much difficulty.

B. There are areas of significantly improved operations which will lead to greater effectiveness of both instruction and administration.

While many improvements in teaching and administration are not as easily documented as are improvements in areas where quantitative assessments are possible, it would appear that such improvements are feasible.

1. Improved teaching. Many students coming to college anticipate that their experience will be significantly different from the type of instructional patterns they experienced while in high school. Though there are some changes in the level of instruction and in some forms of instruction, to a large degree college instruction, particularly at the lower division level, replicates the format of the high school.

The computer as a tool of instruction could make a major contribution to the creation of a noticeably different instruc-

tional environment. Resources committed to the application of computers to instruction would be likely to demonstrate a greater impact than might be true of other instructional techniques. Charles Mosmann, in his recent book on academic computing, noted that computers provided "a unique opportunity to improve the quality of education, and at a small marginal cost, the highest comparative return over any other "instrument." In addition to augmenting traditional instructional patterns by permitting students to deal with problems that could not have been taught in any other fashion, the computer also requires a level of personal involvement that is seldom duplicated in usual course work.

2. Access to more diverse computing software. Many of the campuses do not have the financial ability to make available some of the more sophisticated problem-solving languages that are specifically designed to service particular disciplines. Through a joint effort it should be possible to increase the diversity available throughout the consortium and to provide access by each of the campuses to higher levels of existing software. For instance, Canton could use a higher level COBOL rather than low-level COBOL which its small System 3 is required to utilize.

3. Diversified administrative involvement. If it were possible to combine resources for the acquisition of sophisticated computing machinery, it would be more likely that such things as on-line data processing could be implemented. For computing service to become a more significant management tool, it will

be essential that the administration of computing service begin to include Registrars, Comptrollers, and the like as direct users of the computing system. Too often administrative tasks and policy decisions are relegated to the computer center staffs simply because the level of understanding of the computer service is less sophisticated than it should be. A report by the McKinsey consulting firm stressed this involvement as a key characteristic of effectively operated computing centers in industry.

4. Better administrative procedures. One of the most productive areas of cooperation among the four colleges would be relatively informal. The simple exchange of information about how various administrative problems are being dealt with is an important though hard to define contribution of the consortium. If a single computing arrangement were to amalgamate our resources, the kinds of exchanges possible would be greatly enhanced. For instance, the class scheduling program at Clarkson might be picked up by the other campuses. The implementation of WICHE simulation systems would be interpreted more effectively if administrative task forces were organized for this purpose and registration procedures might be made more efficient through the establishment of comparative data on the effectiveness of the various alternatives.

5. Stimulated cooperation. Presuming that the level of cross registration continues to increase at the modest rate of 10% each semester, by 1980 there will be some 1,050 students enrolling in courses across the consortium. Many of these cross

registrations will involve students taking courses involving the use of the computer. If they do not have appropriate terminals and software present on their own campus, they will be severely handicapped in meeting course requirements and expectatations. There are a number of faculty and administrative staff who are taking course work under the cross-registration program. Many of these are also enrolled in computer science courses. The utilization of a common network would facilitate the application of their course work to each institution since the training programs they engage in would involve the use of the computer that is used on their own campuses for administrative and instructional purposes. Thus, a computer center staff member taking a course at SUNY College at Potsdam, for example, would be utilizing the same computer capabilities that are available at his own institution.

Another important aspect of this type of cooperation is already in evidence. A professor at Potsdam took a graduate course in micro-programming at Clarkson and subsequently offered an undergraduate course on the same topic at Potsdam. Again, the type of interaction that would be fostered by a common computing system would have a demonstrably more efficient impact.

C. <u>The Associated Colleges of the St. Lawrence Valley can meet the criteria that are generally applied toward the evaluation of successful cooperative computing arrangements established elsewhere in the country</u>.

1. Charles Mosmann, in his summary of the reasons why the Triangle University Computing Center (TUCC) has been successful, credits their continued success to several factors which are replicated within our own consortium. First, the four colleges are relatively similar in size, thereby limiting the element of threat generated by the potential domination of any one institution. Secondly, the colleges are all geographically close together. This permits frequent face-to-face and telephone communications. Thirdly, there is a high level of cooperation among the campuses in other respects. Consequently, the computer arrangement is only one aspect of a larger picture of cooperation.

