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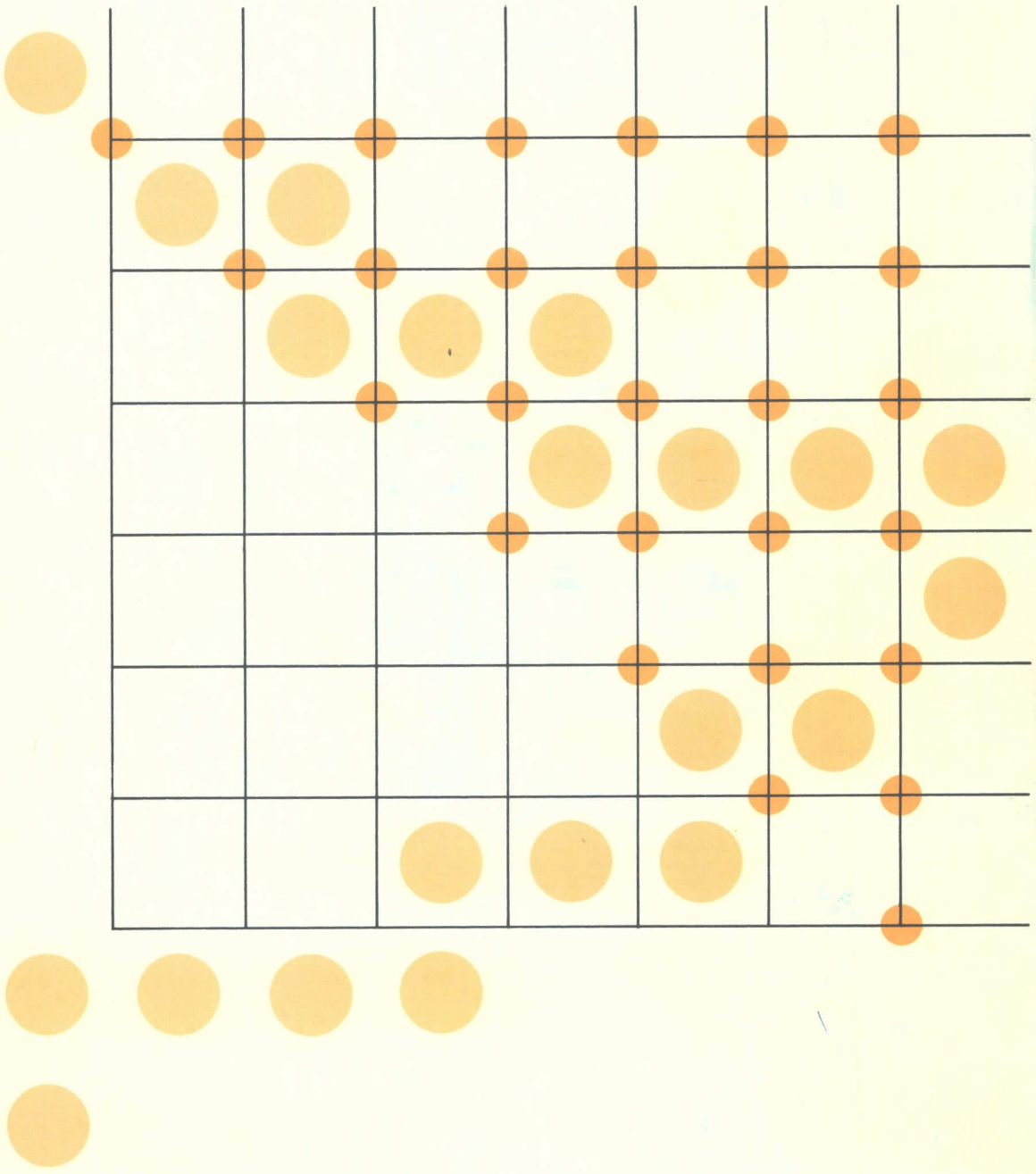
CANADIAN UNIVERSITY SATELLITE APPLICATIONS NETWORK (CUSAN)

A FEASIBILITY STUDY



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ABSTRACT

A survey is conducted to determine the nature of satellite communications research at Canadian Universities. The results of the survey are studied and two main areas of activity at Universities are identified:

1) projects that are directly related to satellite communications and being conducted primarly at Electrical Engineering Departments;

2) projects which are either in the computer network communications area or dealing with remote sensing topics and need satellite link facilities to broaden the project scope or facilitate inter-university cooperation.

The potential sources of funding for the operation of a proposed dedicated organization to coordinate such research activities are also investigated, as well as University patent and publication policies.

Based on this study, an organizatonal structure for coordinating satellite communications research at Canadian Universities is proposed. Two different models are considered, such that one is similar to the NSERC centralized type of organization and the other consists of several research centres located at geographically distributed universities. The terms of reference and advantages and disadvantages of each model are examined and an organizational structure to operate the program is proposed. These model structures are proposed to initiate the necessary discussions prior to the formation of a body that will eventually coordinate and possibly fund satellite communications research at Canadian universities. However, further work is necessary to explore in more detail the funding sources for such an organization and to modify or enhance the organizational form of the proposed models.

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INTRODUCTION

This study was undertaken on behalf of the Department of Communications, Ottawa, to explore the nature of ongoing research projects at Canadian universities related to satellite communications and further, to identify the potential use of a Canadian University Satellite Applications Network, (CUSAN). The goals of this study include:

a) Determine current satellite communication related research projects being conducted at Canadian universities.

b) Conduct a survey of facilities at Canadian universities which could be interfaced with a university satellite network.

c) Conduct a survey of courses offered at Canadian universities with coverage of space communications related topics.

d) Identify potential application projects at Canadian universities. For each project, establish the potential benefits, facilities required, the appropriate technology, inter-university and industrial relationships, funding requirements and potential sources of funding.

e) Survey the Universities to determine the various patent, licensing and publications policies and identify their potential impact on projects.

f) Aggregate the potential sources of private and public funds for the projects.

g) Recommend a Terms of Reference (TOR) for the program. The TOR should identify major participating organizations, the objective of the program and the link between the program's objective and the objectives of the participating organizations.

h) Identify evaluation criteria that may be used to assess the eligibility to participate in the program.

i) Recommend an organizational structure for the ongoing operation of the program.

j) Give an example of how a project would be handled by the program.

To initiate the study an informational letter and a general survey questionnaire were prepared and sent to 127 departments at Canadian universities. These departments consisted of Electrical and Mechanical Engineering, Computer Science and Physics Departments. We received a total of 40 replies, of which 26 were in favor of establishing such a facility and only one, the Electrical Engineering Department of McGill University, felt such a link was not necessary.

Most of the positive responses were received from Electrical Engineering Departments. The Computer Science staff responses were second in number and, as anticipated, showed they are more interested in satellite use for data transmission and computer linking applications. Five responses received from other disciplines can be broadly categorized as from the remote sensing area.

Scanning the replies, two groups can be identified as potential satellite users. The Electrical Engineering group, which are involved in general in communications research, indicated the major use of the network would be for implementing designs and for system evaluation. The Computer Science and the remote sensing groups were primarily interested in the use of the satellite facility for data transmission. Although not directly involved in communications research, these latter groups felt an urgent need for a university satellite network to enhance their capability to evaluate their computer and local area network and to establish a direct network link with co-workers.

The survey also indicated a desperate situation in hardware capability. Among the Electrical Engineering and Computer Science Departments, only the

University of Ottawa has an uplink capability. On the other hand, the remote sensing group seems to be more equipped in hardware and have dedicated facilities to handle their needs.

The questionnaire was followed by a personal telephone interview of some of the individuals with positive responses. Although this phase of work was not totally satisfactory, additional information was obtained that clarified their responses and allowed each individual to express his opinion. Most of the difficulty encountered in carrying out the telephone interviews was the unavailiability of individuals. The telephone responses were also generally positive. However, while every individual interviewed expressed the urgent need for such a network, they were generally concerned about the feasibility of the network operation with existing university resources. In particular, it was indicated that participation in an operational satellite link will require an initial capital cost for equipment, not available to many individuals, and a subsequent substiantial operating budget. The latter also has an implication of dedicating technical manpower, without which the potential use of the system will be severely limited. In addition, the link maintenance and operational costs were anticipated to be excessive for most budgets of university researchers.

As a part of the survey some of the industrial firms currently involved in space science research were also contacted. This contact was established by a telephone interview. It was generally indicated by these firms that they currently have direct contact with specific university researchers and that further discussions regarding the establishment, of a formal university satellite network and their possible contribution to such a net should be deferred until further progress on the concept is made. As a result, visits to inverview management at the different industrial firms was not considered.

In summary, the survey of universities indicated that, at least in principle, nearly everyone is in favor of establishing a formal university satellite network system. However, concerns were expressed as to the means to implement and operate the system, due to both the intial installation costs and then the operation and maintenance costs.

CURRENT RESEARCH ACTIVITIES AT CANADIAN UNIVERSITIES

Appendix B shows the list of current projects that may benefit from the CUSAN. These projects are either in satellite communications areas or computer communications or networking topics. The satellite communications research projects are all isolated topics, handled by individual researchers, working in their own areas of expertise. In most cases, they are simulation projects and are limited in scope, due to the limitation in manpower and resources. All satellite ground stations except for the one at the University of Ottawa and those used by the remote sensing group, are of the TVRO type. One project at the University of Windsor uses the TVRO station located at a tavern to conduct research on satellite signal spectra.

In personal telephone interviews the Electrical Engineering staff showed a lack of understanding of the potential role of a CUSAN type facility as a research tool. However, it was pointed out that this stems from the unavailability of such a network system and the limited past experience of most staff in this area. It was generally felt that currently individual research projects are tailored to the resources available from NSERC funding and in some instances from research contracts and none of these are sufficiently large in resources to permit the undertaking of expensive long term goals. In the case of research contracts, they are not broad enough in scope to extend investigations for a long period of time.

These telephone interviews also indicated that at present satellite communications research at universities lacks program coordination. Considering the need for university freedom in selecting research areas, it was nevertheless felt that a general coordination is desirable. It was pointed out that satellite communications is an area in which Canada has, for sometime, proven to be an international leader. However, while many efforts are currently being made to assist Canadian universities in high technology areas, such as microelectronics, VLSI and CAD/CAM applications, the satellite communications research area has been kept out of reach of the university community.

Considering the projects listed in Appendix B, it is evident that they can be classified in two categories:

1) projects that are directly or indirectly related to the communications area, and

2) projects that are in the computer and remote sensing areas.

The former group is expecting to use the CUSAN for research purposes, and such a facility can accelerate or expand their research activities. The latter group, on the other hand, intend to use CUSAN as a link facility for data transmission. Their involvement in CUSAN will enhance research activities by providing an increased interaction among various research teams. It is also expected that the use of CUSAN by both groups will generate a greater awareness of the potential applications of satellite communication facilities and thus provide an expanded future utilization of the system as a communications tool.

As a part of the survey, an attempt was made to identify courses at Canadian universities that are related to the satellite communications area. It was found that the number of courses specifically related to this area was small. On the other hand, there are many university courses on various

aspects of signal processing for control, information and transmission which cover topics that are indirectly related to satellite communications. For this reason, the list of courses was expanded to include these other related areas as well. This list is shown in Appendix C.

INDUSTRIAL FIRMS

Our telephone interviews with industrial firms, unfortunately, provided us with a less successful response. Contact was established with Telesat Canada, SPAR, Microtel and Andrew Antenna corporations. The general opinion expressed was favorable towards coordinating and promoting further satellite communications research at universities, but it was unclear as to how and why each firm should contribute directly to the establishment of a University Satellite Network. Because of this lack of interest, a site visit to directly interview appropriate management at each firm was not undertaken. It was felt that the main reason for their lack of interest was due to the uncertainty about the concept and possible feasibility of the system. Furthermore, at such an early stage of the network concept, the personnel contacted could not volunteer a committment on the part of their organization. We concluded that the industrial firms must be approached after some degree of credibility is established about the possibilities of CUSAN being realized. In addition, the areas of possible involvement of industrial firms and the benefits of CUSAN to their activities needs to be identified. They also felt that, currently, contact with various university staff for specialized R/D work is readily established and formalizing the contact process may not be necessary.

Our most successful interview was with Telesat Canada. They supported the CUSAN concept in principle and offered assistance in establishing communication with their own staff in order to identify research areas that

would prove beneficial to their needs. Telesat also indicated that, while their regulations do not permit free allocations on satellite transponders, they can contribute financially to the program. The details of this contribution, however, needs to be discussed after the organizational structure of the CUSAN is better defined. A possible contribution of a limited amount of hardware was also indicated, but we were encouraged to explore other sources of hardware contributions, before approaching Telesat in this regard.

The results of our interviews with industrial firms, along with the encouragement provided by Telesat, indicates there is a favorable concensus as to the need for the establishment a CUSAN type facility. However, unless further progress on the concept is made, a serious response of support from industry may not materialize. Furthermore, the next approach to industry must be made co-operatively with the Department of Communications, or at least with a more defined input from DOC to facilitate negotiations.

POTENTIAL SOURCES OF FUND

To date only two potential sources of funding have been identified, the Natural Sciences and Engineering Research Council (NSERC) and Telesat. None of the industrial firms approached were prepared to volunteer a commitment at this stage. This response by industry, however, should not be interpreted as being negative towards the CUSAN concept. Their indication was that the issue of any direct and indirect contribution must be decided at higher management levels and only after the status of the CUSAN is clarified.

It is expected that once the CUSAN program is established other sources of funding can be identified, which may include the Treasury Board, the Space Science Branch of NRC, and various private and government agencies.

The latter two groups can be quite diverse since the university staff may use CUSAN for both communications related research and other research where the activities require a satellite link.

The possibility of using NSERC funding for CUSAN projects was discussed with several NSERC officials. Their replies were clear, indicating that NSERC funds are for the support of university research and any CUSAN project would have to compete, within the regulations, with other submissions. It was also indicated that, normally, a block funding program, such as that needed to support CUSAN, is not within the NSERC mandate or budget capability. However, if such preferential treatment was deemed necessary, it would have to be handled separately and through direct negotiations, between DOC, NSERC and the government agencies.

Under normal NSERC operation, project funds can be applied for from the operating and equipment grant programs. Currently, the average annual operating grant level in Electrical Engineering, is at about the $16,000 level with individual grants varying considerably, from $1,500 to about $80,000. Grants for the purchase of equipment fall within three categories: the normal equipment grant for items costing less than $125,000, major equipment grants for items between $125,000 and $275,000 and major installation grants which are considered for new laboratory facilities requiring funds in excess of $275,000.

Normal equipment grant applications are considered by a committee for each discipline and the average annual success rate ranges from 20% to 30%. Major equipment applications normally compete nationally among all disciplines and have a much lower success rate, which varies annually and is based on available NSERC funding for the equipment category. Major installation applications are usually reviewed by a team of experts and by NSERC personnel and are only funded, pending the availability of funds, if a national

facility of the proposed type is felt to be essential. Other criteria for the success of such applications are the location of the university, the rating of the individual applicant and the ranking of the application among other proposed national facilities.

As mentioned earlier, Telesat Canada also indicated the possibility of providing direct support for the CUSAN program. They stated however, that Telesat regulations do not permit free access to satellite transponders, but that funds could be allocated by Telesat to offset CUSAN operating costs.

POTENTIAL APPLICATIONS PROJECTS

Our survey unveiled a good number of current projects at universities that can benefit from the CUSAN program. The general list of such projects are indicated in Appendix B. However, they can be categorized in two separate groups: projects of an engineering nature that have potential for the further development and better utilization of satellite communications systems and projects that will utilize CUSAN primarily for data transmission. This latter group, although not directly related to the satellite communications field, has the greatest potential for further increasing the application modes and demand for such facilities, as well as enhancing the rate of progress in other communications fields, in particular, computer networking.

