Health Informatics Education Working Paper

H.D. Covvey and A.B. Pidduck

CS-99-24

September 1999

Health Informatics Education Working Paper

H.D. Covvey
A. B. Pidduck
September 20, 1999

Table of Contents

Executive Summary

Executive Summary

We have reviewed the characteristics of medical and health informatics education and training programs, and come to the following conclusions:

- Existing programs, with a few exceptions, focus narrowly on medical (or nursing) informatics rather than taking the broader view of all of health.

- There is the opportunity to create a Graduate Health Informatics program with a strong Computer Science focus (e.g., awarding a graduate degree in CS) that would have little or no competition in Canada.

- There is the need for a post-professional program (Certificate/Diploma) in Applied Health Informatics that is accessible to mature employed staff wishing to upgrade their knowledge and skills in order to contribute more fully to the deployment of systems in health environments.

Based on our findings we have proposed the development of two programs at the University of Waterloo:

1. **A Graduate Program in Health Informatics.** This will be developed over a period of 3-4 years. It will start in the Fall of 1999, during which graduate students would be offered the opportunity to do their thesis research in a health application domain. In the next and succeeding years, several graduate-level as well as a number of undergraduate courses will be developed and offered, faculty with credentials in HI will be recruited, and funding will be sought for CS research projects with health applications. Graduates from this program will receive a Masters or Ph.D. in Computer Science with Specialization in Health Informatics.

2. **A Diploma Program in Applied Health Informatics.** This program is already in development and has its first courses targeted for the Spring of 2000. The program will be rolled-out gradually, as it is developed, will rely primarily on adjunct faculty, and will be promoted via the EPSP organization. Material developed for the AHI Diploma Program will also serve as the basis for undergraduate courses.

This document summarizes our findings, outlines the two programs, and indicates the steps that must be taken to bring them to full realization.

Introduction

Health Informatics Program Working Paper

H.D. Covvey and A.B. Pidduck
September 20, 1999

Introduction

The Need for Health Informatics Education

Health organizations have recognized that they are "Information Organizations" that require a well-architected information technology (IT) infrastructure for efficient and effective operation. Most, if not all, health organizations have established or have access to Information Services (IS) departments charged with defining, selecting and procuring, deploying, managing, and maintaining the IT that supports virtually all health processes and enables service delivery. Most have also identified and satisfied the need for IT leadership (in the form of CIOs, VPs of IS, or Directors of IS) and for capable IT staff. Health organizations have thus become strategically and tactically dependent on the knowledge and skills of IT professionals.

Traditional Sources of Health Informatics Education

There have been several "traditional channels" that have produced the professionals needed within the health system:

1. Health Informatics Academic Programs.

We define Health Informatics Academic Programs as university or college-based formal curricula that are intended to produce IT professionals with Bachelor, Masters, and/or Ph.D. degrees, prepared specifically for addressing health informatics challenges. There are a number of such programs in North America. However, all but one in Canada (the Health Information Sciences program at the University of Victoria) and at most a few in the U.S. are oriented to the production of academicians in Medical Informatics. The UVic program in Canada and the University of Illinois program in the U.S., address both the broader field of health informatics and the production of professionals suited for line positions in the health industry.

2. Health Informatics Elective-Augmented General Academic Programs.

Academic programs such as Computer Science and Information Science (and possibly a few Schools of Business) at universities and colleges sometimes offer students the opportunity to take electives or to do undergraduate or graduate projects or theses on health informatics-related topics. Such programs produce Computer Science, Information Science, or Business professionals with at least focal Health Informatics expertise.

3. Self-Managed Health Informatics Post-Professional Education.

Many IT staff and leaders currently serving health organizations obtained diplomas or degrees in computer-related disciplines such as Computer Science, Information Science, or the equivalent. Alternatively, they may have majored in other areas including Nursing, Business, Mathematics, the Arts, and so on. Both groups extended their initial background with selected courses and/or self-education to develop the health informatics-related knowledge and skills required to fulfill their roles within health organizations.

4. On-the-Job Health Informatics Learning.

A number of IT staff still assume health IT roles with no academic qualifications, and/or with little in the way of formal Computer Science and Health Informatics knowledge and skills. Individuals without

academic degrees or diplomas, with academic credentials but without formal education or training in computer-related topics, and with little no health system knowledge, learn via on-the-job experience. The tremendous demand for IT skills in health and the relative shortage of qualified professionals causes health organizations to tolerate this situation.

Needed HI Educational Programs

Based on the above, we see a significant need for educational programs that offer two distinct Health Informatics qualifications:

- **A Health Informatics Graduate Degree.**

  A Health Informatics graduate degree program is conceived as a multi-disciplinary, graduate education program to provide students with the knowledge and skills to be researchers and developers, and to be teachers and supervisors of Health Informatics students. Specialization will be related to the innovative uses of information and information technology in the health environment. Candidates are expected to have an undergraduate degree in Computer Science or Information Science. Alternatively, they may have an academic degree in another discipline with an adequate selection of courses in Computer Science and the willingness to satisfy undergraduate Computer Science requirements by taking required courses or providing evidence of adequate knowledge via examination.

- **An Applied Health Informatics Professional Diploma.**

  An Applied Health Informatics Professional Diploma program is conceived to be a post-professional training program to prepare individuals (especially those with previous health system experience) with incomplete Computer Science backgrounds to address the day-to-day challenges that arise in performing IT management and support roles within health organizations. The AHIPC program is designed for employed professionals and will award a Diploma in Applied Health Informatics. No academic degree or diploma is required of candidates, although such would be an advantage. All essential computing-related knowledge is either taught within the program or acquired via a selection of courses from existing programs.

This working paper considers both the degree and diploma programs, but addresses each separately.

The Motivation/Rationale for Considering HI Education Programs

The over-riding motivation for establishing Health Informatics education programs is the need of health organizations and companies for trained, capable professionals. Beyond this, the following are other major drivers:

- The interest of students in this specialty area has been demonstrated in the enthusiasm generated by elective offerings and graduate research projects in many settings. Health represents an interesting, challenging domain for the application of Computer Science theory.

- Health Informatics has been demonstrated to be an excellent area for interdisciplinary collaboration and research. Essential collaborators exist at the University of Waterloo and have interests that could be served by such a program.

- There is only one existing program in Canada. It is primarily focused at the undergraduate level, however, and produces Applied Health Informaticians. There are no programs in Canada producing academic Health Informaticians.

- Developing a graduate Health Informatics program affords an opportunity for extending masters-level programs at the University of Waterloo and for enhancing multi-disciplinary research.

- The Computer Science Department has expressed a strategic objective to develop a Health Informatics education program.

- The demand for Health Informatics professionals, coupled with the dearth of fully prepared and credentialed candidates, may represent a new opportunity to obtain program funding.

Existing Health-related Informatics Programs

A UW program in Health Informatics is best understood in the context of offerings at other centers. A review of the literature and websites revealed the following health-related informatics programs (with the dates they were established indicated, if known):

Universities with M.Sc./Ph.D. Programs in Medical Informatics:

- Columbia University, New York, NY, USA (1987).
- Harvard-MIT-NEMC, Boston, MA, USA (1992).
- University of Utah, Salt Lake City, UT, USA (1962).
- Stanford University, Palo Alto, CA, USA (1982).
- University of Pierre and Marie Curie, Paris, FR (1968).
- University of Minnesota, Minneapolis, MN, USA.
- UCSF, San Francisco, CA, USA.

Universities with Ph.D. (Only) Programs in Medical Informatics:

- University of Missouri, Columbia, MO, USA (1975) (Also Health Informatics).
- Heidelberg University, Heidelberg, FRG (1972).
- University of Medicine and Pharmacy, Timisoara, Rumania (1984).

Universities with M.Sc. (Only) Programs in Medical Informatics:

- Linkoping University, Linkoping, SWD, 1972.

Universities with B.Sc. (Only) Programs in Medical Informatics:

- University of Manchester, Manchester, UK.

B.Sc./ M.Sc. Programs in Health Informatics:

- Univ. of Victoria, Victoria, Canada (1982).
- University of Illinois, Chicago, IL, USA.

Universities with M.Sc./Ph.D. Programs with Specialization in Medical Informatics:

- Vanderbilt University, Nashville, TN, USA.
- Ohio State University, Columbus, OH, USA.
- University of Virginia, Charlottesville, VA, USA.
- Case Western Reserve University, Cleveland, OH, USA.
- Medical University of South Carolina, Charleston, SC, USA.
- University of Illinois at Urbana-Champlaign, IL, USA.

- University of Texas at Houston, TX, USA.

Universities with Diploma Programs in Medical Informatics:

- Aalborg University, Aalborg, DNK (1994) (Distance Education).