One important factor which is not present at this point is the availability of state legislative support and funding for TUCC.

2. It is unlikely that a combined computing arrangement would require an unusually large computing system. Consequently, it can be organized with an orientation towards service rather than research and development. That is, the computer center would not be established to demonstrate the feasibility of untested computer applications concepts, and its prime role would not be the development of new instructional packages as is true of the PLATO system at the University of Illinois or the Kiewit Center at Dartmouth. The computing arrangement would have a service orientation similar to that at Virginia Polytechnical Institute, which is responsive and accessible to the needs of all of the campuses and would not be an entity serving itself.

3. Unlike many other computer consortia, the arrangement proposed in this working paper entails a high level of commitment from each of the four institutions. This commitment is reflected in the large volume of work contributed by each of the campuses. It would not be restricted to the distribution of one or two terminals to each of the campuses as is the case in most National Science Foundation projects.

IX. Recommendations

After all of the discussions and working sessions conducted by the Computer Committee, it became evident that there were many operational possibilities for interinstitutional cooperation to upgrade the quality and variety of computing services within the four colleges. Equally evident was the conclusion that implementation of the necessary arrangements for this cooperation will be an extremely difficult task. Within and among the four colleges there are a wide variety of computer services required. Hard choices among required and dispensable services shall have to be made.

Amalgamation of administrative and academic computing services in operation at the present time and forecast for the future is clearly not an easy task. Further, while current budget restrictions make it extremely difficult for any single institution to provide all the computer services it requires, the same budget restrictions dictate that any cooperative effort must obtain the best cost/performance increase, must minimize the risk of failure and must be able to justify the investment needed before operation is possible.

The Committee has generally concluded that:

1. Some form of computer system or network is required if the colleges are to meet their stated goals and objectives;

2. The most marked change in computing over the coming planning period will center on the increased use of computers for instructional purposes and for specific

additional administrative functions;

3. There should be cooperative efforts in regard to developing software for both administrative and instructional functions. There does exist a "latent demand" which has not been satisfied, and which only recently became apparent. However, it is important to remember that the campus projections of intended computer utilization might not be realized. The scope of services felt to be desirable now might be reduced when these projects are actually attempted. It is still highly likely that a much greater demand for computing will surface than has been true in the past;

4. For any computing network system to be successful, there will have to be a continuing, conscientious and time-consuming involvement of the senior management at each of the consortium's campuses;

5. A joint computer effort should not be implemented in the expectation simply that the projections are likely to happen. Rather, a more aggressive objective should be adopted--the joint effort should be created to give the greatest assurance that these changes can take place.

Earlier sections of this report have alluded to the advantages of cooperation in the area of computing; these conclusions will not be restated. It will only point out that the following recommendations are made in the light of these conclusions, as well as on the assumptions which were stated during the introductory section. It is our belief that these recommendations can be implemented and phased in successfully. We also believe

that our recommendations provide the best combined alternative to computing within the consortium.

RECOMMENDATION #1: The Associated Colleges of the St. Lawrence Valley should be the administrative agency for implementing the recommendations which follow.

While it would be possible to envision other possibilities for administering the system proposed, it would appear that the Associated Colleges would provide some benefits to establishing a joint computer system that would not be realized by some of the other options. It should be pointed out, however, that the Committee has not done an extensive evaluation of the legal and financial difficulties of organizing computing through the Association, and thus this recommendation should be re-checked with the advice of legal counsel.

The Associated Colleges has been in existence for nearly three years and has established an identifiable sense of purpose that is generally recognized and accepted by faculty and administrators at each of the four colleges. Thus, the Association is able to reinforce the desirability of moving into this area, and it also provides a reinforcement for existing cooperative activities that cover the full range of potentials in administrative and academic programming.

The utilization of the Board of Trustees of the Associated Colleges would provide a clear and structured policy-making organization for the operation of a joint computing effort. Since the Associated Colleges is already chartered as a non-profit educational organization by the Board of Regents, it provides a

ready vehicle for implementing the recommendations combined in this report. With the difficulties that are being encountered in the general effort of regionalism, the establishment of a separate and unique computer consortium would probably create more difficulties than would be the case if the Associated Colleges were the administering agency. The establishment of a significant computing effort within the Associated Colleges would accent the potential for cooperation in many other areas. All activities of the consortium would be strengthened by the inclusion of such an effort within the Associated Colleges' structure.