The survey also showed that, while the university community has a realization of the potential of a CUSAN program, in general, it has a limited understanding of the equipment and interface requirements and its possible operational scheme. While everyone interviewed showed a definite interest in CUSAN, concern was expressed about the possible installation and

operating costs and whether these would have to be met with existing NSERC type funding. Because of the lack of past experience with satellite communications links as well as their cost, they have seldom been considered as a research tool by the university community. However, this lack of experience with satellite links should not be interpreted as a general lack of interest and preclude CUSAN's possible successful future implementation. It simply reflects the limitations in the research funding available to universities. At present the only source of equipment funding is through NSERC with the success rate of applications generally too low. In particular, NSERC equipment applications are only supported if the required equipment is absolutely necessary and is the minimum required to support the research project. A satellite ground station is a costly installation and can hardly be justified as the most economic research tool. In addition, it is a facility that requires both manpower and operating funds, which can not be justified within the NSERC funding program. It is normally expected that universities can operate and maintain equipment from their own funds, after it has been acquired by NSERC funding.

To summarize the list of potential projects from Appendix B, some of the most relevant ones are listed and comments follow. The potential benefit of each project is relatively clear from its title. To undertake these projects within a CUSAN program the required facilities can be sub-divided into two categories: the satellite ground station, and the associated test and interface equipment. The latter group of equipment, whether used in the communication research area or the computer networking area, is expected to be obtained through NSERC type funding. The ground station facility can not be justified easily for NSERC type support. The cost implications for the acquisition, installation and operation of a ground station is better determined by DOC, Telesat and industrial firms experienced in satellite communi-

cations. However, the complexity and signal requirements of the up-link and down-link equipment depends on the research goals of each individual project. During the personal interview of researchers it became clear that, due to the lack of past experience with such a system, a clear evaluation of each individual's needs can not be made easily. However, it was evident that for most of the communications research projects staff can utilize personal initiatives to fabricate at least some of their equipment needs, using local sources and in house supplies. The computer science projects, however, mostly need a turn key system and their required facilities can be less complex. In summary, while the detailed cost implications of required facilities has not been studied, it is anticipated that most ground station costs will fall between $100,000 to $200,000. On the other hand, if the auxiliary test and interface equipment cost must be added to the ground station cost, a fair determination of the system cost can not be identified at this early stage. It was felt that, to estimate one's total equipment needs, every researcher would have to individually determine his potential project costs.

List of Most Relevant Current Projects

1. N. Boutin, J. Adoul, R. Goulet and S. Morrissette, "Canadian Mobile Satellite Modulation Studies, Transmission and Coding of Voice Information", Elect. Eng. U. of Sherbrooke.
2. J. Tranquilla, "Aperture Truncation Effects and Feed Optimization," Elect. Eng., U. New Brunswick.
3. N.D. Georganas and K. Feher, "Satellite Digital Transmission Techniques and Optimal DAMA Satellite Networks," Elect. Eng., U. of Ottawa.
4. P.H. Alexander, "Characterization and Measurement of Satellite Signal Spectra," Elect. Eng., U. of Windsor.

5. J. Mark, J.A. Fields and J.W. Wong," Multiple Access Protocals for Packet-Switched Communication over Satellites," Elect. Eng., & Comp. Science, U. of Waterloo.

6. R.B. Maguire, "Distance Education Teleconferencing Applications", Comp. Science, U. of Regina.

7. A.G. Wacker and D.E. Dodds, "Robust Frame Sync for Noisy Satellite Channels," Elect. Eng., U. of Saskatchewan.

8. P.H. Wittke, P.J. McLane and J.L. Mason, "Frequency-hopped Spread Spectrum Satellite Communications," Elect. Eng., Queen's University.

9. S.T. Chanson, S.T. Wuong, G. Neufeld and P.G. Gilmore, "An Efficient and Fault-tolerant Network for Local Communications," Comp. Science, U. of British Columbia.

10. G.,D. Cormack, P. Hof, F.S. Chute, P.A. Goud and D. Routledge, "Reception, Analysis and Handling of Meteorological Data and Images," Elect. Eng., U. of Alberta.

11. L. Shafai and E. Bridges, "Antenna Developments for Canadian Satellite Applications," Elect. Eng., U. of Manitoba.

PATENT AND PUBLICATION POLICIES

To understand the nature of patent and publication policies at Canadian universities, discussions were held with research administration personnel of the University of Manitoba and Canadian Patents and Development Limited (CPDL). It was indicated that the general patent policies at different Canadian universities are similar, and differ only in the detail of how they are processed and the revenue sharing arrangements. Through an agreement with either CPDL or the Federal Research Corporation, universities attempt to protect inventions originating at universities. Some universities such as Waterloo and Toronto, also prefer to protect their inventions directly

through specially established innovations foundations. When inventions are reported to the CPDL or the Federal Research Corporation, the latter organizations undertake the evaluation of the invention by a patent search and an internal review process augmented by external referees. Based on these steps the patent organization decides on the novelty and the potential of the reported invention as a marketable product and informs the university of their decision. If their decision is positive, the patent right is assigned to the organization, which then processes the patent application and proceeds with promotional steps. The royalty sharing percentages between the exploiting organization and the university and, the university and the inventors are different at the various institutions. In addition, at a given institution the royalty sharing percentages may change, depending on the nature of the research project, the amount of funding provided by the university, the contributions from NSERC type of research funding or research contracts. As an example the patent and publication policy of the University of Manitoba is included, in Appendix E, which gives the details of such a typical agreement. In cases where the external organization such as CPDL, decides not to proceed with the patent application, the university or the inventor can do so, at their own initiative. Also, both latter parties may decide to handle a particular patent application without approaching any external agencies.

Although the mode of handling and the percentage split of royalties is different at various institutions, for the purpose of this study it is sufficient to say that universities generally want a share of the royalties in almost all cases. The exceptions are with research contracts where the university's interest may be waived, when the contract provides for the defrayment of all direct and indirect cost of the research. Since it is anticipated that the regulations of patent policies of different Canadian

universities will not affect projects undertaken through CUSAN, in ways other than normal for research projects currently underway, a comprehensive list of patent policies has not been included. However, to provide a few examples, documents regarding the philosophy of patents at universities and a general survey of existing policies at both U.S. and Canadian universities are also listed in Appendix E.

The regulations involving computer software seems to be in its formulative stage and not all Canadian universities have finalized their software policies. The University of Waterloo has the most comprehensive regulation and a copy of their policies is also included in Appendix E.

The regulations concerning scientific publication is similar at the different universities. Generally, university staff are encouraged to freely publish the results of their research work in scientific journals and conference symposia, unless the funding agency has indicated otherwise and there is agreement to defer publication. Also, if research of a general nature results in inventions of significant potential, the universities can withhold the disclosure for a limited period of time, normally one year, to allow its consideration for a patent protection. Similar rules are also practiced over a student thesis with a potential for a patent protection. In such cases, both student and his supervisor must indicate their agreement in writing, and the parent faculty or the Faculty of Graduate Studies withholds the material for a period of twelve months.

From the above information it becomes evident that for projects under CUSAN the university patent and publication policies may apply differently depending on the organizational structure assumed for CUSAN. In the next section two possible models for CUSAN operation are proposed. If model 1 is selected, the projects undertaken by CUSAN will be treated similar to any

other general project,currently engaged in by university staff. The percentage university and staff royalties will depend primarily on the source of the funding and the organization handling the patent application. However, if model 2 is selected, which proposes separate and national centres for CUSAN, then the operating organization can negotiate individual patent arrangements with the universities. In this latter case, the negotiated patent policy may be a variation of the existing university policies, tailored to be in line with the program funding and operational nature of CUSAN.

TERMS OF REFERENCE FOR CUSAN

Introduction

The survey of current activities on satellite communications research at Canadian Universities indicates that, projects of various kinds in this specific area are already being pursued at a number of institutions. However, these research projects are being conducted in isolation and have been started either by the initiative of individuals or by a research contract from a government agency or industrial firm. There seems to be a total lack of coordination between projects. Two main reasons that can be identified for this lack of coordination are:

1) the absence of a central organization to promote and oversee the university research effort on satellite communications, and

2) the present nature of Canadian university research funding.

Currently, the main source of funds for university research is the NSERC Operating Grant for individual staff. Each university staff member identifies his research goals and applies for an NSERC Operating Grant. The level of funding is normally low and the competition is severe. To retain

an NSERC Operating Grant, a university staff member must prove a high degree of productivity, basically in technical journal publications. Such an evaluation scheme forces individuals to undertake projects that are more amenable to journal publication and prevent them from undertaking long term and risky projects. Furthermore, it encourages university staff to work on individual projects, that can be identified as a personal contribution. It seldom pays to apply for a team grant, since each team grant is normally judged as a single application competing with other individual applications. The system therefore not only discourages inter-university cooperation, but also discourages cooperative research among staff within their own department.

The most useful NSERC funding for cooperative research comes from the Strategic Grant program, namely the NSERC panel on communications and computers. The projects submitted to this panel are judged on their relevance to the national R/D goals, and for their potential in terms of industrial and economic returns. However, while the NSERC Strategic Grant program has encouraged university staff to undertake projects of an applied nature, it has not overcome the problem of university research isolation. Again, each university staff member selects a project based on his own initiative, and then hopes for the successful support of his application.

An advanced satellite communications capability is vital for the Canadian future needs and deserves more attention and a better appreciation by the university community. The technology in this area has matured tremendously in recent years, and the coordination of university research efforts to support it now seems past due. Thus, considering the present nature of the research funding and operation of Canadian universities, it seems essential to form a separate organization to oversee the coordination of university research in this area. Of course, the solution to the problem may not

be unique and all possible alternatives must be explored. We therefore propose structures for two model organizations. These two models are selected to be distinctly different, so that the merits of each organization can be evaluated in a clear manner. However, they have a similar policy forming upper administrative level to ensure the desired coordination of the program to meet the goals of the satellite communications research community.

Organizational Structure

For a CUSAN program to be successful, it must contain two basic organizations: an administrative board and a scientific advisory committee.

The administrative board should include scientific, administrative and legal expertise. Its primary responsibility is expected to be the overall coordination of satellite communications research at Canadian universities. Thus, it must respond to government policies at the national and international levels, to current and future needs of industrial organizations and, most importantly, to the development of the potential of universities to contribute in this area, both in research and by manpower training. To ensure its effectiveness in all these aspects, the board membership must therefore be based on an equal representation from the three key sectors of government, industry and university. The organizational structure of the board must be able to satisfy the following criteria:

1) It must ensure a general coordination of satellite communications research at Canadian universities.
2) It must develop polici es that are flexible and capable of responding to any rapid evolution in frontier research areas.
3) It must search for and aggregate funding from various sources.
4) It must set up working procedures that are responsive to the needs of the country as well as the concerns of industries and universities.

5) It must provide accessibility of the program to all universities.

6) It must ensure the sharing of benefits by all participating Canadian groups.

7) It must manage CUSAN so as to maximize the return from the program, both in research output, as well as manpower training.

While the administration board oversees the overall coordination and operation of the program, the Scientific Advisory Committee will act as a body to assist the board. They would be involved with the details of program directions and undertake the selection of potential projects, as well as determine the level of funding. They would also give advice to the participating institutions, on behalf of the board, as to the direction of desired research efforts. To enable the fulfillment of its duties, the Scientific Advisory Committee membership must also be drawn from the three areas of government, industry and university. However, since this committee should be charged with the task of evaluating the details of projects to be undertaken at universities, it is desirable that its memebership be nearly fifty percent from the university community. The effectiveness of the Scientific Advisory Committee is, of course, critical to the success of the CUSAN program. In particular, for CUSAN to continue to produce front-line scientific and technological advancement of international calibre, the membership of this committee must include the most competent scientists available by world-wide standards. To this end, serious consideration should be given to having at least one member from outside Canada who has an internationaal reputation in the satellite communications area.

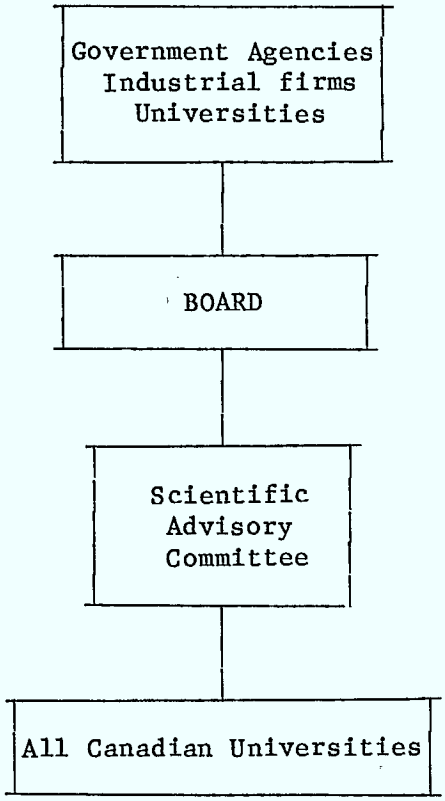
The members of both the Administrative Board and the Advisory Committee must serve on a volunteer basis, to ensure personal dedication and reduce operational cost. The membership selection may be based on invitations and

recommendations coming from all three participating groups.

The coordination of research at the universities, within the terms of reference of the CUSAN program, may be realized in various forms. After considering different alternatives, two models emerged as practical options. It should be noted that these two models were selected so that one is structured like the current project evaluation scheme of NSERC while the other is a more flexibly structured model providing a more efficient coordination and allowing for a dynamic research program.

Model #1

This model is based totally on the NSERC structure, and all Canadian universities participate equally in the CUSAN program. The Administrative Board and the Scientific Advisory Committee operate in the manner described in the above paragraphs. The staff of all Canadian universities who wish to participate submit proposals to the program annually, and the Advisory Committee, based on guidelines established by the board, evaluates these submissions. Based on the merit of each proposal and the availability of funds the successful submissions are identified and the individuals are so informed. The overall organizational structure of CUSAN for this model is summarized in the following block diagram.



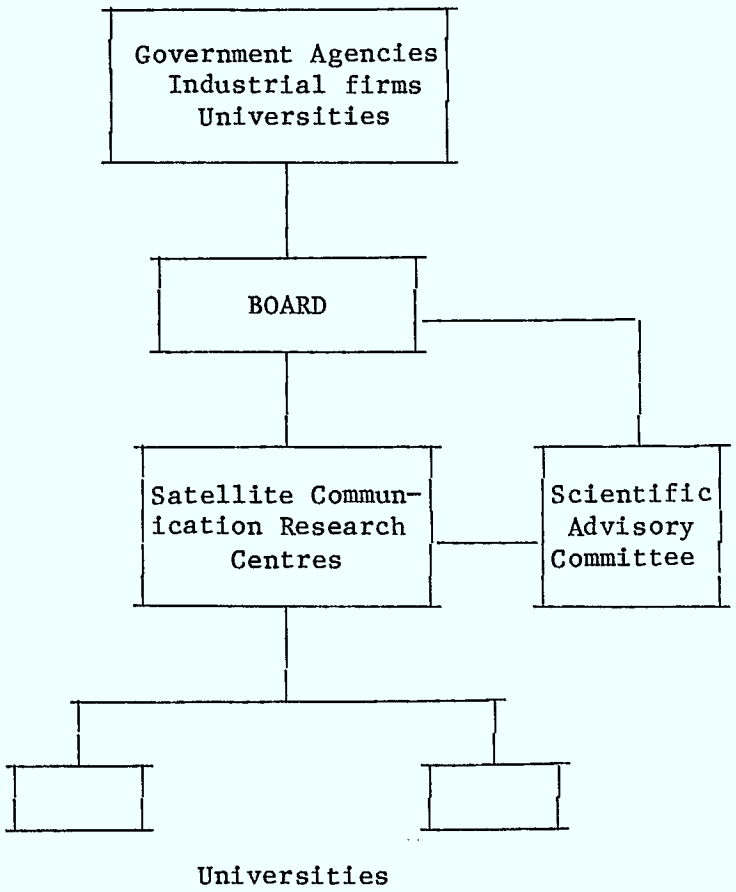
Model #2

In this model, certain universities are identified as those with distinct resources and capabilities in the various areas of satellite communications. Dedicated satellite communications research centres are then formally established in these universities. In the initial stage of the program only a minimum number of centres, perhaps three, need be established. The selection will be based on the expertise and resources of the identified university groups and their geographical locations. In this model, each centre that is established will serve as a sub- division of the overall organization with responsibility to coordinate and assist satellite communications research at neighboring universities. As the activities within the program expand, more centres can be established, to respond to the increasing needs of the research community.