Universities with Post-Doctoral Programs (Only) in Medical Informatics:

- Yale University, New Haven, CT, USA (1986).

Selected Universities with Medical Informatics in the Medical Curriculum:

- George Washington University, Washington, DC, USA (1986).
- University of Limburg, Maastrict, NTH (1987).
- Many others around world.

Selected Other Universities with Medical Informatics Courses (from SigBio, 1986):

- UCLA, Los Angeles, CA, USA.
- University of Pittsburgh, Pittsburgh, PA, USA.
- Chicago Medical School, Chicago, IL, USA.
- University of Rochester, Rochester, NY, USA.
- Duke University, Durham, NC, USA.
- University of South Florida, FL, USA
- Medical College of Georgia, Augusta, GA, USA.
- Louisiana State University, New Orleans, LA, USA.
- Georgia Institute of Technology, Atlanta, GA, USA.
- Many others around world

Other (Unclassified) Medical Informatics Programs Identified via Web Search:

- Department of Medical Informatics, Erasmus University, The Netherlands
- University Hospital of the Freiburg University, Germany
- Institute for Medical Informatics at Hildesheim University
- Karolinska Institute for Medical Informatics, Sweden
- Technical University of Madrid, Spain
- University of Miami Medical Informatics, FL, USA.
- Monash University.
- University of North Carolina, Chapel Hill, NC, USA.
- Oregon Health Sciences University, OR, USA.
- The Medical College of Wisconsin, Madison, WI, USA.
- University of Medicine and Dentistry of New Jersey, Newark, NJ, USA.

Special Focus: The Health Information Science Program at the University of Victoria

Characteristics of the UVic Health Information Science Program

The Health Information Science (HINF) program at the University of Victoria began as an undergraduate program in 1982. Although it remains predominantly an undergraduate program, its objectives in terms of

preparing students most closely match what we perceive to be the needs of health organizations. The UVic program has the following characteristics:

- It started as an undergraduate program in the Faculty of Human and Social Development. It recently began offering a Masters program (an M.Sc. by Special Arrangement).

- In a typical year there are 30-35 admissions:
  - 60% of admissions have no previous degree (most are admitted directly from secondary school).
  - 60% of admissions have at least 5 years of work experience.
  - 25% of admissions have healthcare experience.
  - Approximately 80% of admissions are from BC.

- There are approximately 100 students in the program at the present time, 8 of which are in the M.Sc. program. A total of 209 students have completed the undergraduate program (an average of ~12.3 per year), and 7 have completed the graduate program.

- The year consists of 3 terms of 13 weeks each arranged in 2 sessions (Session 1: Fall term and Spring term; Session 2: Summer term).

- Completing the undergraduate program typically takes 5.0-5.5 years, including four 13 to 16-week work terms and the pre-Health Information Science year dedicated mostly to prerequisites.

- The first year of the undergraduate usually includes 2 introductory Computer Science courses (CSC110 [Computer Programming I] and CSC115 [Computer Programming II]), 2 introductory math courses (Math100 or 102, and Math151 [Finite Math]), 2 introductory HINF courses, and 2 English courses. Two additional required external courses are taken in later years: CSC375 [Introduction to Systems Analysis] and two Statistics courses.

- In succeeding years, students must take at least 4 courses per term, are encouraged to take 5, and are limited to 6. They typically spend 3.5 years in courses and 4 work terms of 13 to 16 weeks (~1 additional year).

- Students must obtain 60 units (or 40 courses, each course is 1.5 units) for graduation.

- The requirements for the Masters program include: in addition to his/her HINF graduate supervisor, the supervisory committee must include 2 members from UVic departments with graduate programs; 18 units (the equivalent of 12 courses) if the student has an HINF degree, or 30 units (the equivalent of 20 courses) if not; the courses include up to four 3rd or 4th year courses augmented by additional work plus 4 graduate courses (unspecified); required attendance at all research seminars, plus presentation at one; a thesis that counts as 9 units (6 courses equivalent); maintain a cumulative grade point average of 5.00 (B); and an oral examination defending the thesis.

- There are 4 full-time faculty, and generally one or more courses are taught by sessionals (there are currently 3-4 adjunct faculty).

- The UVic program does not maintain strong ties to Computer Science. Although students have several CSC prerequisites, Computer Science faculty teach none of the HINF courses.

UVic Health Information Science Courses

The following are the courses offered in the UVic program:

- Introduction to Health Information Science I + II
- Introduction to Healthcare Informatics Applications (HINF171 + 172)
- Hospital Organization (HINF220)
- Introduction to the Canadian Healthcare System (HINF240)
- Medical Methodology (HINF 270)

- Principles of Health Database Design (HINF300)
- Human Communications and Relations in Health Care (HINF315)
- Fiscal Management in Health Services (HINF325)
- Legal Issues in Health Informatics (HINF330)
- Principles of Community Health (HINF340)
- Hospital Information Systems I (HINF351)
- Introductory Epidemiology (HINF380)
- Computer Applications in Nursing (HINF 385)
- Administrative Support Systems (HINF410)
- Patient Care Support Systems (HINF415)
- Healthcare Systems (HINF440)
- Issues in Community Health (HINF444)
- Distributed Processing in Health Care (HINF445)
- Principles of Health Information Systems Design (HINF450)
- Quality Assurance and Ethics (HINF460)
- Epidemiology in Health Services Management (HINF480)
- Directed Study (HINF490)
- Topics in Health Information Science (HINF491)

In overview, the HINF program today is a co-op undergraduate Applied Health Informatics program with a limited graduate component. The program mostly serves West Coast students, assumes no Computer Science background and has a weak affiliation with the Computer Science department. As well, it requires many years of residency and produces primarily professional IT staff for healthcare organizations. It has been praised by healthcare organizations that recruit its graduates. A "Capsule Summary" of the UVic program is included as Appendix 2.

The Status of NLM-Funded Medical Informatics Programs

The National Library of Medicine began funding Medical Informatics programs in 1972, some of which received continuing funding in 1984. (From: "A Descriptive Analysis of NLM Funded Medical Informatics Training Programs and the Career Choice of Their Graduates", R.M. Braude, Proceedings of SCAMC, 1990). The NLM established these programs to train investigators in Medical Informatics and to teach the principles of Medical Informatics to medical students. After 13 years, the NLM reviewed these programs, and elected to downsize the number of programs and to limit future enrollment. The following are the major observations regarding these programs:

- Of 13 original MI training programs funded starting in 1972, only 5 were given continuing funding in 1984.

- The 13 original programs trained a total of 371 students between 1972-84 in a cumulative 106 program-years of training (3.5 graduates/program-year; greatest: 7graduates/year).

- The NLM Program objectives were primarily to train future faculty in Medical Informatics, to train researchers in biomedical sciences, and expose Computer Scientists to practical problems.

- 50% of the programs required a Ph.D. for entrance, while the rest required an M.D./M.Sc./B.Sc. or medical student status. 52% of admitted students had M.D.s, 10% had Ph.D.s/M.D.-Ph.D.s, 5% had M.A.s/M.Sc.s, and 3% had other medical-related degrees (e.g. D.O., D.D.S., etc.), with the remaining 30% having B.A.s/B.Sc.s.

- Approximately 50% of those completing the programs received a new degree (i.e., different from the one with which they were admitted), but ~74% of those who received new degrees were admitted with M.D.s. The interpretation offered is that only about 50% of trainees had a degree objective, and M.D.s were disproportionately represented in the group seeking degrees.

- All programs involved course work in Computer Science; 12/13 included a research project; almost 2/3 involved course work in medicine and a thesis; but only a few used self-instruction modules or provided an internship in IS development.

- Of students achieving a degree, 74% graduated with an M.Sc., and 22% graduated with a Ph.D.

- 52% of graduates wished to obtain an academic position.

- Of 89 that achieved academic positions, 78 (88%) retained them at the time of the review.

It is clear that the NLM-funded programs focussed mostly on Medical Informatics (as contrasted with the broader Healthcare Informatics) and the production of Medical Informatics academicians, and they favored entrants with medical or medicine-related qualifications.

Overview of Identified Graduate Medical/Health Informatics Programs

General Characteristics of Medical Informatics Programs

Although there are many differences, the above programs have the following general characteristics:

- Virtually all programs are Medical Informatics programs rather than Health Informatics programs (the major exceptions being the UVic, the Univ. of Illinois Chicago, and University of Missouri programs). This means that they are mainly focussed on the medical aspects of healthcare.

- Many of the programs are strongly oriented to physicians, preferring or requiring an M.D. degree for entry.

- Most programs are oriented to producing teachers and researchers in medical informatics, rather than service professionals, exceptions being the UVic and Univ. of Illinois Chicago programs.

- Most, if not all, require a project or a thesis.