The centrally-utilized, operating staff could be employed by the Associated Colleges and would be expected to provide services to all four campuses. Each campus would continue, however, to maintain its own computing staff for administrative purposes and to some degree, academic purposes. Consequently, complete control of computer facilities would not be relegated to a single set of staff members but would be distributed throughout the consortium. This would be essential and desirable.

The consortium computing effort should not be administered by the Board of Trustees of the Associated Colleges or directly by the Executive Director of the consortium. There should be an on-going Computing Coordinating Group (CCG) as the primary policy-recommending group for the computer center. This group would consist of the computer services coordinator and a faculty member appointed by the president of each of the campuses. A consortium computer director would meet with the CCG as an ex officio member, without vote.

The coordinating group would be chaired by the consortium Executive Director. Recommendations of the coordinating group would ordinarily be implemented by the computer center staff. However, all policies would be forwarded to the Board of Trustees for certification and reaffirmation. Minority reports or CCG actions could be transmitted to the Board.

If at all possible some additional outside persons should be invited to sit on the CCG. These individuals could come from industry and would be knowledgeable about computing and the administration of such departments. Inclusion of this group would be as helpful to us as it has been to the CHI Corporation which handles the computing for Case-Western Reserve University.

To administer the computing network, the CCG would be expected to do each of the following:

A. The Coordinating Group would make recommendations for the organization and selection of all major pieces of computing equipment needed to provide services as indicated. While the CCG would have to provide as much leeway as possible to each of the campuses, it would be important that the CCG be asked to comment on the intended purchase and selection of all pieces of computing equipment to assure that small groups within one of the four colleges did not work at cross purposes to the longer range goals of the four colleges;

B. The Coordinating Group would recommend for purchase or lease all central computer equipment used for computer services of any kind within the consortium, while the individual campuses would retain ownership of terminals and other input and output equipment;

C. The Coordinating Group would adopt policies for equitably charging for all services rendered the four campuses and to carry out other activities to provide the lowest possible cost for their services;

D. The Coordinating Group would make the primary recommendations for hiring a director of computer services for the four colleges;

E. The Coordinating Group would recommend priorities for software support and maintenance;

F. The Coordinating Group would insure that data in the computer network is accurately processed and secure. The Group would coordinate any new consortium-wide research and development functions related to computing;

G. The Coordinating Group would operate in such a way as to reduce unnecessary duplication and effect the highest degree of complementarity possible among the four campuses.

The relationship of the Associated Colleges to the four campuses in regard to computing services would primarily be on a contractual basis. All such contracts would:

A. Leave primary responsibility for institutional data gathering and utilization of such data with the individual member institutions;

B. Leave the responsibility for accuracy and completeness of any data to be processed by the computer network with the individual campuses;

C. Establish fixed rates of charges for each level of service and priority during each year of operation;

D. Assume that the responsibility for the developing commonly utilized instructional and administrative systems will be placed with the Coordinating Group. The same would be true for the modification and implementation of such software;

E. Assign the administrative responsibility for utilizing efficiently all resources committed to the computer effort to the Coordinating Group.

While a complete detailed implementation plan has not been developed by the computer committee, such a plan, unless modifications are needed, should include items similar to the following:

SINGLE COMPUTER Option #1	STEPS REQUIRED	DUPLEX COMPUTERS Option #2
July 15, 1973	Revision of Working Paper #2 by Computer Committee	July 15, 1973
July 20, 1973	Submission to campuses	July 20, 1973
	Discussions of Working Paper #2	
July 1973	Vice Presidents	July 1973
Aug. 9, 1973	Presidents	Aug. 9, 1973
Sept. 15, 1973	Association, Board of Trustees	Sept. 15, 1973
July 20-Oct.30'73	Campus Computers Users Groups	July 20-Oct. 30'73
July 20-Oct.30'73	Others	July 20-Oct. 30'73
Oct. 30, 1973	Official campus reactions sent to Executive Director by selection of option, modification, or disapproval by	Oct. 30, 1973
Nov. 7, 1973	Association Board of Trustees	Nov. 7, 1973
Nov. 7, 1973	Formation of Computer Coordinating Group	Nov. 7, 1973
Dec. 1, 1973	Screening begins for director of computing	Dec. 1, 1973
Dec. 1, 1973	Activation of various users committees	Dec. 1, 1973
Feb. 1, 1974	Selection of director of computing	Feb. 1, 1974
June 1, 1974	Employment of director of computing	June 1, 1974