Each centre is expected to be operated by the parent university, at no overhead cost. To ensure the proper operation of each centre, the parent

university will hire an appropriate number of technical and scientific research personnel, according to their staffing policies. However, they will be compensated for the personnel cost, by the CUSAN organization. These dedicated staff will be available to assist all participating Canadian universities. In other words, the centres will be shared by staff at all universities and their personnel will assist in conducting those projects approved by the Advisory Committee. Thus, all centres will be designated as national facilities.

Within this model, again all project submissions will be made annually to the Advisory Committee for evaluation and selection. Project coordination can be facilitated by identifying upon project selection the centre that will provide assistance for the project. To ensure the general coordination of the CUSAN program, each centre would have to report directly to the board, with the board deciding annually the funding level of each centre. The centres may be run by a director and a local board with membership drawn from regional university staff and appointed by the board. The organizational structure of this model is summarized in the following block diagram.



Comparison of the Two Models

Model 1 has one distinct advantage in that, it provides equal opportunity to all Canadian universities to make their individual contributions to the program. However, it has several drawbacks, as follows:

1) the financial resources of the CUSAN organization will be divided amongst all the universities and, at an early stage in the program, result in an unnecessary duplication of essential ground station facilities;

2) in the initial stages of the program, while the funding level is low, the initiation of a successful program becomes too costly, due to the fact that most of the required funds will be absorbed by installation costs;

3) because of the individual university project submissions, the board and the advisory committee will find it difficult to coordinate the various research efforts and consolidate them towards the national goals as envisaged for the program;

4) no feedback mechanism will exist to probe the successful progress of approved projects and unsuccessful projects will only be detected, too late, at their completion by evaluating the final reports;

5) because the program must fund a large number of university facilities, it is unlikely that dedicated permanent staff can be hired to assist in conducting the proposed research.

Model 2 is not perfect either. Its main disadvantages are:

1) not all universities will have their own hardware facilities;

2) the utilization of the dedicated facilities established at each centre, by staff at other university locations, will require travel and communications funding and cause some research hardships;

3) it will benefit the staff of universities where centes are located in a preferential manner.

This model, however, has several advantages over Model 1, which are:

1) the start up cost of the program will be much smaller;

2) because the centres will have dedicated research personnel, the success of approved projects will be more likely;

3) through regular meetings between the board and the centres, the needs of the program will be better understood;

4) since projects are handled at only a few centres, the board will have an easier task of coordinating the overall research effort and consolidate or direct it towards the national goals of the program;

5) if the research activities within the CUSAN program accelerate, more universities will likely receive their own centres and model 2 in the future may tend to approach model 1, in its operational form.

In summary, we have proposed two separate models for the establishment and operation of the CUSAN program. Neither model seems totally satisfactory, but the second model offers a better chance for the success of the program. It should also be noted that for both envisaged models, funding and other support would only be for research to advance the state of knowledge as related to the satellite communication area, including projects in the computer communications field. Projects that only need satellite communications facilities for data transmission were felt to be out of the terms of reference of the CUSAN program.

REALIZATION OF CUSAN PROGRAM

The initial steps towards the realization of the CUSAN program must be taken by the Department of Communications. When such a program is approved, effort should be made to identify the magnitude and sources of funds for its initiation. Next, the universities willing to participate in the envisaged program would have to be identified. Immediately after, a general organizational structure for CUSAN, based on either of the proposed models, or a variation of them must be established. These latter two steps need not be handled by DOC itself and may be delegated to an outside advisory group, but must be carried out on behalf of the Department of Communications.

Soon after the completion of the above two tasks and their approval by DOC, the Board and the Scientific Advisory Committee should be appointed. Jointly, they will undertake the task of implementing the program. The board will work towards finalization and approval of terms of reference for the program and soliciting additional sources of funds from the Treasury

Board, government agencies, Telesat, the Space Science Branch of NRC, NSERC and private and industrial organizations. The board may decide to delegate these tasks to an advisory committee, which in turn will report directly to the board. The Scientific Advisory Committee will finalize the terms of references for the coordination of the research efforts at universities and establish the criteria for the evaluation of proposals.

At this stage, an administrative body should be established to inform the universities of the details of the program and to handle the day to day operation of the program. Such an administrative body may be formed by the sponsoring DOC section at headquarters. During the first year of operation the Scientific Advisory Committee should meet as often as is needed to attend to policy and operational matters. In subsequent years, it should meet at least twice yearly, once for the evaluation of the proposals and shortly thereafter, to discuss policy matters. However, if proposed model 2 was implemented, both the board and the Advisory Committee must also meet, at least twice a year, with the representatives of each centre to coordinate their activities. Such meetings may be part of the regular meetings of the Scientific Advisory Committee.

Evaluation of Proposals

As suggested earlier, the membership of the Scientific Advisory Committee must be selected from the most competent group of individuals who are familiar with satellite communications research, the communication goals of the country and objectives of the CUSAN program. As such, they should be in a position to evaluate the proposals submitted to the committee. However, every effort must be made to circulate the proposals amongst the staff of the three participating organizations, namely, government agencies, industrial firms, and universities, to receive external opinions in the

evaluation of the difficult submissions.

In evaluating each proposal three main criteria may be used:

1) the relevance of the proposed research to the goals of CUSAN,

2) the completeness or clarity of the proposal, and

3) the competence of the applicants to undertake the proposed research.

Since, it is expected that the total cost of all meritorious applications may exceed the available funds, the Scientific Advisory Committee should rate all proposals to identify the most deserving ones.

To ensure the success of the program, the applicants must be encouraged to undertake front-line research projects with potential applications in mind. Submission of large proposals, in particular, from collaborating groups at different universities, should be encouraged. In this manner, long term projects, with implications in handling more challenging projects of multi-disciplinary nature, can be attracted to the program. At this time, a maximum project duration is not being recommended. However, a limitation of three to five year project duration may be implemented. For long term projects the Scientific Advisory Committee must request interim progress reports, about mid-way through the program. These progress reports must be evaluated by the Scientific Advisory Committee, before the release of additional funds towards the completion of the project. Each applicant must also be required to submit a final report, which again should be evaluated by the committee. Finally, since we have proposed two possible models for the operation of CUSAN, the handling of any project by the program, will depend on the model that eventually will be selected. For this reason a separate example has not been included, but the above evaluation process clarifies some of the related steps.

POTENTIAL BENEFITS OF CUSAN

Currently communications research in Canadian universities is conducted at the initiative of staff members and is primarily supported by NSERC funding. Projects are selected in an area which has a potential for NSERC funding and can readily result in a publication. They normally are modest in goal and often inexpensive to undertake. More ambitious and useful projects are seldom undertaken since they have a limited chance of success because they are expensive to fund.

The formation of an organization, such as CUSAN, will remedy the situation in many ways. The mere existence of the program will indicate the need for further university research effort on satellite communications and will help in attracting funds for its operation from various organizations. In turn, university staff will direct some of their time and resources to research in the area and propose both technical and application oriented topics that are innovative. The Board and its Advisory Committee will coordinate the national effort by funding in certain areas which will direct the research towards the desired goals. If Canada needs a viable satellite communication technology, CUSAN will help in its progress.

APPENDIX A

Study Goals

TITLE: Canadian University Satellite Network

OBJECTIVE: The objective of this study is to develop the concept of a program designed to enable the departments of electrical engineering of Canadian universities to undertake applied research and development on satellite communications topics.

BACKGROUND: A number of Canadian universities are currently involved in research projects which could substantially benefit from the availability of a satellite communications link. These current projects have been initiated, primarily, by departments of electrical engineering, computer engineering and computer science in areas such as hardware development for space and earth terminal equipment, modulation and accessing systems, propagation studies, computer network systems, etc. Access to a satellite communications channel would enhance and validate the work being conducted on these projects as well as produce a synergistic identificaiton of new applications for the use of and development of current and future Canadian satellites.

The Department of Communications wishes to explore the concept of a Canadian Unviersity Satellite Network, which is intended to foster satellite applications development work at engineering departments of Canadian universities. The concept is based on making a small amount of satellite time available on a regular basis in very early morning hours so that equipment developed at universities could be tested over real links. Universities would be expected to obtain sponsors and funding for their equipment requirements. Satellite time would be eithjer donated by Telesat or paid for by DOC, or a combination of the both.

TASKS:

a) Determine current satellite communication related research projects being conducted at Canadian universities.
b) Conduct a survey of facilities at Canadian universities which could be interfaced with a university satellite network.
c) Conduct a survey of courses offered at Canadian universities with coverage of space communications related topics.
d) Identify potential applications projects at Canadian universities. For each project, establish the potential benefits, facilites required, the appropriate technolofy, inter-university and industrial relationships, funding requirements and potential sources of funding.
e) Survey the Universities to determine the various patent, licensing and publication policies and identify their potential impact on projects.
f) Aggregate the potential sources of private and public funds for the projects.

g) Recommend a Terms of Reference (TOR) for the program. The TOR should identify major participating organizaitons, the objective of the program and the link between the program's objective and the objectives of the participating organizations.
h) Identify evaluation criteria that may be userd to assess the eligibility to participate in the program.
i) Recommend an organizaitonal structure for the ongoing operation of the program.
j) Give an example of how a project would be handled by the program.

REPORTS AND DELIVERABLES: A draft report shall be available two weeks before the end of the contract and returned with comments to the contractor one week after its receipt. The consultant shall prepare 15 copies of the final report with an option for a greater number. A presentation of the study results shall be made at the time of submission of the final report.

MEETINGS: There shall be a beginning of contract meeting and a mid-contract meeting and an end of contract review meeting. When deemed necessary, meetings may be called during the contract by the contractor or the Department.

APPENDIX B

SUMMARY OF SURVEY

APPENDIX B

Summary of Survey

A) QUESTIONAIRES

- 127 letters and questionnaires sent out
- 38 replies
- 26 positive responses.
- 1 negative response, McGill, EE Dept. (they do not think such a link is necessary.)

B) POSITIVE RESPONSE DISTRIBUTION (West to East)

EE Depts.	CS Depts.	Other
1. UBC	1. UBC	1. UBC Oceanography
2. U. Calgary	2. U. Calgary	2. U. Calgary Mechanical
3. U. Alberta	3. Regina U.	3. U. Western Ontario Radio Science
4. U. Saskatchewan	4. U. Guelph	4. U. Waterloo, Physics
5. U. Manitoba	5. Brock U.	5. York U., Space Science
6. Lakehead U.	6. Queen's U.	
7. U. Waterloo	7. Carleton U.	
8. U. Windsor	8. UNB	
9. Queen's U.		
10. Carleton U.		
11. U. Ottawa		
12. U. Sherbrooke		
13. UNB		

POSITIVE RESPONSES

1. U. de Sherbrooke

   Electrical Engineering Department
   N. Boutin, J. Adoul, R. Goulet, S. Morissette

   Current Project: Canadian mobile satellite modulation studies, Transmission and coding of voice information.

2. U. of Waterloo

   Physics Department

   M.P. FitzGerald, G.L.H. Harris

   Potential Project: Astronomy, satellite link to telescopy facilities, e.x. Hawaii.

3. Lakehead U.

   Electrical Engineering Department

   D. Roddy

   Comment: Interested and would like to become involved with CUSAN.

4. U. of New Brunswick

   Electrical Engineering Department

   J. Tranquilla

   Current Project: Aperture Truncation Effects, TVRO feed optimization.

5. U. of Ottawa

   Electrical Engineering Department

   N.D. Georganas, K. Feher

   Current Projects: Satellite digital transmission techniques, Optimal DAMA satellite networks.

   Potential Projects: Satellite local area network interconnection.

6. U. of Windsor

Electrical Engineering Department
P.H. Alexander, M. Morf (Psychology), W. Libby (Psych.)

Current Project: Characterization and measurement of satellite signal spectra.

Potential Project: Satellite conferencing - electric field calculation methods, The current and future state of the electronic cottage.

7. U. of Waterloo

Electrical Engineering Department
J. Mark, J.A. Fields, J.W. Wong

Current Project: Multiple access protocals for packet-switched communication over satellites.

Potential Project: Interconnection of local area networks

8. Brock U.

Computer Science Department
J. Barchonski

Facility: Planned local computer network

9. U. of Western Ontario

Centre for Radio Science, Physics
P.A. Forsyth, G.F. Lyon, J.A. Fulford

Current Project: Ionspheric Irregularities, HILAT Satellite propagation studies.

Potential Project: CANOPUS Data Analysis Network
(30 Canadian scientists)
(J.A. Koehler, U. of Saskatchewan)

10. York U.

Physics Department, Centre for Space Science Research
R.A. Koehler

Current Projects: CANOPUS (Canadian OPEN programme unified study)

Potential Projects: Wide angle Michelson doppler imaging interferometer, Viking ultraviolet auroral imager.

11. U. of Regina

Computer Science Department
R.B. Maguire

Potential Project: Distance education - teleconferencing applications

12. U. of Saskatchewan

Electrical Engineering Department
A.G. Wacker, D.E. Dodds

Current Projects: Robust frame sync for noisy satllite channels

Potential Projects: Low cost MSK receiver

13. Queen's U.

Electrical Engineering Department
P.G. Wittke, P.H. McLane, J.L. Mason

Current Projects: Frequency-hopped spread spectrum satellite communications, Impairment and properties of communications networks.

Potential Projects: Satellite link for VLSI implementation centre.

14. Queen's U.

Computer Science Department
D.B. Skillicorn

Expressed interest in CUSAN

15. U. of Calgary

Computer Science Department
B. Unger

Current Projects: Jade: A Simulation and Software Prototyping Environment.

Potential Projects: Jade applications to electronic mail or distributed programs and database research.

16. U. of B.C.

Department of Oceanography
B. Emerey

Current Project: Interpretation of IE Imagery from NOAA 7/8 Satellites. (Already using a satellite link.)

17. U. of B.C.

Electrical Engineering Department
H.W. Lee, C. Leung, R.W. Donaldson

Current Project: Modulation/demodulation techniques, coding, access control protocols, speech and image coding transmission.

Comment: Addition of some satellite communication facilities would be of interest.

18. U. of B.C.

Computer Science Department
S.T. Chanson, S.T. Buong, G. Neufeld, P.G. Gilmore

Current Projects: 1) An efficient and fault-tolerant network for local communications.
(A gateway to satellite and appropriate protocals are under design.)

Potential Projects: EAN Electronic Messaging System.

19. U. of Alberta

Electrical Engineering Department
G.D. Cormack, P. Hof, F.S. Chute, P.A. Gould, D. Routledge

Current Project: Reception, analysis and handling of meteorological data and images.

Potential Project: Satellite Conferencing

Comment: Dr. Chute, Gould and Routledge are interested but at a later date.

20. Carleton U.

Computer Science Department
W. Lalonde

Comment: Encourage development of such a network and believe that it is a very important project that is not only timely, but past due.

21. U. of Calgary

Mechanical Department
C.W.T. To

Potential Project: Non-stationary random response of non-linear structures to random excitation.

22. U. of Calgary

Electrical Engineering Department
G.S. Hope

Potential Project: Local area network gateway for substation control for a local computer network.

23. Carleton U.

Electrical Engineering Department
J. Wright, R.G. Harrison

Current Project: An Approximate Matched Filter for Detection of Continuous Phase Modulation Signals. Evaluation of Linearization Techniques for Efficient UHF-SHF Solid State Power Amplifiers.

24. U. of New Brunswick

Computer Science Department
B.J. Kurz

Potential Project: Remote Control of a Rock Subsidence Monitoring/Telemetry Network (Currently installed in the Rocky Mountains in BC and remotely cointrolled from UNB via telephone link.)

25. U. of Guelph

Computer Science Department
J.C. Majithic, J. Linders

Potential Project: Integrated Digital Networks. Geo-reference and automated map making.

26. U. of Manitoba

Electrical Engineering Department
L. Shafai, E. Bridges

Current Project: Antenna Development for Canadian Satellite Applications.

Potential Project: Antenna Performance Evaluation by Means of a Geoi-Stationary Satellite.