- Many programs are highly customized to student interests. This can mean that courses, reading, and research are assigned differentially, or that the curriculum is free form and can be configured for each student.

- Most of the North American programs have a strong self-directed component, with some pre-requisites and required courses specific to Medical Informatics.

- Many of the programs are interdisciplinary (among Medicine, a separate Medical Informatics department [often itself being a section in the Department of Medicine], and sometimes Computer Science or Biomedical Engineering or equivalent departments).

- In the United States, the ACM curriculum (ACM Curricula Recommendations for Related Computer Science Programs in ... Health Computing, Vol. 3, 1983) and National Library of Medicine funding have been influential.

- There appears to be a noticeable incidence of hanging-by-the-nails, instability, opportunism, and informality associated with these programs.

- There is a strong call for re-thinking, co-operation, and co-ordination of these programs. (JAMIA)

- The status of these programs has not been adequately assessed in terms of the overall quality of the programs, the depth and breadth of the program content, the relevance of the education versus the needs of the health system, and the abilities, employability, and job satisfaction of the graduates.

Typical Courses Taught in Medical Informatics Programs

Many Medical Informatics-specific courses are taught within these programs, but most programs teach courses selected from the following:

- Introduction to Medical Informatics (topics on the nature, management, use, and processing of medical information).
- Computer-Based Records.
- Medical Databases and Database Management.
- Medical Language Representation and Processing.
- The Clinical Process and Clinical Decision-Making/Support.
- Hospital Information Systems.
- Clinical Information Systems.
- Medical Imaging, Image Processing, PACS, and Telemedicine.
- Modeling and Simulation of Physiological/Healthcare Systems.
- Medical and Biomedical Experimental Design.
- Introduction to Healthcare/Medical Data and Terminology.
- Healthcare Organization, Policy, and Social Issues for Non-Healthcare Professionals.
- Security, Societal, and Legal Issues Affecting Medical Informatics.
- Many variants and many special topics.

Other Knowledge Taught or Required

In addition to these Medical Informatics-specific topics, virtually all programs expect their graduates to arrive with or acquire adequate knowledge in the following areas (the weight associated with each varying from program-to-program):

- Health Sciences, and Healthcare Processes, Management and Organization
- Computer and Information Science
- Basic Mathematics, Physiology, Biology, and Medicine.

Similarly all programs expect students to have or acquire (but few explicitly teach) key intellectual and procedural skills:

- IT Usage for personal productivity
- Formal methods (Systems Analysis, Analytic Methods, Project Management, etc.)
- Research methods (experimental design, biostatistics, clinical and population epidemiology)

- Public presentation and professional writing

The Type of Graduate Produced by Existing Programs

The following are seen as major career goals for graduates of existing Medical Informatics programs (From "Medical Informatics An Emerging Discipline and Institutional Priority", R.A. Greenes, E.H. Shortliffe, JAMA, Vol. 263, No. 8, February 23, 1990):

- Academic medical informatics research, development, and education support.
- Clinical, administrative, and educational management.
- Operational service management.
- Healthcare Chief Information Officer (CIO).
- Corporate research and development.

Without question, however, most programs see themselves as producers of academic research faculty.

Resources Available to Support HI Curriculum Development

The Spring 1999 AHIA Congress was devoted to Health Informatics Education, and revealed a number of resources that will enable the rapid development of an HI curriculum:

- IMIA Working Group 1 has developed recommendations on the content of an Applied HI curriculum (www.imia.org/wg1/).
- AAMC has developed curriculum guidelines (www.aamc.org/medical/msop/imformat/htm).
- The School of Biomedical and Health Information Science at the University of Illinois Chicago has developed an Applied HI program and is interested in collaboration with a Canadian organization (Prof. Walter Panko; www.uic.edu/~wpanko and www.sbhis.uic.edu). This program is particularly interested in the AHI Diploma program described below, as it is strongly distance education-based.
- More and more work is being done in HI education delivery through distance learning techniques (e.g., J. Bourne, Vanderbilt University, The ALN Center; ALN is the acronym for Asynchronous Learning Network; see www.aln.org).
- AHIMA has also developed guidelines.
- A number of individuals have undertaken a formal classification of the role of Health Informaticians: J. Glaser at Partners in Boston, H. Lehman at Johns Hopkins [lehman@hmi.edu] see: www.omie.med and www.jhmi.edu/ewg

The Health Informatics Graduate Program

The Health Informatics Graduate Program

Potential Nature of a Graduate HI Program at the University of Waterloo

Requirements for Program Viability

The viability of a graduate Health Informatics Program at the University of Waterloo depends on several factors:

- The demand for the graduates of the program.
- The relevance of the program to candidates.
- The differentiation of the program from competitors.
- The congruence of the program with the plans, goals, and capabilities of the University and the co-operating Departments.
- The availability of competent and interested teaching faculty.
- The financial tractability of the program.
- The "image" of the Program based on its being a University of Waterloo offering.

We will address each of these in turn.

The Demand for the Graduates of the Program

The qualitative need for graduate Health Informaticians is clear. Institutions that develop (or serve as alpha sites for companies that co-develop with them) innovative applications and approaches, companies that develop health IT products, and academic centers that do Health Informatics research and teach Health Informatics require staff with the knowledge and skills only a graduate program can deliver. The demand for capable staff is increasing due to the growing recognition of the dependence of the health system on IT, the dearth of available IT professionals generally, and the success of competing sectors in recruiting the few candidates available.

The Relevance of the Program to Candidates

Canadians with an interest in serving in health research, development and teaching positions currently have few pathways to prepare themselves:

- There is only one degree-granting program in Canada, the UVic program, and this is located on the West Coast, and attended mostly by BC residents.
- Although university-level Medical Informatics programs exist in the U.S., some are accessible only by medical students, and most are oriented to the production of medical, as opposed to Health Informaticians.
- Few, if any, programs exist that address the needs of employed professionals.

For a graduate Health Informatics program to be credible and relevant to candidates, the following must be true:

1. Candidates must perceive that the program will qualify them for the research, development and teaching roles to which they aspire.

2. Candidates must be convinced that the program is credible and recognized, and will position them for recruitment and advancement.

3. The quality and value of the credential obtained must be recognized by future and present employers.

4. For those who are already employed, there must be mechanisms for attaining the credential on a part-time basis, with as little dislocation as possible.

If one accepts these assertions, there is a clear need for the validation of any program proposal by health organizations, companies, academic institutions, and leading professionals. The last point above speaks for the use of distance education techniques wherever feasible.

The Differentiation of the Program from Competing Programs

Based on our review of existing programs, we see the following being features that would differentiate a graduate Health Informatics program from competing programs:

- It would be located in Canada.

- The program would address health broadly, rather that being narrowly focussed on the medical/clinical component of the healthcare system.

- The program would emphasize Computer Science theoretical issues.

- Research projects and theses would emphasize basic Computer Science research with health applicability.

- The program would produce Health Informatics research and development professionals and teachers, rather than service or deployment-oriented IT professionals.

- The program would be oriented to employed candidates and would evolve a distance education component.

- The program would offer a post-professional certification option as an alternative to a degree, for those who find the graduate program inappropriate or inadequate relative to their needs.

The Congruence of the Program with the Plans, Goals, and Capabilities of the University and the Co-operating Departments

Ideally, a new program should be built on the strengths of the University of Waterloo and avoid any weaknesses. We see the following as indicators of the goodness-of-fit of the proposed program with the University of Waterloo:

- The graduate HI program takes advantage of the well-deserved reputation of the Computer Science Department for producing competent professionals for industry.

- The participation of the Faculty of Applied Health Sciences and of affiliated schools of medicine (e.g., UWO, McMaster), nursing, and allied health will enable the program to target Health Informatics broadly rather than Medical Informatics narrowly.

- The University of Waterloo, with its emphasis on intra and inter-departmental and inter-faculty collaboration that has produced several new multi-disciplinary programs, provides a fertile environment for the emergence of a multi-disciplinary program like this one.

- The track record of the University of Waterloo in Computer Science education will enhance the positive perception of the program.

The Availability of Competent and Interested Teachers.

Although there is adequate interest and expertise to begin program planning, a graduate program in Health Informatics will require the recruitment of capable and experienced faculty. It may be possible to launch the program with as little as one or two dedicated faculty, but likely three to four will be required based on the experience with other programs. In addition three to six adjunct faculty would be needed to address the need for specialty expertise and to participate in research and supervision.

The credibility of the program will rest to a high degree on the reputation and capabilities of its faculty, their experience in Health Informatics research and development, and their credibility in health settings.

Faculty would likely best be cross-appointed between Computer Science and Applied Health Sciences (or other affiliated schools), and consideration should be given to at least one faculty member being based in the Health Sciences program in order to ensure the necessary depth and breadth of cooperation and collaboration.