Continued

SINGLE COMPUTER Option #1	STEPS REQUIRED	DUPLEX COMPUTERS Option #2
Jan. 1, 1975	Submission of implementation plans to Board	Sept. 1, 1974
Feb. 15, 1975	Distribution of Specifications for new hardware	Oct. 15, 1974
April 1, 1975	Receipt of vendor bids	Nov. 15, 1974
June 1, 1975	Evaluation and selection of vendor hardware	Dec. 15, 1974
June 1, 1975	Staff training, software development begun	Jan. 1, 1975
Feb. 1, 1976	Delivery of hardware	March 1, 1975
June 1, 1976	End of parallel operation-one campus	July 1, 1975
June 1-Oct.'76	Timesharing to other campus	July 15-Oct.1,'75
Aug.1-Dec.'76	Remote-batch processing to other campuses	Aug. 1-Nov.(if used)

RECOMMENDATION #2: <u>One of two network configurations should be adopted for implementation by the Board of Trustees of the Associated Colleges</u>.

As the result of this study, the Committee has examined a number of possible computer network configurations that technically could service the needs of the four institutions. However, only two such configurations would appear to begin to satisfy economic and operational criteria necessary for efficient and effective operation.

Before presenting the two options, it would be well to note that it is the Committee's belief that one possible alternative which was brought up frequently by various individuals did not appear to be satisfactory. Specifically, frequent references

were made to the implementation of minicomputer networks on a greater scale than has already been the case.

Minicomputers are very economical as long as the level of computing does not demand any wide variety of program languages or much core storage. It is clear from the study that most of the needs of the colleges go well beyond those few pockets of computing interests which can be satisfied through the use of the minicomputer. The primary reasons the Committee has not recommended consideration of the minicomputer are the following:

1. These computers by definition have a very small memory. They do not have significant file space and do not provide for data file manipulation of any significance;

2. Each of the campuses is looking forward to a greater diversity in the types of users who will be drawing upon computers. Most of the users in the academic area will rely heavily on externally-processed program packages that cannot be adapted to minicomputers;

3. While some minicomputers do have several languages available to them, most of these are incomplete and unable to provide satisfactory performances for many academic purposes. They are difficult to use for original problem-solving because of the language limitations.

4. There is a definite limit to the growth potential of minicomputers, and there is no way at present by which the expenditures made for minicomputers can be efficiently utilized in the construction of a larger network. The expense incurred to permit a minicomputer to communicate with most medium-sized computers would be prohibitive;

5. The fragmenting of computing resources for mini-computers would in some limited ways be cost-effective for instructional purposes. However, these computers could not be used in any way for administrative or research purposes and not at all for many instructional packages. Thus, if these costs are separated from general computing expenditures, the average cost of research and administrative computing is increased.

Consequently, the Committee recommends consideration of two options by the four campuses.

OPTION #1

INSTALLATION OF A SINGLE MEDIUM-SIZED COMPUTER WITH LARGE CORE STORAGE

One possibility for consolidating all of the computing services through a single network would be the establishment of a single central processing unit which services the colleges largely through non-intelligent, or at least lower capability input and output devices based at each campus. This would require the installation of a single machine in the range presently characterized by the IBM system 370, Model 145, the Xerox Sigma 6, the CDC 6400, and the Univac 1106. Such a machine would probably have a large core storage, in the neighborhood of 700 K bytes.

The advantages of implementing such a system would be as follows:

1. A single computer would be adaptable to a very wide range of capabilities and services;

2. Such a machine would have an inherent "image producing value" both for attracting faculty and students;

3. Major improvements in computing systems frequently begin at the top of the line. Thus, a consortium computer of this type would be most likely to take advantage of progress in the "state of the art";

4. Large computing systems tend to have a longer effective life than smaller computers;

5. If such a machine were of more recent vintage (for instance, an IBM 370 vs. an IBM 360,) such equipment would be likely to take advantage of some newer software being developed for newer machines than for older ones. For instance, newer languages may be more likely to fit the System 370 than the System 360.