27. U. of Western Ontario

Computer Science Department
J. Davies

Potential Project: Message system for Canadian Universities.

APPENDIX C

FACILITIES SURVEY

(Based on Replies to Survey)

APPENDIX C

FACILITIES SURVEY

(Based on Replies to Survey

1. U. Sherbrooke, EE Dept.
   Computer, DEC PDP/-11/60: MAP-300.

2. U. Waterloo, Physics Dept.
   Local computer network.

3. U. New Brunswick, EE Dept.
   4 GHz TVRO Station, A local digital data network.

4. U. Waterloo, EE Dept.
   Local area network (can be interfaced at baseband with satellite network)

5. U. Western Ontario, Radio Science,
   HILAT Ground Station

6. York U., Space Science,
   Supermini Node with access to DATAPAC
   (but not yet available)

7. Brock U., CS Dept.
   Planned local computer network.

8. U. Regina, CS Dept.
   Capability to transmit graphics by phone to overlay videodisk and videotape.

9. U. Saskatchewan, EE Dept.
   Local computer (VAX 11/708) and Image Processing System (Comtal Vision 120).

10. Queen's U., EE Dept.
    Local network with equipment for high accuracy measurement of network properties.

11. Queen's U. CS Dept.
    DEC VAX-11/780, Ethernet, Several NS 16032 based network hosts.

12. U. Calgary, CS Dept.
    Extensive local networks.

13. U. B.C., Oceanography Dept.
    Tracking antenna facility working AVHRR data from NOAA 7/8 (upgrading to work TIP data)

14. U. B.C., EE Dept.
    Local computer is a VAX 11/750 with an array processor subsystem; also signal processing equipment.

15. U.B.C., CS Dept.
    Ethernet based local computer network, also, X.25 based interface.

C-2

16. U. Alberta, EE Dept.
    Computer system, satellite link (uplink and downlink) in Geography Dept. used for meteorological data and images.

17. U. Calgary, Mech. Dept.
    Local computer network.

18. U. Calgary, EE Dept.
    Computer (VAX 11/750), Charles River HP and Intel system.

19. Carleton U., EE Dept.
    Extensive RF and Microwave test equipment and components.

20. U. New Brunswick, CS Dept.
    Telemetry Network Master Station (IBM-PC)

21. U. Guelph, CS Dept.
    Local area network

22. U. Manitoba, EE Dept.
    4 GHz and 12 GHz receive only ground stations; Data General computer network.

23. U. Western Ontario, CS Dept.
    Local Area network, datapac connection gateway.

APPENDIX D

COMMUNICATIONS COURSES OFFERED AT CANADIAN UNIVERSITIES

APPENDIX D

COMMUNICATIONS COURSES OFFERED AT CANADIAN UNIVERSITIES

Based on Replies to Survey and Available University Calendars

University of Alberta

E.E. 656	Statistical Communications
E.E. 657	Advanced Communication Theory
E.E. 680	Microwave Measurements & Techniques
E.E. 682	Microwave Circuit Theory

University of British Columbia

E.E.

483	Antennas and Propagation
469	Microwave Engineering
565	Data Communications
566	Communication & Information Theory
585	Antennas and Diffractions

Physics

500	Electromagnetic Radiation

Computer Science

CPSC 417	Computer Communiations
CPSC 538	Computer Networks and Protocols
PSC 530	Distributed Systems

Brock University

COSC414	Computer Communications Networks

University of Calgary

ENEL 611	Digital Systems

Carleton University

Systems & Computer Engineering

94.554F1	Principles of Digital Communication
94.565W1	Advance-Digital Communication

Carleton University - continued

94.566F1	Multi-User Communications Systems
94.567W1	Source Coding and Data Compression
94.568W1	Mobile Communications Systems
97.563W1	Communications Technology
97.566W1	Communication Circuits
97.567F1	Antenna and Array Engineering
97.459	Communication Links
97.551	Passive Microwave Circuits
97.562	Microwave Solid State Electronics
97.569	Nonlinear Microwve Devices

Concordia University

N712	Digital Communications by Satellite
N614	Spread Spectrum Communications
N611	Statistical Theory of Communications
N612	Principles of Digital Communications
N613	Error Control Coding Techniques in Communications

University of Manitoba

24.426	Communications Systems
24.425	Digital Communiations
24.427	Antennas
24.429	Microwave Engineering
24.726	Microwave Generation and Radiation
24.727	Scattering and Diffraction of EM Waves
24.743	Experimental Methods of Microwave Engineering
24.778	Microwave Circuits
24.811	Digital System Design
24.813	Statistical Communication Theory
24.814	Digital Communication and Coding
24.815	Digital Signal Processing
24.819	Topics in Antenna Theory and Design
24.820	Advanced Engineering Electromagnetics
24.825	Satellite Communication
24.826	Spread Spectrum Communication
24.827	Computer Communication Network

McGill University

E.E.

304-524B	Telecommunication Transmission Systems
304-528B	Communication Networks
535a or b	Space Communications and Instrumentation
531b	Radio-Wave Propagation
532	Communications Theory and Analogue Signals

McGill University - continued

Physics

Storm Weather Group

University of New Brunswick

Computer Science

Data Communications and Teleprocessing

E.E.

EE 6823	Advanced Antenna Theory
EE 3181	Electronic Surveying

University of Ottawa

E.E.

ELG4376	Satellite Communications
ELG5174	Satellite Communications I
ELG5177	Satellite Communications II
ELG 7176	Digital Satellite'Earth Station Engineering

Queen's University

E.E.

435	Data Communications and Networks
835	Data Communications and Networks
867	Computer Communications (Graduate Course)
868	Computer Communications (Graduate Course)

University of Saskatchewan

E.E.

EE812B	Advanced Topics in Wave Propagation
EE816A	Telephony I

Physics

PHYS822B	Radio Physics of the Upper Atmosphere

University de Sherbrooke

E.E.

416	Communications
443	Radiation et antennes
452	Systemes de communications
471	Theorie des systemes de communications digitales

University of Toronto

E.E.

ELE1229H	Advanced Antenna Theory
ELE1231H	Satellite Commuication Systems
ELE1236H	Microwave Techniques
ELE1237H	Microwave Measurements
ELE1515H	Data Communications
ELE1531H	Communications Networks
ELE1504H	Statistical Communication Theory
ELE1537H	Topics in Communications

University of Windsor

E.E.

88-329	Communications I
88-419	Communications II

York University

Physics 3540.03 Communications Theory and Applications
Computer Science 4060.03 Teleprocessing and Networks

APPENDIX E

Patents Policies and Regulation

SURVEY OF PATENT POLICIES AT CANADIAN UNIVERSITIES

The following is the result of the most recent survey on patent policies at Canadian Universities. It was conducted in the Spring of 1981 by Dr. Beal, Director of Research Services at Queen's University. The replies on the patent policies are expected to be up-to-date, but the software policies may have changed to some degree. For this survey, a total of 58 universities were approached and 29 replies were received (34 major universities with 26 replies). The results are summarized on the following pages.

QUESTONS	RESPONSES				
Patents and Inventions	Yes	No	N/A	No Answer	
1. Does your university have a formal policy on patents and inventions by					
a) Academic staff	23	1	-	-	
b) Non-Academic staff	18	4	1	1	
c) Students, both undergraduate and graduate?	17	5	1	1	
2. Does the university assume it has a fundamental legal right to the ownership of inventions developed in the course of normal university work?					
a) for academic staff	15	7	1		1 ambiguous
b) for non-academic staff	13	8	2	1	
c) for students, both undergraduate and graduate?	11	10	2	1	

3. How much of the net proceeds from the successful licensing of a a patent is returned to the inventor?

1 57.5%; 7 50%; 1 30-80%; 1 50%
1 15%; 1 40%; 1 50-75%; 1/3-1/2%;
1 50-80%
1 Case decision by Committee;
2 15% as per CPDL
1 50-20% acc. to scale; 1 100-30% acc. to scale; 1 50-30% acc. to scale; 1 ~ 62%; 1 left to inventors; 1 negotiable; 1 varied.

4. Is there any special way in which the remaining part of the net proceeds is used? (e.g. returned to relevant university departments to stimulate research)

1 General Revenue; 1 to indiv. for Re search support, 8 Res. Support Dept. or Fac.; 2 case by case decision; 6 Res. support, general; 4 none;, 2 n/a.

5.a)How are decisions made on policy relating to patents and inventions/	9 Standing Committee; 1 Dean of Res.; 1 Research Office; 3 Univ. & union 1 Dean SGSR & Comptroller; 4 Sen. Com. or similar; 1 Board of Governors; 1 Ex. Com. on Res.
b)How are decisions made on whether the university should proceed to patent possible inventions?	10 Standing Com.; 1 Ex. Com. or Res.; 1 V.P. Academic; 1 Dean, Dept.Head&Inv. 1 Univ. Res. Officer; 1 Dean SGSR 3 Res. Office; 1 Dean of Res.; 2 N/A; 1 CPDL
6. How are negotitions made on the licensing of inventions for commerical development?	4 Standing Com.; 2 Fed. or Centre 3 CPDL or Res. Corp; 1 Dean & Dept. Head & Inventor 1 V.P. Academic; 7 Res. Officer&others
7. Are the inventors themselves involved directly, with others, in these negotiations?	19 Yes 1 No 1 Usually 3 N/A
8. Do the above arrangements apply broadly also to the licensing of novel computer software developed by uni versity staff and/or students?	10 Yes 6 No 2 Probably 2 No policy; 2 policy being developed 2 N/A
9.a)Does your university have a special office or organization (e.g. for industrial liaison) that is fully equipped to deal with the above matters?	14 Yes (Inc. 2 Centres or Foundations) 5 No 1 Univ. Res. Officer; 1 N/A
b)Does it include professional legal expertise?	4 Yes; 6 No; 11 Legal advice when needed 4 N/A
c)Does it include professional patent expertise?	2 Yes; 7 No; 9 Expertise when needed 4 N/a
d)Does it get involved in negotiating appropriate patent/software clauses in research contracts?	13 Yes; 3 No; 2 Sometimes; 1 Expertise when needed 1 will in future, 1 None so far 3 N/A
10. Approximately how many cases of inventions and associated matters are dealt with each year?	~ 20 to 30 5 ~ 10 to 20 6 ~ 1 to 10 11
11. In approximately how many cases are royalties on inventions or software currently being received by the university?	~ 8 to 10 1 ~ 5 to 6 2 ~ 1 to 5 11 1 with substantial software Others with some software

Survey of Institutional Patent Policies and Patent Administration

THE FOLLOWING DOCUMENT is based on a survey taken by the Society of University Patent Administrators in 1977. Subjects of the survey were the patent policies of universities with employees who are members of the Society. As far as can be determined, this is the first such survey since the publication in 1962 by the National Academy of Sciences—National Research Council of *University Research and Patent Policies, Practices and Procedures*. The latter document is primarily a compilation of patent policies exactly as furnished by the institutions surveyed.

The 1977 survey was undertaken because of a growing interest in patents and the perception of a need for an up-to-date survey of patent policies which would be composed of carefully prepared questions and would provide analysis of the replies. The questionnaire used in this survey is based on one that was tested at six institutions and further refined before distribution. (A copy of the questionnaire is included as Appendix A; responding institutions are listed in Appendix B.)

Forty-eight major research institutions provided information for this document. The answers to the survey questions have been tabulated and the implications of these results are discussed. It will be noted that there is a wide variety of answers to certain questions, which is a result of the differences in institutional organization and practices. In some cases there are multiple answers to one question by the same institution. In questions involving titles, where many variations are possible, the answers have been grouped by titles that are considered to be equivalent. Where only one institution has responded in a particular way to a particular question, such answers generally have been grouped as "other."

Although a number of institutions that were surveyed did not reply (a few with large patent portfolios), the information provided and analyzed should be largely representative of the general community of research universities.

1. Name of institution (see Appendix B).

2. Who authorized the institution's patent policy?

(a) Trustees, regents, or equivalent	37
(b) President, chancellor, or equivalent	5
(c) Faculty	2
(d) Other (such as state law or state agency)	4
	48

Where an institution checked more than one answer, this has been interpreted to mean that more than one body acted on the policy. In such cases, only the highest-ranked body was counted.

3. What office administers the patent policy?

Research administration office	18
Vice president or dean of research	10
Research foundation	8

Vice president for administration	3
Patent committee	3
Patent office	3
Other	3
	48

4. To whom is the office in (3) above responsible?

Vice president, vice chancellor, provost, or similar officer	24
President	12
Trustees	3
Director of foundation	3
Dean	3
Other	3
	48

5. Is there a patent committee?

Yes	34
No	14
	48

6. What is the composition of the patent committee?

Faculty and administration	23
Faculty only	7
Faculty, administration, and students	4
	34

Note that four institutions have patent committees that include students (presumably graduate students).

7. What are the functions of the patent committee?

Formulate patent policy	22
Determine royalty distributions	16
Make decisions on patenting inventions	26
Negotiate license arrangements	2
Other	5
	71

This question received multiple answers and all functions may not have been described. For example, some patent committees may be involved in arbitration (see 16 below) but this item was mentioned only once.

8. Does the patent policy cover:

(a) Faculty	47
(b) Professional staff	47
(c) Nonprofessional staff	43
(d) Graduate students employed by institution	46
(e) Graduate students not employed by institution	25
(f) Undergraduates employed by institution	42
(g) Undergraduates not employed by institution	21

Of the institutions responding, one had not yet adopted a patent policy, which accounts for the maximum number of 47 rather than 48. The significant decrease in coverage for both graduate and undergraduate students not employed by the institution probably relates to the fact that employment (and thus the payment of salary) is used in many cases as the basis for a university claim to equity in inventions, rather than the provisions of funds or facilities (see 15 below).

9. By which of the following does the institution control the disposition of patent rights (with the understanding that a sponsor may subsequently take control)?

(a) Taking title to inventions	36
(b) Directing or approving disposition by inventors	11
(c) The voluntary referral of an invention to the institution if there is no sponsor requirement	11
	58

Eight institutions checked *both* (a) and (b), which may mean that the policy is covered by (b), but that in some cases the inventor is required or elects to give title to the institution as provided for under (a). However, two of these eight institutions also checked (c), possibly an attempt to cover both inventions in which the institution has an equity and those in which it does not (see 15 below). The remaining nine institutions in category (c) constitute a large number in which the institution exercises no control at all (unless there is a sponsor requirement).

A policy as in (b) of directing or approving disposition by inventors provides much greater flexibility than that listed in (a). Under (b), title can be directed to the institution, to a patent management firm, or to the government or another sponsor without the necessity of title first going to the institution.

10. Does the institution enter into agreements with possible inventors (see 8 above) to establish patent rights? Complete only one response:

(a) For all possible inventors	16
(b) For all possible inventors who *participate* in sponsored research	8
(c) For all possible inventors who are employed	14
(d) For all possible inventors who are employed only in sponsored research	6
(e) No agreements with anyone	4
	48

The twenty-four institutions responding affirmatively to (a) or (b) are well covered insofar as the requirements of sponsored research, particularly government-sponsored research, are concerned. Institutions covered by (c) and (d) are not fully meeting the obligations of sponsored research, since these obligations extend to all persons who participate in or perform part of the work, not only those who are employed by and paid from a grant or contract. The four institutions responding affirmatively to (e) are not in compliance unless the terms of the applicable patent policy can be held to be as legally binding as an individual agreement.

For inventions that result from research which is not sponsored, the thirty institutions designating (a) or (c) are all fairly well covered, except that (c) would not apply, for example, to a graduate student who makes an invention but is not employed by the institution. Among the other seventeen respondents there is a gap that is partly explained by the eleven who responded to 9(c) above (in which referral of an invention to the university is entirely voluntary unless there are sponsored research requirements).

11. Does the institution use, or have its administrators considered using a single agreement to cover both patents and copyrights?

Yes	13
No	35
	48

12. Are one or more patent management firms used? If so, give names.

Yes	40
No	8
	48

Research Corporation was predominant, followed at a distance by Battelle, University Patents, Inc., and others.

13. If a decision is made in the institution (not by a patent management firm) to make a patent application, who makes the decision?