The Financial Tractability of the Program.

This will not be addressed here, but is a matter that the proposed Task Force should give high priority.

The "Image" of the Program Based on its being a University of Waterloo Offering.

There are several aspects of the "image" of the University of Waterloo that will be of great value to a Health Informatics program:

- The reputation of UW as a producer of highly qualified, practically-oriented graduates particularly will affect health organizations' and companies' perceptions of this program.

- UW's strength in Applied Health Sciences and Computer Science will enhance the perception of this as a health (rather than medical) informatics program.

- The Computer Science Department's recognized excellence in areas with high relevance to Health Informatics (Networks, Database Management, Artificial Intelligence, Graphics, Visualization, Data Mining, and Software Engineering, to name a few) is a powerful asset for such a program.

- UW's relationship with industry will foster both the perception of the practical relevance of the program and the potential for interesting research collaborations.

- The broad health focus (rather than a medical focus) will make the program attractive to more students and make its graduates more attractive to health organizations.

We believe that UW is an ideal environment for this program and that the program will flourish unencumbered by the constraints and negative forces faced by many U.S. Medical Informatics programs.

Alternatives for Offering Graduate Health Informatics Education

There exist a number of alternatives for offering a graduate Health Informatics educational experience. They are listed here in the order of increasing difficulty of implementation:

- **Health Informatics Research Specialization:**

  The minimum program possible would permit CS M.Sc./Ph.D. students to do their thesis research in an area of interest to HI. This would require a co-supervisor with expertise in Health Informatics who would guide the HI aspects of the student's research and his/her Health Informatics self-study program.

- **Augmented Health Informatics M.Sc./Ph.D. Research Specialization:**

  At a slightly higher level, the Health Informatics Research Specialization option could be augmented by one or more graduate level courses on Health Informatics topics that would be required of students electing specialization.

- **Full Graduate Health Informatics Program:**

  This would be the most challenging program to develop, as it would require the development of at least a small full-time faculty. In addition, probably at least 8-10 preparatory undergraduate half-courses (these would cover non-graduate level health system, health applications, health information management, and other topics specifically required for competence in Health Informatics), and 4-5 graduate level courses, would need to be developed. Thesis work would require supervision, and the overall effort required would parallel other graduate programs. Students would attain either a Masters or Ph.D. in CS with specialization in Health Informatics.

A Potential Model for the Evolution of a Graduate HI Program at UW

We envision the eventual creation of a full Graduate Health Informatics program. However, recognizing the challenge associated with its development, we propose starting with an HI Research Specialization offering, and moving stepwise to a more comprehensive offering.

One model following this approach would be:

- In the Fall of 1999 start with an HI Research Specialization Program. This would involve a few (1-4), carefully chosen students, co-supervised among ourselves, other CS faculty, and an external health system individual who is interested in the selected topic specialization program. The usual graduate-level courses would be taken, and the student would acquire the essential HI-related information via directed study. This parallels the program one of us (Covvey) formerly offered at the University of Toronto. This level of program can be accomplished using adjunct faculty.

- Seek initial funding in the fall of 1999 for one or two HI-related research projects (e.g., via NSERC or CITO). Projects that would be particularly synergistic with existing UW CS strengths and that would attract interest from several CS research groups (e.g., Data Mining, Medical Imaging, Knowledge Acquisition and Management, etc.) would be preferred areas for student theses.

- During Winter 1999 and Spring 2000, develop and seek approval of one or two HI graduate-level courses that satisfy CS criteria for graduate courses but are focussed in HI. Use the courses developed in the Diploma program (see below) to give students access to undergraduate-level HI knowledge.

- In the Fall of 2000 or the Spring of 2001 move to an Augmented HI Research Specialization Program, with five or more graduate students doing theses and acquiring depth knowledge via the new courses.

Seek additional funding for research. This level of program will require at least one full-time-equivalent faculty.

- Plan for, beyond 2001, a full Graduate HI program with three to five HI-focussed graduate-level courses, with 5-10 students in an M.Sc. and/or Ph.D. program. At least two to three FTE faculty would be required for this level of program.

Computer Science Department Goals for a Graduate HI Program

The following are the major goals and objectives of the Computer Science Department related to a Health Informatics graduate program:

- To create new specialization and research opportunities for graduate students.
- To provide new and interesting outlets for the interests of faculty and to become involved in computing innovations in the health field (e.g., virtual reality, data mining).
- To exploit the natural talents of UW faculty in an area of opportunity.
- To use this program as an attractant for top-notch students.
- To strengthen the Computer Science graduate program.
- To produce health informatics professionals who are continuous learners, and who influence their peers regarding excellence in their work.
- To create a center of research expertise in the region.

In addition to these positive objectives, the Department has a number of exclusions that apply to any program. Specifically, the Department has no interest in the creation of a community college-level program, a program that is not up to the high academic standards of the Department and the University, a program that does not enhance the graduate education environment, a program that takes all comers, a program that awards a "junk" degree, or a program that tries to be all things to all people.

Rules to Ensure that the CS Department's Core Values are Protected

In proceeding with the development of a graduate Health Informatics program, the following rules are proposed:

- We must clearly define the nature, content, format, required human and other resources, and deliverables of the program.
- We must develop collaborative relationships with essential partners such as the UWO and Applied Health Sciences, but ensure that excellence remains the objective.
- We must secure and sustain the interest of a core group of faculty (the Task Force described below) and maintain a champion in the development and fostering of this program.
- We must target the development of a flexible but well-defined academic curriculum.
- There must be a clear definition of the minimum learning expectations for the program.
- We should focus on developing a highly skilled, highly specialized, but small student body.

- We should require a thesis as a component of the program.
- We must staff the program appropriately.

Potential Initial Contributors to the Development of the Program

The following individuals have expressed their interest in participating in the development of the graduate Health Informatics program:

- Nick Cercone
- Dominic Covvey
- Anne Pidduck
- Chrysanne DiMarco
- Frank Tompa
- Vic DiCiccio
- George Labahn
- Alan Law
- Grant Weddell
- Paul Kearney (Bioinformatics)
- Richard Cook (Biostatistics)
- Jack Kalbfleisch (Statistics)

Key Required Characteristics of a UW Graduate Health Informatics Program

In order to address the needs of the health sector, to be attractive and relevant to potential students, to be a manageable graduate program, and to satisfy the standards of the Computer Science Department, we see the following as key characteristics that a graduate Health Informatics program must exhibit:

- The program will admit only candidates with a previous undergraduate or graduate degree in Computer Science.
- The program will recognize that many candidates will be employed and therefore unable to be continuously resident at the University of Waterloo.
- The program will be oriented to candidates who have as a primary objective the acquisition of a recognized degree from a program that provides the depth and breadth of knowledge and skills that directly address the practical challenges of his/her job.
- The program will target the production of capable professionals suited for research, development, and teaching positions in health, industry, and academic settings.
- The program will seek recognition by professional associations (e.g., CIPS) as sufficient for or highly contributory to the awarding of their professional designations (e.g., the ISP), given experience requirements are satisfied.
- The program will be suited to mature candidates, who may have, but generally will not have, previous health-related education or training.
- The program will evolve in the direction of offering as much material as possible via distance education techniques.
- The program will require at least some on-campus attendance for the thesis-related research work, although write-up could be done off-site.

A Straw Model of Potential Courses in a Graduate HI Program

We have outlined below a "straw set" of courses that could contribute to or constitute a graduate curriculum in Health Informatics. These courses are defined here so that those not familiar with a curriculum of this type can appreciate its content and the magnitude of the development effort.

UNDERGRADUATE LEVEL

1. An Overview of the Health System for Non-Health Professionals (Optional) (Full Course)

Example Content: The structure and components of today's health system, health system governance and funding, healthcare delivery institution (hospital, ambulatory care, long-term care, etc.) organization and departmental function, healthcare provider types and roles, major health system issues, patients and patient rights, integrated delivery system components and concepts, major health system restructuring and re-engineering initiatives, health policy, the regulatory environment of health (Canada and U.S.).

2. Introduction to Health Informatics: Perceiving the Big Picture (Half Course)

Example Content: Definition of Health Informatics (HII) and the role of the Health Informatician, understanding the challenges of HI, the tools for the Health Informatician, the HI body of knowledge and body of skills, overview of the major applications of IT in support of health, setting personal competence goals, the need for and characteristics of "broad-spectrum IT professionals", research and self-study methods, essential reading and continuing education.

3. Principles of Health Information and Information Management (Half Course)

Example Content: The nature and types of health information, the health data model, health terminology and classification systems, data standards for interoperability, the nature, measurability, accuracy and completeness of medical data, time-orientation of medical data, etc.