6. Newer machines will also be easier to integrate with advances in peripheral and auxiliary gear such as faster mass storage, new terminals, etc. Newer machines have a special communications processor built into them which provides the computer with somewhat superior capabilities.

Among the disadvantages of implementing such a system would be the following:

1. The cost for such a machine goes considerably beyond the level now projected by the four campuses. Depending on the type of machine finally designed and implemented, the price for such a system on a rental basis would approximate $300/500,000 annually for hardware alone. This would break down to about $200/300,000 for the central processing unit and

and approximately $100/200,000 for peripheral equipment;

2. A higher level of guaranteed support from each of the campuses would be required to provide an adequate level of confidence that such a system could be maintained and operated over an adequate period of time;

3. Such a system would require a complete consolidation of all computing resources in a pattern significantly different from that presently in operation;

4. The transition from the individual systems to the complete operation of a single system would be lengthy and difficult. The conversion of many programs would be required, and there would be long periods in which the phase-in would not permit service to all of the campuses.

OPTION #2

A DUPLEX COMPUTER NETWORK

The second possibility for satisfying all of the needs of the consortium would be the institution of a duplex computing configuration involving two medium-sized computers with individually smaller core capacities than would be required for a machine acquired under Option #1. If this option were to be initiated from scratch, it would be more expensive than Option #1 since the total core storage and attendant software would be greater. However, many of the essential elements for

installing such a network are already in place. This system, in essence, would require the acquisition of a machine such as a System 360, Model 40 or 50, located at the SUNY Potsdam campus, interacting with an upgraded Model 44 at the Clarkson campus. The Potsdam-based machine would be primarily used for providing time-sharing services to all four campuses and some administrative data processing. The Clarkson-based computer would primarily be used for remote job entry, batch processing for administration and research, and other large computing operations. It is not now clear that it is technically possible for the two machines to be physically separated. That network configuration will have to be studied more to determine whether this form is possible. The advantages in installing such a network would include the following:

1. There would be a better utilization of existing computing equipment, particularly of the IBM 360, Model 44, which is presently at Clarkson. Since this machine will probably be upgraded simply to carry Clarkson through the period of time between now and the 1975 planning period, the investment in this resource could be applied toward the over-all computing network. Similarly, at Potsdam it is doubtful that the Model 30 they are utilizing can service their immediate needs satisfactorily without some upgrading in the size of the computer. Consequently, this proposal would permit the interconnecting of these computers to involve a relatively small incremental cost increase to permit more efficient four-college utilization of the two computers;

2. A distributed network of computers would create a [illegible]e active involvement of each campus in the effort. Therefore

each college would have considerably more personal participation in the operation of the system;

3. The network would have "fail soft" characteristics; that is, if for some reason one of the machines should fail, it would be possible for the other machine to take up a large portion of the high priority jobs. If Option #1 were adopted, it would be very difficult to locate a nearby comparable computer that could handle the essential services;

4. A duplex computer network would have an inherently greater ability to allow for expansion and flexibility. Both machines, and particularly the Potsdam-based computer, could be expanded in terms of the model types being utilized and in terms of the core storage capability. Thus, a relatively small change could be made at Potsdam to install a Model 40 computer. If the time-sharing and other services reach a saturation level, the Model 40 could be exchanged for a Model 50. By the same token, additional core storage could be added on fairly rapidly. Since there is an upward compatability within families of computers, the amount of software conversion would be relatively limited;

5. This type of network would largely be built on existing technology which has already been in operation in many places around the country. Thus, less developmental effort is required than might be true of new equipment:

6. A major asset of this option would be the relatively easy transition when compared to other possibilities. The installation of a remote batch processing and time-sharing service would draw upon from two separate computers. Thus they could be phased-in over the same time period. Such a phase-in would permit each

institution to begin working on those areas of computing that it feels to be most critical for its own purposes. It would also permit the two colleges to continue their operations with relativley little conversion or modification as the result of consortium operations.

7. The total costs of purchasing an additional central processing unit able to communicate with the Model 44 would be about $200/350,000. The peripherals would run approximately $100/150/000. These expenses would be above and beyond those already accounted for in the investment of the Model 44.