Patent committee	11
Research administration office	9
Associate provost, vice president, or dean for research	9
Research foundation	4
President	3
Vice president for business or finance	2
Patent office	2
Other (such as state, governing board, inventor)	5
No answer	3
	48

14. Does the institution's patent policy require reporting by those covered by the policy (see 8 above) of:

(a) All inventions, even if there is no institutional or sponsor equity	19
(b) All inventions on which patents are applied for, even though there is no institutional or sponsor equity	5
(c) All inventions where there is some institutional or sponsor equity	19
(d) Only those inventions that must be reported to a sponsor	5
	48

Institutions that are diligent in pursuing technology transfers and public use of their inventions probably fall into group (a).

15. What is the basis of the institution's claim for institutional equity in an invention? That is, what is the legal consideration for the institution to obtain rights?

(a) Payment of salary or stipend	29
(b) Provision of funds or facilities	34
(c) Other (such as patent services furnished to inventor or state legal requirements)	7
	70

Twenty-two institutions checked more than one of the answers. Twenty-one of these responded to both (a) and (b). There is a question as to whether the citation of salary or stipend as a consideration for patent rights is reasonable or even legally enforceable.[1] Faculty are not employed to develop patentable inventions, their salaries and promotions are not based on the value of inventions they may make, and where they have tenure, according to Blackwell, "the agreement by the college to continue to employ them would not, so far as they are concerned, constitute consideration."[2]

The provision of funds and facilities for research does not have the handicap of (a) above and can be used for both employed and non-employed inventors (such as students). Further, the institution would have no equity (unless the inventor would choose to handle it through the institution) in an invention whose conception or reduction to practice does not involve institutional funds or facilities.

16. Is arbitration or some other form of decision-making provided for in the event of a disagreement as to the institution's equity or rights in an invention?

Yes	27
No	21
	48

The absence of arbitration provisions in twenty-one institutions is somewhat surprising.

17. Does the institution ever relinquish to the inventor its rights to an invention?

Yes	40
No	8
	48

If so, under what circumstances?

Miscellaneous answers included cases in which sponsor and institution chose not to patent.

18. Does the institution ever handle for inventors those inventions in which it has no equity?

Yes	22
No	26
	48

If "yes," what are the conditions?

Miscellaneous answers included paying more than normal royalties to the inventor.

19. If the institution retains patent rights for inventions, what share of royalties is paid to the inventor(s)? Net or gross?

Maximum possible	1
Net 80% scaled down to 25% as total royalty increases	2
Gross 50% plus first $3,000, then 25% to $13,000, then 15%	2
Net 60% 0-$25,000; 50% $25,000-$50,000; 40% $50,000-$75,000; 30% above $75,000	1
Net 50% plus first $1,000 of institution's net	1
Gross 15% plus 50% of additional net	1
Net 50%	6
Net 50% or gross 25%	1
Net 50% maximum, 20% minimum by arbitration	1
Net 50% after first $5,000 net	1
Net 50% until expenses, then 20% of gross	1
Net 42.5%	1
Net 40%	1

[1] See Blackwell, T. E. *College Law*. (Washington, D.C.: American Council on Education, 1961.) pp. 175-180, "The Administration of Faculty Patents."
[2] Ibid, p. 179.

Net 40% 0-$50,000; 30% $50,000-$100,000; 15% above $100,000	2
Gross 15% until costs recovered, then 40% net	1
Net 33%	1
Gross 28%	1
Net 25%	5
Gross 20%	1
Gross 15%	9
Net 15%	4
Case by case	3
No answer	1
	48

Although the difference between gross and net royalties varies widely from patent to patent, the answers to this question are listed such that the amounts to inventors decrease in order of total royalties from top to bottom. The median answer is 33% of net royalty income for the inventor. Royalty shares to inventors appear to have increased significantly since the 1962 survey referred to at the beginning of this document. The method of giving the inventor a large initial share and decreasing on a sliding scale (indicated in five of the answers) has the merit of providing a climate of greater cooperation among researchers by reducing the potential rewards to the one researcher who is named the legal inventor.

20. What disposition is made of the institution's share of royalties?

Research	26
General institutional funds	10
Research and patent costs	6
Education and research	3
Patent costs	2
Other	1
	48

21. What steps, if any, are taken to insure that all inventions are properly disclosed?

None (although the patent policy may so require)	23
Regulations	11
Periodic reminders	8
Periodic meetings	5
Special educational program	4
Annual invention statement	3
Other	2
	56

Eight institutions used more than one method of obtaining invention disclosures. It is likely that a greater number used more than one method but did not indicate this.

22. Does the institution have any institutional patent agreements (IPAs) with federal agencies? If so, list the agencies.

Both HEW and NSF	10
HEW only	11
NSF only	3
	24

Note that more than half of the responding institutions have no IPAs.

23. In negotiating sponsored research agreements with industry, does the institution accept requirements for sponsor to obtain:

(a) Title to all inventions	27
(b) Exclusive license	26
(c) Exclusive license for limited period	26
(d) Exclusive license for limited period with march-in rights for lack of diligence	28
(e) Nonexclusive license	31
(f) Other	7
	145

Many institutions indicated more than one answer; three questions were the average number of these. The number of (a) and (b) answers could cause concern about the diligence of institutional endeavors for protection of the public interest. Where title to inventions is given to a sponsor as in (a), the inventor's normal share of royalties under a patent policy presumably disappears.

24. Under the arrangements described in (23) above, is there any provision for royalties or other reimbursement to the institution, such as increased indirect costs?

Royalties	21
Increased indirect costs	17

None	10
	48

As in 23(a) above, where the compensation to the institution for patent rights consists of increased indirect costs or is nonexistent, the inventor's share of royalties presumably disappears.

25. For inventions owned or controlled by the institution and not assigned to a patent management organization, which of the categories of (23) above best describe the institution's policies for assignment or licensing?

(a) Title to all inventions	3
(b) Exclusive license	11
(c) Exclusive license for limited period	8
(d) Exclusive license for limited period with march-in rights for lack of diligence	19
(e) Nonexclusive license	13
(f) Other	5
	59

Only eleven institutions indicated more than one answer. Note that many more of the responding institutions indicated willingness to give greater rights to a research sponsor (see 23 above) than to a licensee or assignee.

26. How many patents were applied for on the institution's inventions during the last ten years by:

(a) Inventor	165 (known)
(b) Institution	889
(c) Patent management organization	554
(d) Industrial sponsor	119
(e) Government sponsor	60 (known)
	1787

Although the number for any one institution varies from 1 to 150 for the total of categories (a) through (e) combined, the average is 37 per institution, or about 4 per year per institution. While this may not appear to be a large number, over a ten-year period the total of 1787 for all institutions is significant.

27. How many of the patents listed in (26) above were issued? 937

28. How many of the patents that were issued (see 27 above) were licensed? 469

These answers indicate a high ratio—fifty percent—of patents licensed to patents issued.

Appendix A: University Patent Policies and Patent Administration Questionnaire

1. Name of Institution

2. Who authorized your patent policy?
   a. Trustees or regents
   b. Faculty
   c. President or chancellor
   d. Other (please specify)

3. What office administers the patent policy?

4. To whom is that office responsible?

5. Is there a patent committee?

6. What is its composition?

7. What are the functions of the patent committee?

8. Does the patent policy cover:
   a. Faculty
   b. Professional staff
   c. Nonprofessional staff
   d. Graduate students employed by university
   e. Graduate students not employed by university
   f. Undergraduates employed by university
   g. Undergraduates not employed by university

9. Does your institution control the disposition of patent rights by either (it is understood that a sponsor may subsequently take control):

Taking title to inventions

Or directing or approving disposition by inventors

Or is the referral of an invention to the university voluntary if there is no sponsor requirement

10. Do you enter into agreements with possible inventors (see 8 above) to establish patent rights (complete only one response)
    a. For all possible inventors from 8 above (specify a, b, c, d . . . etc)
    b. For all possible inventors from 8 who *participate* in sponsored research (specify a, b, c . . . etc)
    c. For all possible inventors from 8 who are *employed* (specify a, b, c . . . etc)
    d. For all possible inventors from 8 who are employed *just* in sponsored research (specify a, b, c . . . etc)

11. Do you or have you considered using a single agreement to cover both patents and copyrights?

12. Is one or more patent management firm utilized and if so give names?

13. If the institution (not a patent management firm) decided to make a patent application, what office makes this decision?

14. Does your patent policy require reporting by those covered by the policy (see 8) of:
    a. *All* inventions made even though there is no institutional or sponsor equity, or
    b. All inventions made on which patents are applied for, even though there is no institutional or sponsor equity, or
    c. All inventions made where there is some institutional or sponsor equity, or
    d. Only those inventions made which must be reported to a sponsor

15. What is the basis of the institution's claim for institutional equity in an invention, i.e. what is the legal consideration for the university to obtain rights?
    a. Payment of salary or stipend
    b. Provision of funds or facilities
    c. Other

16. Is arbitration or some other form of decision-making provided for in the event of a disagreement as to the institution's equity or rights in an invention?

17. Does the institution ever relinquish its rights to an invention back to the inventor? If yes, under what circumstances?

18. Does the institution handle inventions for inventors in which it has no equity? If yes, what are the conditions?

19. If the institution retains patent rights for inventions, what share of royalties is paid to inventor(s)? Net or gross?

20. What disposition is made of institution's share of royalties?

21. What steps if any are taken to assure that all inventions are properly disclosed?

22. Does your institution have any institutional patent agreements (IPAs) with federal agencies? If so, list agencies

23. In negotiating sponsored research agreements with industry, do you accept requirements for sponsor to obtain:
    a. Title to all inventions
    b. Exclusive license
    c. Exclusive license for limited period
    d. Exclusive license for limited period with march-in rights for lack of diligence
    e. Nonexclusive license
    f. Other

24. Under the arrangements described in 23 above, is there any provision for royalties or other reimbursement to the university, such as increased indirect costs?

25. For inventions owned or controlled by the institution and not assigned to a patent management organization, which of the categories of 23 above best describe the institution's policies for assignment or licensing?

26. How many patents were applied for on your institution's inventions during the last ten years by:
    Inventor
    Institution
    Patent Management Organization
    Industrial Sponsor
    Government Sponsor

27. How many of the above patents issued?

28. How many of the patents in 27 were licensed?

Appendix B: Institutions Responding to Patent Survey

University of Akron
Ball State University
Boston College
Brown University
University of California System
California Institute of Technology
University of Cincinnati
Colorado State University Research Foundation
Concordia University
University of Connecticut
Cornell University
University of Dayton
University of Delaware
University of Denver
University of Georgia
University of Guelph
University of Houston
University of Illinois at Urbana-Champaign
University of Iowa
University of Kansas
Kansas State University
Kent State University
University of Kentucky
Universite Laval
University of Maryland
University of Michigan
University of Minnesota
University of Mississippi
University of Nebraska
University of New Mexico
Research Foundation of State University of New York
University of Oklahoma
University of Oregon
Princeton University
Purdue University
Rockefeller University
Rutgers University
Salk Institute
Simon Fraser University
University of Southern California
Southern Illinois University
Texas A&M Research Foundation
University of Toledo
University of Virginia
Virginia Polytechnic Institute and State University
Washington State University
University of Wisconsin
Yale University

Administrative Service supplements document principles, policies, practices and procedures in the field of college and university management. They provide additional information about subject fields or offer specific guidance in regard to generally accepted principles and policies. Supplements are the result of a comprehensive review process modeled after that used for the basic chapters of the Service.

Patents at Colleges and Universities

THE AREA OF PATENT LAW and its practice is one of the most complex of legal specialties, generally requiring both a technical and legal background in addition to a proficiency in patent law. Nevertheless, a level of understanding sufficient to handle patentable discoveries in the proper manner can readily be established at any institution, regardless of size. The possession of this understanding can allow the dissemination of important and valuable research findings by publication, by patenting, or by both, in a manner that is likely to produce the greatest benefit for the institution, the discoverer, and the public.

Institutions establish patent policies for a variety of reasons, usually to achieve one or more of the following objectives:

1. To facilitate the transfer of technology and the utilization of findings of scientific research in order to provide maximum benefit to the public therefrom.

2. To encourage research, scholarship, and a spirit of inquiry, thereby generating new knowledge.

3. To provide machinery by which the significance of discoveries may be determined so that the commercially meritorious may be brought to the point of public utilization.

4. To assist in an equitable disposition of interests in inventions among the inventor, the institution, and, when applicable, a sponsor.

5. To provide individual incentives to inventors in the form of personal development, professional recognition, and financial compensation.

6. To assist in the fulfillment of the terms of research grants and contracts.

7. To safeguard the intellectual property represented by worthwhile inventions so that it may receive adequate patent protection.

8. To facilitate the development of institutional patent agreements with the federal government.

DEALING WITH PATENTABLE DISCOVERIES

In order to deal with discoveries that may have patentable significance, the following should be present in an institution: first, a documented patent policy approved by the governing board, which defines the rights and obligations of the institution, the inventor, and, when applicable, a sponsor. Second, an institution requires a focal point of adequate patent understanding that will serve as collection point and conduit for discovered information on its way to the Patent Office and to becoming a development activity.

The third requirement is the capability to carry forward the development of a discovery until it results in a usable commodity for which the institution can obtain a financial return. This may be accomplished by an in-house patent management group, by an institution-affiliated foundation, or by arrangements with invention management agencies. None of these three requirements need be costly to set up or expensive to maintain.

Need for Patent Knowledge

Since the early sixties there has been an increasing emphasis on applied research output, a demand that educational institutions be "more relevant to society." Where discoveries in the scientific and technological areas are concerned, this raises the question, "How can your discoveries be used?" The federal government, by its funding policies, has reinforced the need for the educational community to examine the "relevancy" of its research. Research proposals directed at investigating topics

with implicit use in the solving of immediate problems are more likely to be funded than those aimed at basic research generating information that is not presently usable. Technical discoveries from such "relevant" research are more often found to be patentable than are discoveries from basic research. Thus, if an institution accepts federal research support, it is likely to be involved with decisions relating to patents.

The President's Patent Policy Statement of August 23, 1971, the liberalization of some government patent waiver policies, and the use by several agencies of institutional patent agreements indicate that the educational community may become more and more involved in patent determinations. Thus, provisions of the institutional patent policy should be developed to recognize, as far as possible, any current federal requirements or guidelines on the subject. A sound policy can facilitate the release of title rights by the government and be the basis for implementing an institutional patent agreement with federal agencies.

The guidelines in this document are intended to assist administrators in determining the level of activity best suited to the invention and patent needs of their institutions. Inventions as assets may not represent a readily available source of funds that can be applied to solve acute financial problems. However, each institution should, without excessive cost, acquire the capability of bringing to public use any commercially valuable discovery made in its laboratories.

Nature and Scope of Patents

A patent is a property right granted by a sovereign nation, which gives the holder the exclusive right to control the manufacture, use, and sale of an invention for a period of years. As property it may be sold or assigned, pledged, mortgaged, leased (licensed), willed or donated, and be the subject of contracts and agreements. Control may be accomplished by exercising the exclusive rights referred to above or by permitting others to exercise such rights under the terms of a license. The United States patent system is implicitly authorized by the Constitution in the provision that, "Congress shall have the power . . . to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Legislation implementing the Constitutional provision is found in Title 35 of the U.S. Code.

Each country has its own requirements on patenting, including standards for what is patentable, formalities for establishing a patent, the effective date and duration of the patent grant, requirements relating to the use of a patent, and annual taxes to maintain it in force. Under United States standards of patentability, all patent applications are examined for *novelty*, *utility* and *nonobviousness*, and it is the applicant's responsibility to establish these elements to the satisfaction of the Patent Office before the patent is allowed to issue.

Patentable *novelty* and commercial novelty are not necessarily synonymous. A device may lack novelty as far as the Patent Office is concerned and yet be received by the public as a "new" item. The requirement for *utility* appears self-explanatory. In regard to the third requirement, the invention must be *nonobvious* at the time of invention to a person having ordinary skill in the art to which it pertains.

The duration of all U.S. patents is 17 years from the date of issue and they are not renewable. In contrast to the practice in most foreign countries, there is currently no annual tax levied by the United States government to maintain a patent in force, nor are there any current legislative requirements that the teachings of a patent be a commercial reality within a given period of time, under penalty of compulsory licensing or forfeiture.