4. Basic Methodologies (Half Course)

Example Content: Structured thinking techniques, group techniques for program planning and decision-making (e.g., nominal group and consensus mapping techniques), structured problem-solving techniques, experimental method, differential diagnosis, structured breakdown techniques, stakeholder analysis, decision analysis, business planning methods, basic financial methods (budgeting, costing, cost-benefit analysis).

5. Administrative Decision-Making and Support (Half Course)

Example Content: Models of health administration and management decision-making, details of administrator and manager roles and functions, key administrative and management systems (the finance suite, management information systems), provincial and national management information standards and requirements, the health administrative data warehouse and OLAP, other decision support tools, periodic reporting requirements, decision-making roles and functions in different health system settings.

6. Introduction to Health Operations Support Systems (Half Course)

Example Content: The nature of operations support and management in various health settings, staff roles and functions, principles of work process re-engineering and the role of IT, finance and business systems, human resources information system, purchasing, receiving, and supplies management systems, house-keeping management system, admitting-discharge-transfer system, patient and resource scheduling systems, environmental systems.

7. Advanced Health Operations Support (Half Course)

Example Content: Integrated management and support systems; the nature of and systems support for: quality assurance, risk management, utilization management, productivity management, outcomes management, costing and cost management; the Hospital Information System, its purpose, components, and roles; the Ambulatory Care Information System; provider practice management systems.

8. Advanced Methodologies (Half Course)

Example Content: Needs determination methods, requirements definition methods, procurement techniques, basic negotiation techniques, system review and audit methods, knowledge acquisition techniques, quantitative and qualitative evaluation methods, financial analysis methods, human resources and systems management methods, project management, authoring techniques, presentation techniques.

9. Introduction to Clinical Decision-Making and Decision Support (Half Course)

Example Content: The nature of the clinical process and the roles of providers, clinical taxonomies, the diagnostic process, clinical decision-making, the selection of therapeutic interventions and patient care management, the management of the therapeutic process, the role, function, and use of the patient record, methods and systems to support clinical decision-making, the clinical data repository, the computer-based patient record.

10. Introduction to Clinical Systems (Half Course)

Example Content: Chart tracking and management systems, patient and care classification systems, departmental reporting systems (Diagnostic Imaging, Laboratory, Pharmacy, Cardio-Pulmonary, etc.), ambulatory care, surgery, emergency patient information systems, provider office-based records systems, the clinical data repository, near-patient documentation systems.

11. Advanced Clinical Systems (Half Course)

Example Content: Clinical decision support systems, clinical trials in patient care, protocol management/care map support systems, automated interpretation of physiological signals (ECG, EMG, EEG, pulmonary function test analysis, etc.), picture archiving and communications systems, computer-supported report production and retrieval, the computer-based patient record.

12. Research Support Systems (Half Course)

Example Content: Computer support for laboratory data acquisition and processing, clinical trial management systems, population and disease registries, modeling and simulation, mathematical and statistical analysis systems, knowledge access systems, research data warehouses.

GRADUATE LEVEL

A selection of graduate Computer Science courses might include:

1. Data Management for Health

Example Content: Health data process models, document management (multimedia databases), experimental data management (data warehousing, data mining, analytic processing, visualization), business modeling and management, GIS, etc.

2. Health Software Systems

Example Content: Distributed heterogeneous systems, real-time monitoring and control.

3. Health Image Processing

4. Medical Knowledge, Planning, and Reasoning

5. Health Informatics Thesis

Example Content: The HI thesis would involve guided research on a topic of interest to the student in the general area of the applications of systems to health.

Possible Innovative Formats and Delivery Mechanisms

Serious consideration should be given to innovation in the areas of program structure and program delivery both to make the programs attractive to candidates and to increase educational effectiveness. Up to this point we have considered the following:

- Instead of the classic half and full-course framework, structure material in modules that can be taught in a one to three hour session, and offer the program as a concatenation of a large number of these modules (we will call them "micro-courses").

  This allows a more creative structuring of material by breaking out of course "silos" and suits a "challenge-oriented" framework (see below) for presenting material. It also requires the development of course materials at a much more detailed level than the typical course, allows the dynamic reorganization of material, suits the material to presentation by multiple teachers, and facilitates presentation via distance education modalities.

- Offer a high percentage of the micro-courses via audio teleconference, videotape/DVD-augmented audio conference, videotape/DVD and paper self-study, or web-based (real-time web TV or asynchronous) techniques.

  The videotape/DVD and paper self-study, and the asynchronous web-based techniques enable a highly asynchronous educational experience. All of the techniques allow students to participate remotely.

- Provide an examine-out option for virtually all micro-courses. This will allow each student to adapt participation in the program to his/her actual needs.

- Even for micro-courses offered initially in real-time in on-campus settings, audio and video-record the material so that those who were unable to attend can access the material.

- Use case studies as a key component of the educational experience, presenting real-world challenges to which students must formulate efficient and effective responses.

- Make the entire program challenge-oriented (i.e., lead with the problem as context), introducing all material in response to well-defined common challenges faced by health IT professionals (see attached article in Appendix 1).

- Develop relationships with several local health organizations, inviting them to submit issues of local importance as stimulants for projects or theses.

- Develop highly structured research projects that can be introduced and carried out with little or no residency required.

- Provide software that can be installed on the student's own system to enable remote on-line participation (e.g., document conferencing software).

These and other ideas should be tabled and considered by the Task Force and by the Advisory Board.

Questions and Issues Raised To-Date Regarding HI Programs

The following have been paraphrased and presented for consistency as questions. They were raised in responses to the e-mail survey of interested parties. Many of the points raised have been addressed in this document:

1. Should the program be a co-op program?

2. Should the program be distinguished by the cutting edge intellectual and computing resources at UW (i.e., be focussed in narrow areas of UW excellence)?

3. Should the program be started as an on-campus program, and only later move to distance education?

4. Should the program be started as a "specialty" for existing UW students, and later seek the development of a full program?

5. Should an HI program have areas of specialization corresponding to the strengths of existing UW programs (such as Gerontology and Life Style, in the Faculty of Applied Health Sciences; or Software Engineering and Distributed Systems, in Computer Science)?

6. Should the program build on or emulate existing multi-disciplinary programs such as the joint Biostatistics-Computer Science or the Bioinformatics programs?

7. Should the offering of a graduate degree program precede the diploma program because of the need for faculty?

8. Should there be two programs or just one?

9. Can the degree and diploma programs be considered separately, without one depending on the other?

10. Does the diploma program (and probably also the degree program) depend on faculty with domain work experience as well as expected superior academic qualifications?

11. Do the challenges of developing distance education offerings require us to begin with an on-campus program, and then gradually move to development of distance education components?

The Next Steps Related to Developing a Graduate HI Program

In order to move beyond the concept phase, the following steps are proposed (these will likely be refined as the project proceeds):

Phase 1: Secure the Interest and Involvement of Potential Intramural Partners:

We believe that Applied Health Sciences and/or the UWO (or other) Faculty of Medicine are essential strategic partners if UW's CS Department is to successfully mount this program. It may be that other departments would have interest and bring additional strength:

- Optometry
- Statistics
- Systems Design Engineering
- Several departments of the Faculty of Sciences
- Other schools of Nursing and Allied Health

To introduce these ideas to potential partners, to determine their interest, and to secure their involvement, the following steps are proposed.

Step 1: Establish a Computer Science Department Task Force on graduate Health Informatics consisting of interested CS faculty.

Step 2: Have representatives of the Task Force meet with the Dean and others to identify potentially interested departments, groups, and individuals. Consider offering involvement to extramural parties.

Step 3: Arrange a meeting of the Task Force with potentially interested parties, and present the core ideas using this document as a point of departure. Seek formal responses to the document.

Step 4: Establish an "Industry Advisory Board" comprising representatives of health organizations, private industry, and health disciplines (e.g., nurses, physicians, allied providers) with an interest in fostering the production of competent IT professionals. The primary purpose of this body is to act as a sounding board for program proposals.

Step 5: Invite interested parties (Task Force members, potentially interested parties from other departments, and Board members) to a Multi-disciplinary Think-tank on Health Informatics that tables this document and other submissions for discussion. As part of this think-tank:

- Present the perceived need for a graduate program.
- Review the characteristics of existing programs.
- Outline the CS Department's conceptualization of a graduate program.
- Seek participant reactions and discuss potential alternatives.
- Determine if a consensus exists on the nature of a multi-disciplinary graduate program.
- If so, characterize the goals and objectives of the program.
- Define consensus criteria or rules that the program must satisfy.
- Request statements of interest and commitment from participants and their departments.

Step 6: Reconstitute the CS Department Task Force as a Multi-disciplinary Task Force on Health Informatics consisting of representatives of interested departments.