Option #2 has considerably fewer negative aspects to it than does Option #1. These disadvantages are primarily that:

1. The Model 44 is somewhat obsolete already and conceivably the partner machine may also be in the 360 age range. While the major software needs and packages identified in this studey would run on such machines, there is some possibility that new techniques and advances may lock the consortium into inadequate equipment;

2. It is conceivable that an extra staff member would be required for the minimal coordination of this system beyond that which would be required for a single computer. (Approximately four people for Option #2 vs. three people for Option #1);

3. The increase in system flexibility would be acquired at the cost of some fragmentation of computer resources among the campuses.

In surveying the over-all difficulties of implementing either of these options, the Committee feels that Option #2 is the most desirable option to pursue in the future. The

institution of such a system could be initiated more easily and the entire planning and implementation process could be completed in a far shorter period of time than would be the case for Option #1. It would permit the institutions to tailor their computer resources as much as possible without restricting the consortium to a single computer which, if it failed to satisfy the needs, could not be readily dropped from service. Thus, the Committee recommends the acceptance of Option #2 as the preferred course of action.

RECOMMENDATION #3: The four colleges within the Associated Colleges should commit themselves to insuring the financial stability of the computing network option selected over a three-year operational period at a minimum.

The hardware expenditures and some of the support funds presently available within each of the independent computing centers would provide a substantial portion of the funding for the network proposed. However, the estimated growth of these budgets is not likely to reach a level projected for the proposed system. At the same time, with the estimated increase in expenditures, the kinds of objectives stated as being needed by the four campuses cannot be attained either independently or cooperatively. It should be possible over the long-run to make the computing effort within the Associated Colleges self-sufficient in its funding through charge-backs to the colleges after it has passed through the transitional stages.

Each institution will have to voluntarily indicate its willingness to support such a computing network for a minimum

of three years to be certain that an adequate level of stability is provided to sustain this effort. While this is clearly a risk investment, the committee believes that the risk for this alternative is far less than it might be for continuing in non-cooperative manners of computing.

It would be highly desirable for a concerted effort to be made to obtain outside funds for the support of a network such as is proposed. In many ways, the consortium effort is far more substantial in nature than most other computer consortia in the country. While many National Science Foundation and Office of Education networks have been created, very few of these arrangements involve the high level of participation of each of the members as is the case within our own consortium.

RECOMMENDATION #4: <u>The computer hardware secured for cooperative utilization should be located at one of the campuses</u>.

Both Clarkson and SUNY Potsdam have well-developed computer housing arrangements. The committee did not feel it was necessary to locate the hardware off campus since the neutrality of the center was assured through its relationship with the Associated Colleges.

Inasmuch as the highest level of computing is likely to be realized by Potsdam and Clarkson, and since the more sophisticated users of the computer are located at these institutions, ready access to the computer is of somewhat more importance to these colleges than it is to the others. The great majority of instructional and administrative users of the computer at all

campuses do not require such proximity. By and large only the more experimental and developmental types of computer efforts will require substantial direct contact with computer center staff at the central site. For instance, researchers who are utilizing the highest levels of the computer's core capacity will have to be in closer communication with the computer center staff than would be the case for an instructor who is utilizing a prepackaged computer program.

RECOMMENDATION #5: The Associated Colleges should probably obtain the central processing equipment on a lease-purchase agreement which would make it possible for the consortium to own the primary computer equipment after a five-year period.

It is the belief of the committee that central processing units are not likely to change drastically over the planning period; also the current systems which would be bid by vendors would have a lifespan of eight to ten years. The committee does not feel that peripheral equipment such as terminals, disks, tape drives, and the like should be purchased, however. The costs for these items are dropping rapidly and their capabilities are changing. Thus, it would be desirable that this equipment should be retained in a more flexible pattern to permit quick and economical transitions to more cost-effective equipment as soon as possible.

During the study it was found that the primary requirement for the various campuses was the availability of adequate up-to-date program languages and other software. The currency of the computer was not itself a major factor.

Third generation computers are generally operating usefully in excess of seven to eight years. After this time period, their capital value is equivalent to approximately one-half their original purchase price. It is therefore quite likely that the consortium could be utilizing its computing system for the planning period without a substantial loss of flexibility and with a generally dropping level of expenditure by the colleges after the central equipment has been amortized. Since 1980 will mark a significant plateauing of the student population, the equipment might well serve a far longer period of time than has been true in the past.