It is the responsibility of a patent holder (the patentee) rather than the government (the patentor) to police the use of the patent and either to bring infringing parties under a license or to prosecute them for infringement. If the patentee intends to keep the patent in force, he or she is obliged to defend the validity of the patent if it is attacked. The patent granted by the U.S. Patent Office is only prima facie evidence of the exclusive right it purports to establish. The presumption of validity that attaches to a patent may be

subsequently rebutted and invalidated in a federal court proceeding by third parties formally charged with infringement if they present satisfactory proof that the patent should not have been issued.

The 1952 Patent Act sets forth those classes of patent matter that are eligible for patenting. That statute provides that any inventor who "invents or discovers a new or useful *process, machine, manufacture,* or *composition-of-matter,* or any *new and useful improvement thereof,* may obtain a patent therefor, subject to the conditions and requirements of the law." The law also allows the patenting of new varieties of *asexually produced plants* other than tuber-propagated plants or plants found in an uncultivated state. These six categories plus patents for designs compose a complete list of subjects that the law deems to be patentable. Design patents, which relate to the ornamental appearance of useful articles, are seldom encountered in an educational setting.

Some subjects that cannot be patented because they are outside the scope of patents are:

1. Theories.
2. Ideas.
3. Plans of action.
4. Results.
5. Methods of doing business.
6. Discoveries of laws of nature or scientific principles.
7. Things immoral or injurious to health and the good of society.
8. Works eligible for protection under the copyright laws.

Patents and Publication

Patents and publication are closely related. A patent is a form of publication, which describes an invention to the world at large in return for a limited period during which others can be excluded from using the invention. However, care must be taken in disclosing an invention, such as by publication in a scientific or technical journal, in order to avoid placing the invention in the public domain and thus losing the right to obtain a patent.

In the United States a patent may be obtained if a patent application is filed within one year after the invention is disclosed through publication or commercial use. In many foreign countries a patent cannot be obtained if there has been any disclosure of the invention to the public prior to the filing of a patent application. However, under an international convention, a patent application in the United States generally will preserve for one year the right to file patent applications abroad even though there has been publication of the invention subsequent to the U.S. patent application but before foreign patent application is filed.

ELEMENTS OF AN INSTITUTIONAL PATENT POLICY

An institution seeking to establish or clarify its position regarding rights to and disposition of patentable inventions should develop a statement of patent policy. The statement should be broad enough to encompass all foreseeable patent situations, yet specific enough to allow administration of the policy without frequent recourse to policy deliberations by an advisory committee. The statement should briefly define the administrative structure for processing a patentable discovery and it should be directly and succinctly presented for clear understanding by lay persons in the field. The basic purpose of a patent policy is to define the rights and obligations of both the inventor and the institution as regards patent matters. To the extent that policies on consulting deal with patents, it is advisable to take them into account when formulating a patent policy.

Some institutional patent policies are incorporated into patent manuals that provide the reader with a brief orientation on patent matters. These publications can be helpful to neophyte inventors, but they should be prepared such that the institutional policy is clearly distinguishable from general instructional materials.

The following topics typically are found in institutional patent policies:

1. Preamble.
2. Applicability of the policy.
3. Establishment of the inventor commitment.
4. Rights of the parties.
5. Income-sharing arrangement.
6. Administrative arrangements.

Preamble. Although optional, this section is recommended. It should relate the basic purposes of the institution, its obligations to the public, and the scholarly aims of its faculty to the institution's interest in patents and ways in which patents serve these ends. The preamble should be kept short and to the point and establish a sound foundation for what is to follow.

Applicability of the Policy. This section defines research situations, sources of funds, all categories of persons who may invent (that is, faculty, staff, and student), activities in which such persons are engaged, and any combinations of these elements that would bring an inventor into the scope of, or exempt him or her from, provisions of the policy. Educational institutions do not usually lay claim to all inventive concepts generated by their employees or students. Rather, they limit themselves to those that arise as a result of employment relationships or use by the researcher of institution resources, facilities, or information.

Establishment of the Inventor Commitment. Once an institution determines the criteria for applying the policy to individuals, its personnel may be required to dispose of inventions as determined by the institution in one of several ways (listed in generally decreasing order of enforceability):

1. By a formal inventor agreement—a legally enforceable contractual commitment by a person to dispose of inventions as determined by the institution. The agreement becomes a standard form for the institution and should be drafted by an attorney to insure its enforceability. It is best executed by the individual when he or she assumes employment.

2. By a state statute which stipulates that inventions made in state institutions or by state employees be disposed of in a predetermined manner.

3. By a person giving his or her written assent to the stated patent policies of the institution, which policies pronounce an obligation by the individual with respect to inventions.

4. By a stated patent policy containing a patent commitment which is established by the governing board and brought to the attention of individuals, but to which such persons are not required to give their personal formal assent.

5. By the presence of a policy allowing the individual to dispose of inventions as determined by the institution or to retain title, at his or her option.

To allow an institution conducting sponsored research to fulfill its contractual obligations, it is essential to have for every person engaged in such research a valid, binding commitment to assign inventions.

Rights of the Parties. The policy should specify the rights that the institution, the inventor, and sometimes outside sponsors have in the invention. The *institution* usually receives a valid, binding assignment of title to the patent application together with a commitment by the inventor to cooperate in executing legal documents, reviewing patent prosecution papers, and in some cases, assisting in the development or marketing of the patent. The *inventor* is entitled to receive from the institution a clear statement of his or her rights and share of income, and the institution's plans for bringing the invention into public use, including a contingency for reassignment to the inventor. *Sponsors'* interests in these situations are usually represented by the institution based on the terms of the research agreement. Sponsor equities in patents must be scrupulously observed by the institution to permit it to perform and maintain its contractual obligations.

Income-Sharing Arrangement. Educational institutions that accept assignment of patents from inventors customarily share royalty income with them. The inventor's share generally ranges from 15% to 50% of net income, although there are a few policies that authorize income outside these limits. Some institutions use sliding scales of income-sharing between these limits with a greater percentage going to the inventor from the early receipts and the rate of sharing declining as the amount of royalties increases.

Most royalty-sharing arrangements are predetermined, that is, the inventor cannot negotiate a higher rate of sharing than stipulated in the institutional policy. Predetermined sharing rates have the advantage that it is unnecessary to pass judgment on the relative worth of each invention. They are easier to administer and usually reward the inventor equitably because a valuable inven-

tion's true merit is reflected in the greater total royalty revenues it generates, a portion of which inures to the benefit of the inventor. Where several individuals collaborate on a patentable invention the inventor's income share is divided among them in portions agreeable among themselves (including co-developers who may not legally be inventors).

Administrative Arrangements Defined by Policy. Patent policies usually specify that patent activities be placed under the administrative cognizance of an institutional patent committee appointed by the governing board, the president, or the faculty senate with a majority of the individuals on the committee representing scientific or technical disciplines. It is not uncommon for a dean, a vice president, or even the president to serve as chairman. This committee often has the responsibility for recommending or establishing patent policy, adjudicating disputes, determining which inventions shall be the subject of patent applications, and overseeing the administration of patent matters within the institution.

ADMINISTRATION AND DEVELOPMENT OF INVENTIONS

The provisions of the institutional patent policy usually determine the make-up of the administrative organization for patents. Typically found at the top of the structure is the patent committee described above. The size of the administrative organization below this committee will vary, depending in part on the amount of research resulting in patents at the institution and on whether or not the institution assumes its own patent development and marketing responsibilities or delegates them to another organization.

Serving the committee as its operating arm on a part- or full-time basis is the institution's "focal point" on patents, an administrator usually drawn from the office of research administration, the legal department, or the business office. This administrator need not be a patent or general attorney but must have a thorough understanding of institutional patent policy and enough background in patent procedures and patent law to handle procedural and policy problems arising in the management of patents.

In a large operation, the patent administrator and any assistants may be a part of the institution's administrative group and often will work full time on patent-related matters. In a modest institutional patent operation, this individual may come from one of the basic science departments and spend only a few hours per month on duties related to patents. Regardless of the size of the patent operation, there should be at least one person who understands the essential requirements for handling patentable information (which is also perishable). This should insure that valuable property rights are not lost to the institution by premature disclosure, publication, or public use prior to filing a patent application or to releasing the invention to an affiliated patent development group.

Development and Marketing

The development and marketing of inventions typically occurs in one of three ways: in-house, by an institution-affiliated foundation, or by a patent management organization.

In-house. In this case, the institution controls and performs the invention evaluation that precedes the decision to patent, the filing of patent applications, the demonstration of the invention's feasibility, and the licensing (not necessarily in this order). This option is initially more costly, because it requires an early outlay for patent application costs and the overhead costs of patent administrative services. However, if sizable royalties are earned, this approach may be the most advantageous overall.

Institution-affiliated foundation. This option can have the advantages of better availability of funds to carry on the development of inventions (a speculative activity) and greater freedom to employ commercial methods to develop and promote the uses of the inventions. Assuming equal capabilities to develop inventions, the presence of a foundation may result in less income for the institution because of the foundation's expectation of sharing income. Both the in-house management and the institution-affiliated foundation management of patents allow the inventor to work closely with the unit that is promoting the invention. The inventor's ready assistance and background often are crucial to getting the invention covered by a

patent and "off the ground" as a commercial success.

A patent management organization. Patent development and marketing by one of these organizations has some distinct advantages: it permits an institution to be active in patents with a minimum financial outlay and it allows considerable legal, marketing, and patent management expertise to be tapped at no immediate cost to the institution. The chief disadvantage in this arrangement is, of course, that a substantial portion of any royalties earned is shared with the patent management group as compensation for services. Also, because of the large number of inventions handled by organizations of this type and the geographical limitations involved, it is possible that this arrangement will diminish the valuable personal input of the inventor in development and marketing efforts.

These three routes of invention development need not be mutually exclusive for an entire patent program. Many institutions utilize more than one, depending on the type of invention reported and the location of the various capabilities needed to develop it.

It is advisable for an institution involved with patents to have available the services of a patent attorney to answer questions, interpret the law, prepare, file and prosecute patent applications as the need arises, and serve as a representative during patent-related negotiations. Because of the diversity of complex patent subject matter generated in colleges and universities, it is desirable that the attorney be affiliated with a firm that includes individuals with a wide variety of technical backgrounds. The American Patent Law Association can be of assistance in making a selection.

Patents in Sponsored Research

The patent policy of the institution may be an important consideration at the time a research proposal is submitted to a sponsoring agency. It is important for the faculty performing research to be aware of any agency patent policies that may conflict with the institution's patent policy. If this information is known in advance, the faculty member will be able to determine the institution's position with regard to the submission of proposals that are likely to produce patent policy conflicts. When there is a conflict it may be possible to negotiate the differences, thereby assuring the availability of research funds. If the faculty is made fully aware of the situation, the chances are improved that they will support the administration's efforts to negotiate acceptable arrangements.

When the funding agency has an institutionally acceptable patent policy, there is normally no problem in accepting funding because the usual terms and conditions of the granting document will have been approved in advance. However, due to changes that take place in government regulations, contracts, and granting documents, knowledgeable people in the office of research administration should monitor the incoming grants and contracts to insure that no changes have been made in the patent (as well as other) requirements. If there are changes, the office responsible for patent matters should be alerted to interpret these alterations with regard to the institution's own policy and, if necessary, assist research administrators in preparing the necessary arguments to the funding agency to effect a modification of the terms of the contract.

Federal grants and contracts usually contain a provision on invention reporting. These requirements stipulate that the contractor make periodic reports of inventions made by researchers, including the timely submission of invention disclosures and a final report at the termination of the contract. Where it is determined that an invention has occurred as a result of or during the course of sponsored research, it is the duty of the office responsible for patents to obtain a complete and properly prepared disclosure from the investigator and to insure that it is properly filed with the contracting officer in order that the grant or contract can be closed without undue delay.

Institutional Patent Agreements

DHEW and NSF regulations provide for the negotiation of Institutional Patent Agreements (IPAs) which provide the grantee a first option to retain principal rights in and to administer inventions made in the course of or under research grants and awards from these agencies. The grantee has the right under the IPA to elect to file patent applications in the United States and in

foreign countries on any subject invention and to administer such invention pursuant to the provisions of the agreement.

In early 1978 the Federal Procurement Regulations were amended by the General Services Administration to provide for use of IPAs in contracts with educational institutions. Federal agencies are encouraged to use an IPA when negotiating contracts with universities. The agreement prescribed for use in the February 2, 1978 *Federal Register* provides flexibility and permits changes as required by applicable agency statute or by special administrative needs (see references).

PATENT LICENSING

A license is the legal right to use the patented invention of another. It may be established by contract or implied from the conduct or legal position of the parties. This document is concerned only with those licenses established by contract. Licensing is the primary method by which a patented invention developed in an educational institution is put into public use (see references). Some important points concerning licensing are:

1. The degree of the licensee's motivation to employ the invention in a commercially successful way and the licensee's capabilities for development, manufacture, and marketing are of primary importance.

2. A license agreement must be a valid and legally enforceable document which precisely defines the rights being transferred and the obligations assumed.

3. To protect the public interest, exclusive licenses should generally be for a limited term. However, they should be of sufficient duration to enable a licensee to recoup unusual development and market penetration costs plus a sufficient additional return to bring forth the licensee's risk capital.

4. Royalty rates can be assessed on a variety of bases and can vary widely. In general, they are reasonably consistent for the same class of products.

5. Exclusive licenses should provide for cancellation in the event the licensee does not make adequate progress in development and marketing.

6. Licenses should provide that the licensee cannot use the name of the inventor or of the institution for sales or promotional purposes without prior approval.

7. In some cases an outright assignment of a patent for a consideration, lump sum or deferred, will be an attractive alternative to licensing.

TRANSFER OF TECHNOLOGY OUTSIDE THE PATENTING PROCESS

It is not uncommon for educational institutions to provide considerable public utilization of their scientific findings without the benefit of patents. Typically, this is accomplished by the publication in appropriate journals of small amounts of information which in themselves are not patentable but which in the aggregate are important contributions to the advancement of numerous technologies.

More complete concepts are often produced that may or may not be patentable and about which an institution is unsure of the commercial prospects. Institutions have a responsibility to the public, to themselves, and to individual developers to move these discoveries into public use. Some discoveries lend themselves to nonexclusive release, while others demand limited-term exclusive arrangements to bring forth the incentive of commercial organizations to commit their resources.

Where some exclusivity to unpatented technology is necessary, disclosure agreements may be employed by an institution and recipient organization to define the terms and conditions under which the information is released and under which the recipient evaluates the concept. Such agreements usually provide for the ultimate protection of the institutional patent position, if any, and for follow-on licenses or other contracts that specify conditions such as those under which the recipient organization may commercialize the discovery. Also provided for is the degree to which the recipient organization may be compensated therefor, the title to any patent that may be available, and other items. Institutions that are highly motivated to technology transfer or that have limited funding available for patent applications should consider this alternative.

The decision of whether to seek a patent application or use a disclosure agreement usually is

made when the invention is reviewed by the patent committee. Disclosure agreements are binding contracts between the two organizations. They must be carefully drawn and must precisely define the idea disclosed. Therefore, their preparation calls for expert assistance.

Invention Disclosures

An invention disclosure in this context is a complete description of an invention written by the inventor to report an invention to the institution or a sponsor. Along with the original laboratory notebooks and records it is one of the most important documents in an institutional patent program. The invention disclosure is based on the information contained in laboratory notebooks. (See Appendix B, "Guidelines for Keeping Laboratory Records.")

It is customary for the office responsible for patents to provide a disclosure form or set of guidelines for preparing disclosures. Whichever is used, completeness is more important than format. The invention disclosure should be couched in good technical language rather than in legalistic style. If the invention becomes the basis for a patent application, a patent attorney can put it in language that is acceptable to the Patent Office.

The invention disclosure is valuable in several ways. Writing the disclosure helps the inventor to mentally clarify the inventive concept and, if the concept has not yet been reduced to practice, to better organize his or her thoughts concerning it. A good disclosure is essential for the technical evaluation of the invention, for an accurate assessment of its commercial feasibility, and for a determination of its patentability. In the latter case, the disclosure is often used as the descriptive information supplied to the Patent Office for making the novelty search. Its clarity and completeness strongly affect the quality of the patent search.