Step 7: Charge this Multi-disciplinary Task Force with developing a document that fleshes out a consensus program or programs, including:

- A vision of the graduate program.

- A set of program goals and objectives.
- A description of the nature of the graduates produced.
- An analysis of the likely number and type of interested candidates.
- The impacts of any competing offerings.
- A broad outline of the core curriculum.
- Alternative modalities for delivering the program (e.g., on site lectures, distance education, self-directed learning, etc.).
- A rough timeline for implementation.
- A statement of the resources required (including extra-mural participation).
- A list of issues requiring resolution.

Step 8: Present this expanded document for review and comment by the industry Advisory Board. Review feedback via the Task Force and finalize the document.

Step 9: Present this document to the Dean(s) for approval in principle and for feedback regarding the requirements that a full proposal must satisfy.

Step 10: Charge the Multi-disciplinary Task Force with the development of a final proposal, addressing:

- The requirements and issues raised by the Dean(s).
- The principles that must guide curriculum development.
- The completion of any of the above sections.
- A detailed curriculum along with education modality (e.g., what is to be taught via didactic, self-directed, etc. methods). This should include:
  - The required body of knowledge and skills.
  - Course structure.
  - Outline of the learning objectives and content of each course.
  - Definition of general and specialization tracks by type of student (e.g., student with or without health system background).
  - Thesis/project and other requirements to fill out comprehensive educational experience.

Step 11: Seek academic approvals.

Phase 2: Secure the Interest and Involvement of Potential Extra-mural Partners

It will likely be necessary to go beyond the University of Waterloo and to develop adjunct relationships with faculty interested in Health Informatics at other universities, for example, the Health Sciences Faculty at McMaster University.

Step 12: Identify potential collaborators in region and elsewhere (individuals, groups, universities, institutions, companies).

Step 13: Approach potential collaborators on a one-on-one basis.

Step 14: Provide documentation of the program concept and plan to potential collaborators.

Step 15: Request a statement of interest from respondents.

Step 16: Convene an HI Program Workshop at the University of Waterloo.

- To review nature, differentiation, objectives, etc. of the UW HI program.
- To have topical workshops among intramural and extramural collaborators (individuals interested in like areas, e.g., decision support, AI, DBMS/CIS, software engineering).

- To develop detailed statements of collaboration/contribution.
- To discuss methods of interaction (physical meetings, internet/teleconferenced sessions, etc.)
- To discuss potential areas of focus and research.

Step 17: Reconstitute the Multi-disciplinary Task Force to include extramural representatives. Charge this Task Force with resourcing and overseeing the development of the full graduate Health Informatics Curriculum within the goals, objectives, and principles previously defined.

The Applied Health Informatics Diploma Program

The Applied Health Informatics Diploma Program

Description

The Applied Health Informatics diploma program is conceived to be post-professional training program to prepare individuals to address the day-to-day challenges that arise in providing IT leadership and support within health organizations. The AHIPC program is designed for employed professionals and will award a Diploma in Applied Health Informatics. No academic degree or diploma is required of candidates, although such would be an advantage. All essential HI-related knowledge and skills are taught within the program. Students with at least a basic knowledge of computing will find themselves at an advantage.

Existing Certificate/Diploma Programs

Relatively few examples exist of competing programs, although a number appear to be in the planning stages. In the U.S., the University of Illinois (W. Panko) offers a distance-based Applied HI certificate program. Initial discussions with Panko indicate that he is strongly interested in collaborating with other academic institutions with an interest in developing such a program. Panko has offered to share course materials and particularly desires a Canadian collaborator in order to gain access to EU materials. Panko's program uses asynchronous learning techniques and is based on the Internet.

Indications exist that BCIT is in the early stages of developing a diploma program, that York University is initiating a program within the School of Business, and that other universities and community colleges are considering offerings as well.

Currently, no distance education-based diploma programs exist in Canada.

Some Key Characteristics of an Applied HI Diploma Program

The following as some of the key characteristics of the diploma program:

- The candidate may or may not have a previous academic degree.
- Students wishing to specialize in AHI will come into the program with one of three types of background:
    - An healthcare-only background: individuals who have trained in healthcare disciplines, e.g., physicians, nurses, allied professionals, technologists, health administrators, etc.
    - An IT background: individuals with previous education, training, and or substantial experience in information technology (e.g., partial or complete University, Community College, or Professional Program backgrounds in areas such as Computer Science, Information Science or the like.)
    - Both an healthcare and IT background: individuals who have acquired a reasonable level of competence in both areas.
- Students will desire entry to one of two "streams":
    - The Management Stream: that will prepare individuals to manage IS departments and groups, and to perform roles such as CIO, Director, Manager, and Project Leader.
    - The Technical Stream: that will prepare individuals to undertake systems development projects and to perform roles such as AHI Programmer, AHI Software Development Team Leader, and

other technical roles. Individuals who elect the technical stream are required to either have an undergraduate degree in Computer Science from a recognized program, to acquire such a degree, or to augment the management courses with the "Education program for Software Professionals" (EPSP) or the "Education Program for Network Professionals" (EPNP), according to their specific interests.

- The candidate will be employed full-time and unable to be resident (except for short stays) at the University of Waterloo.
- The candidate will have as a primary objective the acquisition of practical knowledge and skills that directly address the day-to-day challenges of his/her job.
- The candidate will likely pay personally for the program, may receive a subsidy, and will get some time off for continuing education.
- The program will be unique and attractive, having the look-and-feel of commercial professional education programs.
- A diploma will be sufficient formal evidence of successful completion of the program.
- The program will be recognized by professional associations (e.g., CIPS) as sufficient for or highly contributory to the awarding of their professional designations (e.g., the ISP), given experience requirements are satisfied.
- The candidate will generally be mature, and have previous training and experience.
- The program can be entirely offered via distance education techniques, although some Waterloo-based classes may be included, particularly during course development.
- Some on-campus attendance may be required for the research project.
- The price of the program will be in the range typical of professional education programs, but tractable by the individual (institutional subsidies are rarely available to health system employees).
- A certificate of completion will be awarded to students who successfully complete each course, with a Diploma awarded on completeion of all required courses.

The Content of the Applied Health Informatics Diploma Program

The Applied Health Informatics diploma program would initially use adjunct faculty with expertise in Health Informatics, but would later incorporate Computer Science and Applied Health Sciences faculty and potentially one or more contract Health Informatics professionals. The expectation would be that this program would be largely distance education-based, and result in a Diploma in Applied Health Informatics.

The following are initial proposals regarding required courses:

A. For students with a computing background (e.g., the typical introductory Computer Science courses, a Community College Computing Diploma, CS degree, or substantial practical experience in programming and general systems use), and adequate knowledge of the health system.

B. For students with a computing background (e.g., the typical introductory Computer Science courses, a Community College Computing Diploma, or substantial practical experience in programming and general systems use), with little or no knowledge of the health system.

C. For students with only basic "computer literacy" and general use of personal systems, but with a thorough knowledge of the health system:

D. For students without a computing background of any kind, but with a thorough knowledge of the health system.

AHI Management Stream:

All Management Stream AHIPC (A, B, C, D) students would be required to successfully complete the following courses:

1. Introduction to Health Informatics: Perceiving the Big Picture (15 Hours)

Example Content: Definition of Health Informatics and the role of the Health Informatician, understanding the challenges of HI, the tools for the Health Informatician, the HI body of knowledge and body of skills, overview of the major applications of IT in support of health, setting personal competence goals, the need for and characteristics of "broad-spectrum IT professionals", research and self-study methods, access to the literature and essential reading, key memberships, continuing education, maintenance of competence.

2. Principles of Health Information and Information Management (15 Hours)

Example Content: The nature and types of health information, the health data model, health terminology and classification systems, data standards for interoperability, the nature, measurability, accuracy and completeness of medical data, time-orientation of medical data, etc.

3. Basic Methodologies (15 Hours)

Example Content: Structured thinking techniques, group techniques for program planning and decision-making (e.g., nominal group and consensus mapping techniques), structured problem-solving techniques, experimental method, differential diagnosis, structured breakdown techniques, stakeholder analysis, decision analysis, business planning methods, basic financial methods (budgeting, costing, cost-benefit analysis).

4. Advanced Methodologies (15 Hours)

Example Content: Needs determination methods, requirements definition methods, procurement techniques, basic negotiation techniques, system review and audit methods, knowledge acquisition techniques, quantitative and qualitative evaluation methods, financial analysis methods, human resources and systems management methods, project management, authoring techniques, presentation techniques.

5. Introduction to Health Operations Support Systems (15 Hours)

Example Content: The nature of operations support and management in various health settings, staff roles and functions, principles of work process re-engineering and the role of IT, finance and business systems, human resources information system, purchasing, receiving, and supplies management systems, house-keeping management system, admitting-discharge-transfer system, patient and resource scheduling systems, environmental systems.