Although a concentrated effort must be made to finance the equipment initially, if the system is looked at as one in which the equipment should be made to prove itself to be economical over the planning period, the initial investment would be less than would appear to be the case at first glance.

RECOMMENDATION #6: <u>The cost for implementing the proposed computer system could be distributed according to a formula adopted in advance of the implementation of this system</u>.

It would be virtually impossible for the committee to suggest an accurate costing system for the support of either option. It is clear that some recognition would have be given Clarkson for the substantial investment it has made in the model 44 which would be utilized under Option #2. Similarly, recognition of rental costs and electrical costs would have to be considered. Overall, it would appear that the approximate

breakdown of institutional assessments in percentages would be:

Clarkson	45%	SUNY Potsdam	25%
Canton	15%	St. Lawrence	15%

These percentages would include both actual and contributed costs. A more definitive formula would be dependent upon a higher level of analysis than has yet been undertaken. It is assumed that the distribution of charges will be adjusted dynamically to reflect changing computer loads at the member colleges as their computer utilization changes.

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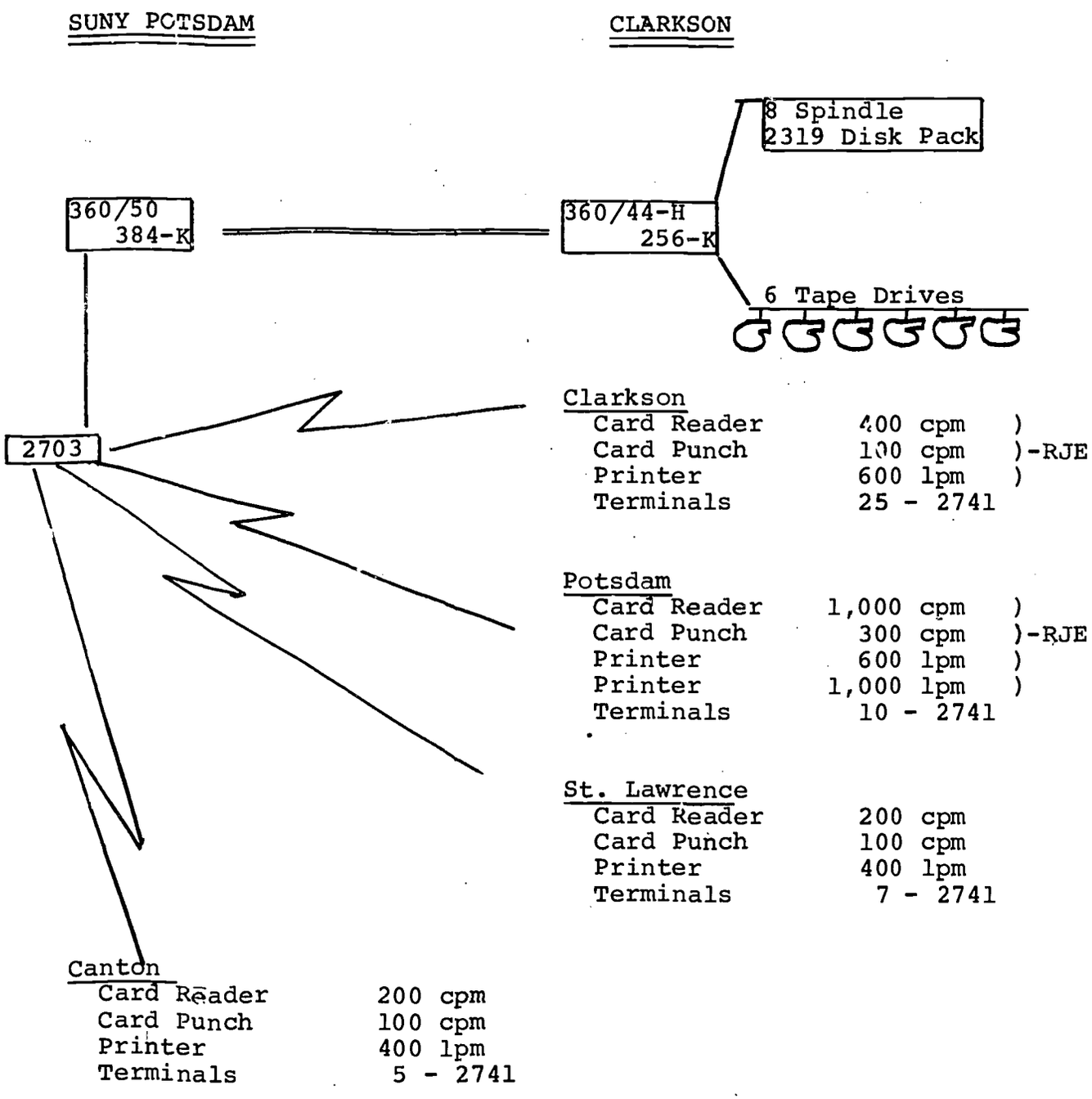
APPENDIX A