The invention disclosure may later be used as the basis for the preparation of the patent application. Well-prepared disclosures readily transmit the patentable idea to the patent attorney and assist in preparing an application that precisely describes the invention. The less attorney time required for this, the lower the cost to the institution. Finally, when witnessed laboratory records bearing earlier dates are not available, the invention disclosure can serve as proof of the date of conception, or at least of the earliest recording of the invention. It thus may be an important document in any controversy over which of two parties first made the invention.

Disclosures of inventions are required under the terms of federal research agreements and must be sufficiently complete and of a quality that will allow the supporting agency to evaluate and prepare a patent application in the event that the contract terms entitle it to do so. A complete and accurate invention disclosure is extremely important to patent management organizations because they are usually not located in close proximity to the inventor. These organizations must, therefore, rely heavily on the inventor's written description to assess the worth of the invention and to determine any interest in accepting it and in carrying it forward to patenting and commercial development. (A typical set of instructions for preparing invention disclosures appears as Appendix C.)

Administrative Service supplements document principles, policies, practices and procedures in the field of college and university management. They provide additional information about subject fields or offer specific guidance in regard to generally accepted principles and policies. Supplements are the result of a comprehensive review process modeled after that used for the basic chapters of the Service.

APPENDIX A: PATENTS AND COPYRIGHTS—A COMPARISON

	Patents	Copyrights
Coverage	Processes, machines, products of manufacturing, compositions of matter, plants, and improvements on the above, and designs.	Books, periodicals, lectures, dramatic or dramatico-musical compositions, musical compositions, maps, works of art, drawings or plastic works of a scientific or technical character, computer programs, photographs, pictorial illustrations, labels, motion pictures and video tapes, audio recording.
Essential criteria	Must be novel, have utility, and be nonobvious.	Need not be novel, only the original product of the creator.
When statutory rights established	Patent Office (usually about 19 When patent is granted by the months after application date).	The material mentioned above under "Coverage" is copyrighted from its creation. However, the copyright should be registered within three months following publication.
How statutory rights established	By filing a formal disclosure of the invention (with allowable appended claims) in the Patent Office together with the prescribed fee.	Rights are established by the creation of the work. Registration occurs when the prescribed number of copies are deposited in the Copyright Office, together with the prescribed fee and the appropriate application form.
Examination	Examined for essential criteria (see above).	Examined for essential criteria (see above).
Outside professional services	The services of a registered patent attorney should be obtained for filing and prosecution.	No outside services required. Registration may be accomplished by the author.
Cost	Patent Office fees ($235 average) plus attorney's fees may result in $1,000 to $2,000.	$10 plus cost of deposit copies.

	Patents	Copyrights
Term and Renewability	17 years, not renewable.	28 years for works copyrighted before January 1, 1978, renewable for a second period of 47 years. For works copyrighted on or after January 1, 1978, author's life plus 50 years. For works made for hire (such as for associations or institutions), for anonymous and for pseudonymous works, 75 years from publication or 100 years from creation, whichever is shorter.
Marking	Failure to place patent number on patented article does not invalidate the patent.	Failure to employ copyright notice on the original publication or an improper notice on the original publication may be corrected within a period of five years. If the correction is not made by then, the work falls into the public domain.
Who May Apply	Except in unusual circumstances, the inventor's signature must appear on the patent application.	Only the author or those deriving their rights through the author may copyright the work.

APPENDIX B: GUIDELINES FOR KEEPING LABORATORY RECORDS

1. Legibly enter in ink concurrent with your daily work a complete and accurate record of your research activities and sign and date each page.

2. Whenever possible, preface each series of pages with a brief heading of the most generic *nature* of the work performed (that is, statement of problem) rather than what you expect or hope will be the *results* achieved. Avoid gratuitous conclusions.

3. Similarly, when an experiment or run is completed and it represents the reduction to practice of only one or more species, include a paragraph setting forth still other species and parameters of variables stating the reasons you expect them to be effective in order to later provide a valid basis for a generic claim. This is conveniently included under a "Modifications and Extensions" heading and need not include complete data at that time.

4. Faithfully have your work corroborated by having your notebooks witnessed by dated signature of an associate (*not* a co-worker or one who collaborates in your research area and who could be or is a joint inventor). Notation of witness should appear after the last line of your experiment and not necessarily only at the bottom of every page. If necessary or desirable, explain in detail the work performed.

5. Prior to destroying any samples, run sheets, or records of any kind, check with the director to make certain they are of *no* value to any project member.

6. Clear *all* proposed publications (including abstracts) with the director in order to most fully protect and preserve property rights in research.

7. Record your observation of physical results even if not fully appreciated or understood at that time.

8. Utilize the last four to five pages for an index, as desired.

9. Start a new page for each new experiment and draw a continuous diagonal line through unused portions of pages remaining at the close of an experiment.

10. Avoid erasures but where necessary cross out with a single line.

APPENDIX C: GUIDELINES FOR PREPARING AN INVENTION DISCLOSURE

The following guidelines illustrate the preferred layout and content for invention disclosures. Completeness is very important in preparing the disclosure in order that it can serve as a basis for a worthwhile patent search and for preparing the patent application. To be complete, the disclosure should include all the pertinent experimental data available, both pro and con, which has a bearing on the inventive concept. (The data, if voluminous, may be attached as an appendix.) It is also important that the inventor have considered the various alternative ways of constructing (in the case of apparatus) or performing (in the case of a process) the invention. This is something a potential infringer would do, and having the alternative embodiments on hand permits the preparation of a patent application which is broad in scope. The inventor should, however, specify which embodiment is preferred.

The Disclosure

The disclosure should contain the following elements:

A. *A Title.* The ideal title is brief but comprehensive, technically accurate and descriptive.

B. *An Abstract of the Invention to Be Disclosed* (of about 100 words).

C. *Statement of the Background of the Invention.* The disclosure should state the field of art to which the invention pertains. The basis for this requirement is that an accurate description will permit a future patent application to be properly classified in the Patent Office, and therefore it is helpful if the inventor can accurately categorize the invention within the field of his or her endeavor.

D. *Description of the Prior Art.* A statement of the prior art known to the applicant should be set forth. This will include a description of the various

existing devices or processes and their shortcomings that are remedied by the present invention. If published material such as scientific papers, patents, or commercial literature relating to or describing the prior art is known to exist, it should be cited (or supplied, if available).

E. *Summary of the Invention.* In this section describe in detail:

1. How the invention is designed. Where alternative designs are available, describe these and select the preferred embodiment. To clarify, attach and refer to descriptive drawings, flow charts, circuit diagrams, etc.

2. Ranges of operating conditions, such as time, temperature, or pressure, where these are relevant to the invention. Preferably these should be in terms of broad ranges of conditions and narrower optimum or preferred ranges. Where materials may be varied, sufficient specific materials should be enumerated to illustrate the range of usable materials. A sufficient number of specific working examples should be set forth to illustrate the variations in conditions and materials.

3. How the invention operates to produce a result or results not achieved in the prior art.

4. The new concept that has been invented: describe succinctly.

5. All advantages such as efficiencies, cost benefits, etc. produced by these new results.

F. *Utility of the invention.* Indicate briefly and in general terms, particularly for chemical cases. Where the utility is evident from the earlier sections, this section may be omitted.

G. *Publication of the Invention.* List (and append, if possible) all publications in which the invention was described or occasions on which it was described orally to others; for example, at symposiums.

H. *All budget numbers used to defray any research costs that are invention-related.*

I. *Signatures, Witnesses, and Dating.* Each inventor should sign the disclosure before a witness who understands the invention. The witness should also sign. Each set of signatures (inventor and witness) should be dated.

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THE BUSINESS OF SOFTWARE LICENSING AT THE UNIVERSITY OF WATERLOO

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The licensing of software can be a significant asset in the supplementing of university income. The staff at the University of Waterloo have been distributing and licensing software for over fifteen years. This paper discusses why this activity has developed, problems peculiar to software as an intellectual property, and some recent changes in the University's historical approach.

The University of Waterloo

The University of Waterloo (UW) was founded in 1957 and has grown to an enrollment of over 21,000 full and part-time students, with 745 faculty members and 1800 support staff. Since its inception it has emphasized the teaching of computing and the use of computers by undergraduate and graduate students in many disciplines. In particular UW supports a large Department of Computer Science within the world's largest Faculty of Mathematics. This department taught 10,415 student-term courses in the last academic year.

Because of the emphasis on student computing, UW has been forced to be a pioneer in developing software suitable to an educational environment. There is an interesting discussion of UW's early efforts in this field in the May 1982 issue of "Perspectives in Computing"[1] published by IBM. The article includes an interview with Professor J.W. Graham who is a leading innovator in computing at UW.

Software Development at Waterloo

The first major programme written at Waterloo was a "load and go" FORTRAN compiler that was named WATFOR for WATerloo FORtran. WATFOR was written to run on the IBM 7040-7090 family of

machines which were installed in many North American Universities at the time. The programme was successful in reducing the run time for an average student job by a factor of 60 to 100, thereby making it practical to run several thousand student jobs per day. In addition it provided excellent error diagnostics. A year later, WATFOR was re-written to run on the IBM 360 family of machines, and it quickly became a programme in great demand throughout North America.

This pattern was typical of many subsequent software developments at UW. The software was written originally to meet a need at UW, which was seeking to keep its undergraduate programmes, particularly in Computer Science, up to date. Once the software was ready for use, it was immediately attractive to other University installations as well. Thus a policy for sharing UW software with the rest of the world had to be developed.

Watsoft

UW's second response to the problems of software explosion and funding crisis has been the establishment of a wholly-owned separately incorporated company called Waterloo Software Applications Centre Inc. The function of this company is to act as a holding company for subsidiaries which will engage in software related enterprises for profit which will be returned through the holding company to UW. The first of the subsidiary companies, WATSOFT Products, Inc., has already been established. Its primary business is software distribution, but it is anticipated that it might expand into software development in its own right. The accompanying chart shows the corporate relationship amongst WATSOFT, UW and some other companies that have become involved. The corporate structure is expected to yield benefits as follows:

(i) University of Waterloo: UW will continue to derive the same benefits it enjoyed when it distributed the software directly. In addition, it derives benefits from selling computer services to subsidiaries at commercial rates, and income may increase due to more professional and aggressive marketing. Liabilities, always a major cause of concern, will now be limited to UW's investment in the Company concerned.

(ii) Software Authors: Through the medium of a separate company, it is possible to extend financial incentives to software producers which are difficult to provide within the University itself. Such incentives can include share ownership as well as royalties.

(iii) Customers: Software users will benefit from dealing with a business which can assume business risks, and which will take a more commercial approach to software packaging and documentation.

Institute for Computer Research

Because of the emphasis in this paper on the software production environment at UW, it is appropriate to mention the recent formation of the Institute For Computer Research. The ICR is made up of a number of research groups in computer-related fields. The groups are being brought together to foster cooperation among themselves, and to share facilities and staff. The member groups participate in technology transfer through contract work, shared development projects, production and licensing of software, and publication in research journals. The ICR will also provide industry with an improved relationship with UW computer-related research activities through:

(a) highly qualified graduates familiar with state-of-the-art technology,
(b) industrial sabbaticals,
(c) update courses to allow industrial managers to quickly get current in new technologies,
(d) closer cooperation on research ventures,
(e) an improved flow of information in both directions, and
(f) timely awareness of new research results.

Interested companies can participate in three ways: an Affiliates Program, a Visiting Professionals Program, and a Corporate Partners Program. A detailed description of these programs can be obtained by writing to the Director of the Institute, Dr. Eric Manning, at the University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1.

Historical Approach to Software Distribution and Licensing

Until recently, UW has distributed its software under the guidance of these policy objectives:

(1) Software is distributed, or "shared," with other educational institutions for a license fee designed to recover UW's costs of distribution, development and maintenance.
(2) UW seeks to protect its proprietary interest in its software.
(3) UW seeks to minimize any potential liability arising from its distribution of software.
(4) Distribution of software to commercial and government installations is done at a "competitive" price, to avoid charges of unfair competition with tax paying commercial software businesses.

Scope of Licensing Operations

By the end of the 1981-82 fiscal year, UW had 1732 Software Licensing Agreements in force. Gross income for the year amounted to some $1,700,000. There are approximately 30 Software Products sublicensed to over 1000 installations worldwide.

A Changing Environment

Two recent developments have caused the University to modify its historical approach to software licensing and distribution:

(1) A diversification of software sources within the University. While most of the software licensed to date has been produced by the Computer Systems Group, an increasing number of programmes are being produced by other research groups, in application areas as well as Computer Science related work. This diversification has caused the University to adopt a formal policy approach to software licensing and distribution.

(2) Funding Crisis; Many universities in Canada, and particularly in Ontario, are facing a financial crisis brought on by diminishing government support. Consequently, UW is seeking other possible sources of income. Its reputation and experience in software product development and licensing provides one promising source of additional revenues.

In response to these developments the University has recently adopted a formal Software Policy (see Appendix A) and a set of corresponding guidelines. The policy establishes a formal way for UW to interface with software developers throughout the University. Its main emphasis is on the question of "ownership" of software, or, more precisely, ownership of the rights to use or otherwise exploit software products produced on the campus.

Secondly, UW has incorporated a wholly owned subsidiary company, called Waterloo Software Applications Centre, Inc., which will act as a holding company for other subsidiary companies in various software-related fields. One such subsidiary, WATSOFT Products Inc., has already been established to distribute and license UW produced software, and possibly to develop software on its own under contract or for commercial exploitation.

Software Policy

There are a number of features of the new UW Software Policy that distinguish UW's approach to certain key issues from the approach of most other Universities which have tackled this problem.[2]

One such feature is the distinction made between software and inventions or other forms of intellectual property. While UW's Patent Policy formed a starting point for the development of the Software Policy, there is an important difference in that the University hires staff members to write software, but it doesn't hire people to "invent" things. Thus, while the UW Patent Policy can straightforwardly acknowledge the ownership rights of an inventor to his invention, regardless of whether the inventor is Faculty, Staff or Student, it is reluctant to do so in the case of Software. A distinction is made, in the case of "Software created for the University in the discharge of the normal responsibilities of employment." The University assumes it owns any software of this status, and all rights pertaining to it. Except in this case, it is assumed that the individuals or research groups who originate software own it, with the provision that UW retains the right to use, for internal purposes, any software written

using UW facilities.

When a researcher, student or research group writes a programme or software package, the question often arises whether the programme has any potential attraction to others. An author or originator can approach the University with a request for assistance in distributing his product. The principles governing University participation in any such distribution are:

(a) A right of refusal; UW retains the right to refuse to participate in any given case.

(b) Assignment of Rights; the Author must assign to UW all rights necessary for UW to be able to enter into licensing contracts.

(c) Assurance of Originality; UW demands written assurance from the Author that it is his work.

(d) Access to Maintenance; the more widely a programme is used, the more likely it is that errors or "bugs" will be detected. UW requires assurance that maintenance sufficient to meet its contractual obligations will be forthcoming either from the author(s) or someone else thoroughly familiar with the programme.

(e) Revenue Sharing; Arrangements differ depending on the circumstances under which the software was created. In the case of software produced by formally recognized research groups, most of the revenue is allocated to the group for further research. In the case of individuals, revenues are split among the author(s), the department or faculty which contributed resources, and the University. These ratios can be altered to accommodate special circumstances.

Table I — Revenue Sharing Guidelines

Originating Group	Software Owned by	Owners' Share	Dept./Fac. Share	University Share
Semi-autonomous Research Group	Group	90%	N/A	10%
Formal Research Group	Group	80%	10%	10%
Operating Dept.	University	N/A	67%	33%
Individual(s)	Individual(s)	33%	33%	33%

In adopting the software policy UW recognizes that there remain several important issues which require attention. These arise mainly because of the unique character of software as an intellectual property and include:

(i) Evaluation: It is difficult, particularly in the case of application programs, to know how good a program really is. Some of the questions that arise are:
(a) What is the value of the program to a potential user?