6. Introduction to Clinical Decision-Making and Decision Support (15 Hours)

Example Content: The nature of the clinical process and the roles of providers, clinical taxonomies, the diagnostic process, clinical decision-making, the selection of therapeutic interventions and patient care management, the management of the therapeutic process, the role, function, and use of the patient record, methods and systems to support clinical decision-making, the clinical data repository, the computer-based patient record.

7. Introduction to Clinical Systems (15 Hours)

Example Content: Chart tracking and management systems, patient and care classification systems, departmental reporting systems (Diagnostic Imaging, Laboratory, Pharmacy, Cardio-Pulmonary, etc.), ambulatory care, surgery, emergency patient information systems, provider office-based records systems, the clinical data repository, near-patient documentation systems, the basics of the computer-based patient record in various settings (Family Practice, Acute Care, Long-term Care).

8. Introduction to Multimedia Health Systems and Communications (15 Hours)

Example Content: Health communications: types and purposes, technologies and media; principles of signal and image processing; sources and capture systems for signals and images; signal and image communication, presentation, and utilization; PACS; telemedicine; computer support for health communications; workflow (groupware) support in health environments; automated interpretation of signals and images; CHINs and WANs; the institutional LAN; the future of multimedia health communications.

9. Research Support Systems (15 Hours)

Example Content: computer support for laboratory data acquisition and processing, clinical trial management systems, population and disease registries, modeling and simulation, mathematical and statistical analysis systems, knowledge access systems, research data warehouses.

10. Project (15 Hours)

Example Content: All students will be expected to successfully complete a project in the student's area of interest.

In addition, all Management Stream AHIPC students *without* a thorough knowledge of the health system, but *with* an adequate computing background (type B students) would also be required to successfully complete:

11. An Overview of the Health System for Non-Health Professionals (30 Hours)

Example Content: The structure and components of today's health system, health system governance and funding, healthcare delivery institution (hospital, ambulatory care, long-term care, etc.) organization and departmental function, healthcare provider types and roles, major health system issues, patients and patient rights, integrated delivery system components and concepts, major health system restructuring and re-engineering initiatives, health policy, the regulatory environment of health (Canada and U.S.).

All Management Stream AHIPC *without* at least basic knowledge and/or substantial experience in computing (type C and D students) would also be required to successfully complete:

12. Principles of Computer Science for non-Computer Science Professionals (30 Hours)

Example Content: This course could be addressed by an existing introductory or survey course, or be constituted specially. Content could include key concepts related to the theory of computing, programming, software engineering, programming languages, operating systems, file and database management, artificial intelligence, graphics and human-computer interactions, etc. The objective

would be to give the student a basic knowledge base that would be useful in planning and decision-making, rather than a set of applicable tools and skills.

13. Recommended Pre-AHIPC Preparation

Type C and D students would be wise to attend an introductory course in Computer Science, as well as training programs in the use of systems for personal productivity, or the equivalent prior to starting the program.

The total hours associated with the Management Stream program will be:

Type A Students:	150 Hours
Type B Students:	180 Hours
Type C+D Students:	180 Hours plus pre-AHIPC preparation.

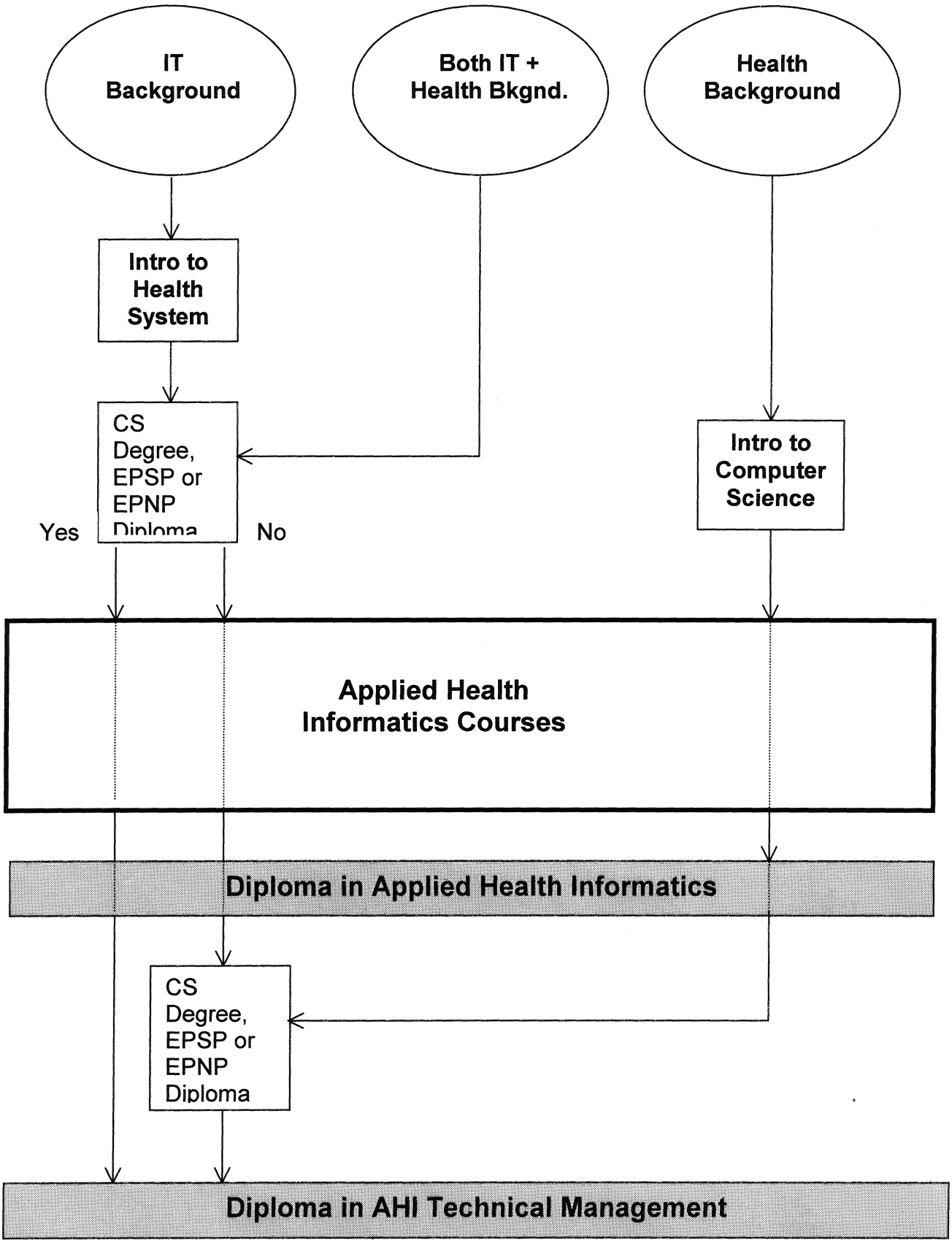
AHI Technical Stream:

- All Technical Stream AHIPC (A, B, C, D) students are required to successfully complete the management stream courses appropriate for their backgrounds (see above).
- In addition, Technical Stream AHIPC students must complete: an undergraduate degree program in Computer Science, or the Education Program for Software professionals (EPSP), or the Education Program for Network Professionals (EPNP), or show competence by examining out of any of these.

The EPSP program or the EPNP program adds approximately 140 additional hours to the total time shown above.

Administration

The AHI program will be implemented as an addition to the Education Programs for Software Professionals and for Network Professionals at the University of Waterloo.


IT Background
Both IT + Health Bkgnd.
Health Background
Intro to Health System
CS Degree, EPSP or EPNP Diploma
Yes
No
Intro to Computer Science
Applied Health Informatics Courses
Diploma in Applied Health Informatics
CS Degree, EPSP or EPNP Diploma
Diploma in AHI Technical Management

The Next Steps Regarding the Diploma Program

Step 1: Convene a group of faculty interested in professional education.

Step 2: Develop a full description of a diploma program, including:

- A vision of the diploma program.
- A set of program goals and objectives.
- A list of potential faculty.
- A description of the nature of the certificants produced.
- An analysis of the likely number and type of interested candidates.
- The impacts of any competing offerings (presently none appear to exist).
- A broad outline of the curriculum.
- Alternative modalities for delivering the program (e.g., on site lectures, distance education, self-directed learning, etc.).
- A rough timeline for implementation.
- A statement of the resources required (including extra-mural participation).
- Proposed pricing.
- An initial estimate of costs and potential revenue
- A list of issues requiring resolution.

Step 3: Obtain approval in principle.