I. Network Configuration (Tentative)



II. Languages Provided

A. Immediately Available

FORTRAN IV	Available
COBOL	Proprietary
PL/2 F	Proprietary
RPG	Available
BASIC (Interactive)	Proprietary
Statistical Library	Available
Mathematical Library	Available
GPSS	Available
Assembler	Available
PLANIT	Available
Coursewriter III	Proprietary
Sort/Merge	Available
Sequential Files	Available
Index Sequential Files	Available
Direct Access Files	Available
Bio-Medical Statistical Package	Available
Scientific Sub-Route (SSP)	Available

B. Available If Desired

WATFIV	Proprietary
SIMSCRIPT	Proprietary
ALGOL, SNOBOL, LISP	Available without substantial supportive services

C. Not Likely to be Available

APL	--Too expensive
SPSS	--Duplicates Bio-Med
IMSL	--Duplicates SSP
WATBOL	--Too expensive
PL/C	--Too expensive
ITF/PL/1	--Too expensive
TSO	--Too expensive
ATS	--Too expensive

III. Operational Characteristics

A. Remote Job Entry Services

1. Three shift availability - 24 hours
2. Extra time provided for internal operations and possible down time
3. Response time for student compiles - 30 minutes
4. Response time for administrative compiles - 3 hours
5. Response time for large research compiles - overnight

III. Operational Characteristics (continued)

A.
6. Scheduling algorithim identical for all colleges
7. Handles all administrative, student and instructional uses of computer, most research applications
8. Operating system is OS/360 for both machines
9. Complete confidentiality and security in system through tape labeling, password protection, data set integrity, problem program integrity

B. Time Sharing Services

1. Response time - 2 seconds or less
2. Available from 10 a.m. to 11 p.m.
3. Self-contained, no tie-in to other computers elsewhere
4. Initially 30 ports serving 47 terminals

C. Staffing

1. No staffing change for administrative data processing at Canton or St. Lawrence (to provide present services, plus 30%)
2. Potsdam could separate computer center directorship from computer science department chairmanship
3. Clarkson could downgrade level of computer center director and could drop two systems personnel
4. Consortium staff would involve:

Director of Computing	Asst. Systems Programmer
Assistant Director	Secretary
Sr. Systems Programmer	Circuit Rider

5. All colleges should establish a 1/3-1/2 time position for academic computing

IV. Primary New Budget Items

Items	Annual Charges $	
360/50 384-K	(Purchase, or Lease/Purchase)	$ 400,000.
Maintenance	10,000	
Disk Drive-2319	48,000	
Tape Drive	48,000	
Front end		
2540	8,400	
Printers	18,000	
2703	30,000	
Terminals (47 @ $115 per mo.)	64,860	
Modems (82 @ $25 per mo.)	24,600	
RJE sub-systems	14,600	
Proprietary software - one time		5,000
- monthly	12,000	
Consumables	5,000	
Telephone charges	12,000	
Personnel		
Director	23,000±	
Assistant Director	19,000±	
Sr. Systems Programmer	17,000	
Jr. Systems Programmer	14,000	
Secretary	6,000	
Circuit Rider	14,000	
Fringe Benefits @ 25%	23,250	
Approximate Totals	$ 411,710	$ 405,000

V. Offsetting Factors (not including efficiencies or add-on benefits)

A. Potsdam	
Entire hardware budget	$ 130,000
Release of Dept. Chairman 1/2 time	15,000
B. Clarkson	
Release of 2 systems programmers	37,000
Release of computer center director	22,000
C. St. Lawrence	
Replace hardware budget	50,000
D. Canton	
Replace hardware budget	44,000
Total Reduction	$ 298,000