(b) Is it a program which does what the author believes or represents it to do?
(c) Does UW want to be associated with the sponsorship or distribution of the program?

The problem of evaluation is a critical one for which there are no easy answers. One suggestion currently under consideration is to assign programmes a category something like this:

Category A: A program guaranteed to meet its performance specifications and which UW will maintain.
Category B: A program the user accepts as is. UW will attempt to assist in removing bugs within certain limits.
Category C: An untested program which UW will only maintain as discretion dictates.

IBM used to use a similar kind of categorization for its program products.

(ii) Marketing: Until recently, almost all the programs UW distributed were products like computer utilities, language compilers, assemblers and other special programs of interest to those who offer computer services to others. These have been marketed in a passive manner, more or less waiting for customers to call and ask for the products of their choice. In the case of application programs, it is likely more aggressive marketing may be required in order to have a program become widely used. Such marketing must take place among potential users, rather than suppliers of computing services, which could be costly and time-consuming. Presently at UW, we leave the marketing to the author(s), who promote their programs through conferences, publications, etc.

(iii) Protection of Proprietary Interest: The difficulties here all arise from the nature of computer programs as forms of intellectual property. Unfortunately the law is only beginning to catch up to the computer revolution, and the legal means of protecting authorship rights such as patent, copyright or trade secret law are only beginning to become properly applicable to software. To discuss each of these briefly:

(a) Patents: From time to time the Patent Offices in both the United States and Canada have issued patents for software products. Few of these patents have survived a challenge in court, though not all have been challenged yet. In those cases where patents have been upheld at the level of the US Supreme Court, the decisions have been split. There is an interesting and brief discussion of patentability of software in Computer Law and Tax Report, Vol. 7, Number 9, April 1981.[3] To the question "Are programs patentable," the answer appears to be "Yes and no." In one case cited in the above reference, the

majority opinion of the Court said "When a claim recites a mathematical formula..., an inquiry must be made into whether the claim is seeking patent protection for that formula in the abstract. A mathematical formula as such is not accorded the protection of our patent laws..." But, "when a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect . . . , then the claim satisfies the requirements of Section 101." Patents do not seem to provide a reliable means of protection at the present time.

(b) Copyright: Almost everyone who distributes or licenses software invokes copyright. Is it effective? There is no doubt that a specific version of a program can be printed, bound and copyrighted, thereby protecting that version from unauthorized copying by others. However, if someone were to take the program and change all the variable names, or even just some of them, would this still be the same version for copyright purposes? If it is, then perhaps a few additional minor changes would be sufficient to render the new version noninfringing. Despite the difficulties, some progress has been made over the last ten years or so in updating the copyright law to extend its applicability to works which exist in non-printed media. In a case in federal court in San Francisco in August, 1981, the judge ruled that a program stored in ROM (read only memory) was copyrightable under the US 1976 Copyright Act which became effective in January 1978.[4] The Act says that "works of authorship" are copyrightable if they can be fixed in "any tangible medium of expression, now known or later discovered, from which they can be perceived, reproduced, or otherwise communicated either directly or with the aid of a machine or device." The judge ruled that under Section 101 and 102 a computer program is "a work of authorship" subject to copyright, and a silicon chip is "a tangible medium of expression" within the meaning of the copyright law.[4]

In the US, the Computer Software Copyright Act of 1980 went into effect on December 12, 1980. The new Act includes the first federal legislative definition of a computer program: "A set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result." With programs thus defined, Congress has made it clear that programs can be copyrighted.[5] Notice that this definition does not distinguish between source and object programs. To the extent that programs can be copyrighted, it may be

argued that they cannot be protected by trade secret. The purpose of copyright protection is to encourage public distribution of the article that is copyrighted, which is inconsistent with trade secret protection. However, neither copyright nor patent protects ideas, so protecting an algorithm by trade secret and contractual methods is still important.

(c) Trade Secret: UW still relies primarily on trade secret and contractual methods to protect its proprietary interests. The large number of contract clauses concerning proprietary interests quoted earlier illustrates this approach.

(d) Trade Name Registration: UW has registered trade names such as WATFOR, WATFIV, WATBOL, WATERLOO PORT and others to prevent other software suppliers from marketing similar products under these names. One case arose a few years ago in which a company advertised a WATFOR package for a computer system for which WATFOR hadn't been written. It wasn't necessary to go to court in this instance, since the company desisted after receiving a letter from UW lawyers.

(e) Security Devices: Over the years UW has adopted two kinds of security devices to aid in the prevention of theft. In the case of software written for large systems, certain instructions can be inserted which ensure that the software is being run on the licensed machine, and which will render the program unusuable after a given expiry date. Thus customers must renew or cease using the product after the license period has expired. In the case of software written for microcomputers, UW is using a "security chip" which customers for certain products must buy. Without the chip, the software, which is distributed on PROM'S (Programmable read only memory chips) is unusable.

The following are some of the clauses presently used in UW Software Licensing Contracts which illustrate the objectives listed above:

1. Cost Recovery:

Example 1. This License shall run for a term of years from the day of 19 : provided that if the Licensee shall not then be in default with respect to the terms of this Agreement, the term hereof, at the option of the Licensee, may be extended, upon giving written notice to that effect to the Licensor, and provided that the Licensor consents in writing, this Agreement shall be extended for an additional period of one (1) year and, at the option of the Licensee, and with the written consent of the Licensor, the term hereof may be further extended, in similar manner and provided that the Licensee shall not then be in default, from year

to year during each renewal year thereafter. Such notice of renewal shall be given by the Licensee to the Licensor at least forty-five (45) days prior to the date of expiration of the then current license year and the Licensor shall give notice of consent to the renewal within thirty (30) days of the expiration of the then current license year. Each renewal shall be upon the same terms and conditions as herein set out.

Example 2. The Licensee shall pay to the Licensor yearly and every year during the said term, for the use of the said Program, a license fee of Nine Hundred Dollars ($900.00), the first of such payments to be made in advance on the date of the commencement of the license term referred to above and the subsequent yearly payments of Nine Hundred Dollars ($900.00), shall be made in advance within thirty (30) days of the date of commence-

Note that one of the effects of the 1st clause is to give UW an option not to renew the Agreement on an anniversary date. This can be used to renegotiate a new price if circumstances warrant, as well as to allow UW to drop support for a given product or withdraw it from the market.

2. Proprietary Interest:

Example 1. Title to the Program and any material associated therewith shall at all times remain in the Licensor.

Example 2. This License shall be non-exclusive and the Licensor shall have the right to grant any further and additional licenses or to make such other use of the said Program as it shall desire.

Example 3. The Licensee may modify the said Program and/or any material associated therewith, in machine readable form, to adapt the same for the Licensee's own use having regard to the Licensee's own peculiar requirements and to this extent may merge the program into other program material to form an updated work, provided that upon the termination of this license, the program and material associated therewith shall be removed from the updated work and shall be destroyed as provided in the within Agreement. The Program, though merged with any other program material, shall be used only on the CPU's above referred to and shall remain subject to the terms of the within Agreement.

Example 4. The Licensee shall acquire no right, title or interest in, to or with respect to, the name "WATBOL" or to the Program itself and the Licensee agrees that the name WATBOL and the Programs are and shall at all times be the sole property of the University of Waterloo.

Example 5. The Licensee shall at all times hereafter keep secret and confidential, the Program and all technical information, data or materials relating to the Program.

Example 6. The Licensee shall not assign, sublet or transfer the within License, nor shall the Licensee for purposes of financial gain, offer a service to any person, corporation or entity, which service includes the use of the said Program.

Example 7. Upon the termination of the within Agreement, whether pursuant to the terms hereof, or by effluxion of time, or otherwise, the Program and any materials associated therewith shall be removed from any location in which the Program is being used and all materials, duplicates and copies relating thereto shall be destroyed by the Licensee. The Licensee, upon such termination, shall provide the Licensor with such reasonable evidentiary information and material as shall enable the Licensor to satisfy itself as to such removal and destruction of the said Program, materials, duplicates and copies relating thereto. Without intending to limit the generality of the foregoing, upon any such termination the Licensee shall complete, execute and give to the Licensor the "Termination of the WATBOL Agreement" form provided by the Licensor.

Example 8. (a) Whenever any representation, written, printed or oral, shall be made by the Licensee relating to the said Program, such representation shall be accompanied by a reference to "WATBOL" and the Computer Science Department, University of Waterloo, as the originator of the Program.

(b) Any reference to the term WATBOL shall be accompanied by appropriate notice stating that WATBOL is a trademark of the University of Waterloo.

3. Potential Liability:

Example 1. The Licensor and the Licensee agree that the content of the WATBOL Program is fully defined in machine readable form on the WATBOL Distribution Tape to be delivered by the Licensor to the Licensee; the said parties hereto also agree that there are no understandings, agreements, warranties or representations express or implied, between the said parties with respect to or relating to the content of the WATBOL Program other than as defined by the said Distribution Tape.

Example 2. The Licensor agrees to furnish and provide such maintenance, without charge, at such time or times, and for such period of time, as the Licensor in its absolute discretion shall deem necessary and advisable. Any communications regarding Program Maintenance shall be addressed to the WATBOL Coordinator, Computing Centre, University of Waterloo, Waterloo, Ontario, N2L 3G1.

Example 3. The Licensor makes no representation with respect to its adequacy of this program for any particular purpose or with respect to the adequacy to produce any particular result. The Licensee agrees that the Licensor or any of its employees, agents or contractors shall not be liable under any claim, charge or demand whether in contract, tort (including negligence), criminal law or otherwise, for any and all loss, cost, charge, claim, demand, fee, expense or damage of every nature and kind arising out of, connected with, resulting from or sustained as a result of executing this Contract or for performing all or any part of this Contract. In no event shall the Licensor be liable for special, direct, indirect or consequential damages, losses, costs,

charges, claims, demands, fees or expenses of any nature or kind.

Example 4. The Licensee agrees to indemnify the Licensor, its successors and assigns, against any and all loss, cost, charge, claim, demand, fee, damage or expense of every nature or kind which may at any time hereafter be sustained by the Licensor by reason of or in consequence of having executed or performed all or any part of this Contract.

Example 5. The Licensor shall not, by reason of termination or nonrenewal of this Agreement, be liable to the Licensee for compensation, reimbursement or damages on account of the loss of prospective profits on anticipated sales or on account of expenditures, investments, leases or commitments in connection with the business or goodwill of the Licensee or otherwise.

The fourth paragraph cited above seeks to shift the risk of using the software to the customer installation. This paragraph is one UW has always insisted upon, but it has caused more administrative problems than any other aspect of the contracts. Understandably, most prospective users do not wish to sign such a broad indemnity.

Conclusion

Software products are created at UW in four distinct environments: (i) individuals in academic faculties or departments, (ii) research groups, (iii) operating departments or (iv) within the Institute for Computer Research. In all cases except operating departments, software products and the rights to exploit them are regarded as the property of the originators. The new software policy adopted by UW stresses the importance of the establishment of ownership rights, and provides a policy for interaction between authors and the University if University assistance is requested for distribution or licensing.

Software authors have the option of turning to WATSOFT Products Inc. for assistance in marketing and licensing. In this case, the authors would enter into a business arrangement with the Company. Authors have another option of distributing their products themselves, or arranging for some other private sponsor. In all cases, UW reserves the right to use software developed using UW resources.

The problems peculiar to licensing of software arise from its unique characteristics of being easily plagiarized and copied. Current laws in both Canada and the US have not yet met the challenge posed by these problems. However, progress is being made particularly in the area of Copyright Law in the US. In the meantime, the most effective protection of proprietary rights for software lies in trade secret and contract law; supplemented where possible by hardware or software security devices.

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4. *Computer Law and Tax Report*, Warren, Graham and Lamont, Inc., Vol. 8, No. 3, October 1981.
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Appendix A

UNIVERSITY OF WATERLOO POLICY Number: 61

Effective Date: July 1, 1982

New

SUBJECT: COMPUTER SOFTWARE

I. GENERAL

The term "software" as used in this policy statement includes any sequence of coded instructions for a computer, including any hardware modifications required for the sequence of instructions to be executed by, or made available to, the computer.

This policy recognizes the responsibility of the University to enrich the domain of new and useful knowledge and to ensure that the results of the development of computer software are made available, with appropriate benefits and safeguards, for the University of Waterloo and members of its faculty, staff and student body. It applies to all faculty[1] and staff[2] and registered students[3] acting individually or as members of University organizational element. The policy does not apply retroactively to software which has been developed and/or distributed and/or been in use under prior agreements.

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[1]Faculty appointments are defined in Policy 53.

[2]Staff members are defined in Policy 54.

[3]"Registered students" means graduate or undergraduate students registered at the University of Waterloo.

UNIVERSITY OF WATERLOO POLICY Number: 61

II. OWNERSHIP OF SOFTWARE

A. The rights of the University and its faculty, staff and students can be subject, in the case of research funded by an external granting or contracting body, to special stipulations on ownership or use that the external body might establish as a condition or term of a grant or contract. In such instances, the

ownership of the software will be established in advance as part of the terms of the particular grant or contract and in advance of the activity in any case.

B. Where no external stipulation exists, and subject to other defined special rights, the University has no direct equity in the ownership of any software developed by a member of its faculty, staff or student body, except software created for the University in the discharge of the normal responsibilities of employment.

   Staff members whose duties include software development and who intend to develop software outside their employment responsibilities should submit a written description of each project to their department head early in the development. If this is not done, the presumption normally will be that software developed by a staff member is the property of the University.

C. The originator of any software not owned by the University is free to use or distribute the software unilaterally.

D. An originator of software developed at the University of Waterloo shall promptly inform the University (through the Office of Research) of distribution activities, including applications for patent, copyright, or trade name registration, and publication in book form.

E. Where software has been developed with the support, facilities and/or equipment of the University, the owner of the software shall grant to the University a non-exclusive, free, irrevocable license to use the software for the University's own purposes. This license shall not necessarily include the right to exploit, sublicense, or sell any produce or process which involves the proprietary interests of others, or arises from the use of software made available to the University under the policy.

III. DISTRIBUTION OF SOFTWARE

A. The University shall normally attempt to recover any direct or indirect costs incurred in the development of software from the revenue accruing from publication or distribution of software.

B. The University invites any of its members to submit their products to the University for development and distribution assistance, under the following principles:

   1. The University reserves the right to refuse to participate.
   2. The owners must assign to the University all rights required for the software product to be distributed legally under a University contract.
   3. The University will require formal (contracted) assurance that the software is owned by the authors and that there are no third party claims or attachments.
   4. The University will require assurance from the authors that required levels of maintenance and service will be

provided over a stated period of time.

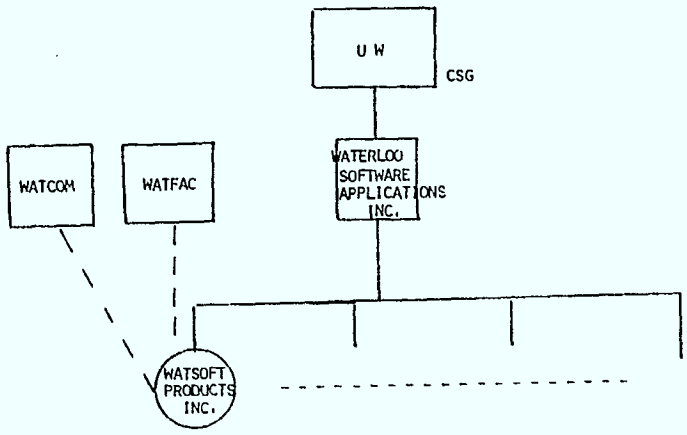
5. In consultation with the authors, the University will establish:
   a. markets
   b. marketing conditions
   c. pricing of the product
   d. method of distribution
   e. protection of the product

IV. REVENUE SHARING

The sharing of revenues accruing from distribution of a software product shall be determined by the University from time to time, according to the particular circumstances.

V. GUIDELINES

Guidelines for the administration of this policy are available from the Office of Research.



WATSOFT PRODUCTS INC. DISTRIBUTES SOFTWARE UNDER LICENSE FROM:

U W (CSG)
WATFAC
WATCOM

Figure 1

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