Step 4: Develop detailed curriculum plan and summaries of proposed courses, including:

- A characterization of the knowledge and skills that would be acquired by the certificant.
- A definition of the course structure.
- A statement of learning objectives and content for each course.
- Definition of general and specialization tracks by type of student (e.g., student with or without health system background).
- A description of the project and other requirements that must be fulfilled to complete the educational experience.

Step 5: Develop a detailed business plan with all costs, estimates of revenue, etc.

Step 6: Obtain approval for the program.

Step 7: Launch the program.

APPENDIX 1: RELATED ARTICLE

The article that follows is to be presented at the American Medical Informatics Conference in November 1999. We have also organized a full-day workshop on the same topic that should generate material of interest to the Task force.

The Need for a Skills-Focussed Applied Healthcare Informatics Curriculum

H. Dominic Covvey, B.A., M.Sc., I.S.P., Health/IT Advisors, Vancouver BC and the University of Waterloo, Waterloo, Ontario, Canada, and Janice E. MacNeill, B.Sc., H.H. Angus and Associates, Toronto, Ontario, Canada.

ABSTRACT

Experience with Information Systems (IS) staff, interactions with healthcare senior management, and discussions with faculty and students have led us to the conclusions that few healthcare organizations have conceptualized and articulated an optimal organizational role for IS (particularly for IS leadership).

In this paper we will describe the multi-polar, often conflicting "expectations" faced by many of today's healthcare IS departments, and define a set of useful and sustainable institutional model roles for IS. Then, we will formulate the set of challenges which IS professionals in these roles must be prepared to address. We will use this to propose a challenge-oriented, skills-based, methodology-focussed curriculum in Applied Healthcare Informatics, and delivery mechanisms that suit potential candidates.

MAJOR HEALTHCARE INFORMATION TECHNOLOGY DEPLOYMENT MODELS

Although each healthcare organization has an idiosyncratic belief system regarding the optimal role of Information Services, for our purposes here we define three major IT deployment models:

- As-Is Technology Deployers: this type of institution demands proven, commercial off-the-shelf (COTS) solutions, avoids the risks inherent in being on the leading edge technologically, and focuses its creativity on implementing and gaining value from systems. These organizations require IT professionals with strengths in areas like needs analysis, requirements definition, best solution selection, procurement, implementation, negotiation, etc. Lack of deep theoretical informatics and systems development knowledge has not been and will not generally be a professional disability.

- Innovators: these institutions are "early adopters" (beta sites) of systems, or even go so far as to develop systems in-house or to highly customize commercially-available systems. They are risk takers, and their focus is to have systems available for use that are functionally ideal and technically modern and sophisticated (e.g., interoperable, object model based, etc.). Clearly, organizations of this type require IT professionals that are steeped in technology and informatics theory, and competent in software engineering. We will define 2 types of Innovators: True Innovators that develop new solutions, and Limited Innovators that adopt "bleeding edge" solutions.

- Hybrids: some institutions have a mixed approach, allowing some degree of technical innovation, but limiting this by carefully selecting applications or tightly bounding project budgets. Their need for knowledge and skills will depend on the mix.

While it is true that many organizations will be hybrids, as a modicum of innovative excursion will be commonplace, most healthcare organizations today are either As-Is Technology Deployers, As-Is Technology Deployer-dominant hybrids, or Limited Innovators that are merely early adopters of COTS offerings. The reason for this is that many organizations have decided that their line-of-business is healthcare, not IT, and they have avoided or quit the innovation game.

Given the above, most healthcare organizations need IT professionals with the knowledge and skills that will support the usage portion of the life cycle of COTS technology, with far less demand for deep informatics and system development capabilities.

HEALTHCARE SYSTEM EXPECTATIONS ON IT PROFESSIONALS (SEVEN HATS)

Few Healthcare organizations formally conceptualize and effectively articulate the role that they expect their IS department in general and their IS leadership in particular to play. However, experience shows that the following are common, but often unstated, expectations of IS leadership (we can think of these as different hats that IS leadership is expected to wear):

- That IS act as an Industry Seer and Innovator: Tell us where the industry is going, and/or will go, and what we should do to take advantage of this. Organizations with this expectation are usually technology risk takers. Their objective is the maximization of what they perceive to be their unique, optimal, or special approach to healthcare, and they see COTS technology as commodity technology that will not allow them to realize the fullness of their healthcare vision. Early adoption and/or systems development is commonplace in these environments, and IT decision-making is often driven by technology visionaries.

- That IS serve as an Organizational Enabler: IS must understand what we are/want to be as an organization, and must tell us how it can enable that. Typically the organizational strategic plan drives IT requirements.

- That IS be a User-Driven Responder: In its most extreme form, IS is a Wish-List Realizer. IS's role is to find out what everybody wants and do as much of that as IS, with the support of the users, can get the budget committee to fund. In such situations, getting technology dollars often depends on getting provider support, as IT competes directly with other provider requests.

- That IS be a Technology Penny Pincher: IS is charged to operate within a specific budget, while responding to either the strategic plan or user requests, triaging those requests as required.

- That IS act as a Cost Recoverer: IS has the responsibility for implementing systems to improve productivity or reduce costs. Systems are funded if and only if they are cost-benefit justified. The introduction of IT is dependent on departments' willingness to be re-engineered.

- That IS be a Market Packager: IS is to use IT to distinguish us from our competition.

- That IS be an Informatics Theoretician (mostly academic medical centers with Medical Informatics programs): IS is expected to spawn innovative ideas, theories, or approaches in the field of healthcare informatics.

Often IT professionals have to wear more than one of these hats on at once. Although some combinations are compatible, others are not, as they may compete or generate conflict (e.g., the User-Driven Responder and the Technology Penny Pincher roles).

PRODUCTIVE IT PROFESSIONAL ROLES (SEVEN HATS THAT FIT TOGETHER)

If we, as a profession, are to educate organizational management as to what the viable roles are that IT professionals should play, rather than just tolerating confused, competing, or non-productive roles, what is a reasonable set of roles? The following are proposed as roles that are compatible and productive within the organization and worthy of fulfillment:

- Technology, Industry, and Applications Comprehender and Interpreter: Introduce the organization to proven technology solutions, articulating the contributions such solutions can make in support of organizational objectives. Also reveal how technologies could enable new services, better processes, and/or new delivery mechanisms.

- Management and User Educator and Mobilizer: Introduce IT as a strategic and tactical tool to management, support staff, and healthcare providers. Fully comprehend stakeholders' needs for support of the healthcare process, and assist them in translating these into appropriate technology requirements. Obtain buy-in and acceptance. Work with staff to develop the business case for systems and to assign them appropriate budgetary priority.

- Solution Finder, Evaluator, and Procurer: Find solutions to organizational requirements, evaluate their congruence with requirements and constraints, determine the best fit, and assure their fair and successful acquisition.

- Solution Planner, Implementer, and Impacts Evaluator: Plan (including costs and benefits) and prepare for, deploy, and determine the acceptance and success of systems. Co-operate with and facilitate the re-engineering of healthcare processes and products that take advantage of the IT infrastructure.

- IT Resources Manager: Ensure that the information, the technology and the human resources are applied in a way that supports the delivery of desired impacts within organizational constraints (e.g., budget, schedule, quality standards, regulations, etc.).

- System Developer/Development Manager (within Innovator or Hybrid organization): Execute and manage the systems development life-cycle in accordance with best practices of, for example, software engineering, facilitating the creation of systems capabilities that are not addressable by COTS technology.

- (For selected situations only) Informatics Theoretician: create innovative new ideas, theories, or approaches in healthcare informatics.

FILLING THE ROLE

For the purposes of this article, we define Theoretical Healthcare Informaticians to be the conceivers, inventors, developers, and generators of innovative healthcare information and IT concepts, methods, and applications. We define Applied Healthcare Informaticians (AHIs) to be problem-solvers and solution deployers, the finders and implementers of healthcare IT solutions. Based on the assertion that most healthcare organizations are not True Innovators, it follows that most require Applied, rather than Theoretical, Healthcare Informaticians.

Both types of Informatician, but especially the Applied Healthcare Informaticians, are confronted by a large set of challenges (see Table 1: Example Healthcare IT Challenges) within the scope of their jobs.

TABLE 1: EXAMPLE HEALTHCARE IT CHALLENGES

Although the number of challenges that will be faced by an AHI over his/her career is large, there is a finite set of challenge types or "IT proto-challenges" (basic, recurring, non-reducible problems that require effective responses from IT professionals). The following should be considered only as examples from the complete set[1]; the emphasis here is on the non-theory areas:

Informatics Solution Deployment:
Business and Problem Comprehension and Analysis
Problem Valuation and Prioritization
Team Facilitation and Consensus Building
Process Design and Re-engineering
Needs/Requirements Definition/Specification: Hardware, Software, Staff and Processes
Solution Identification and Characterization
Solution Comparison, Evaluation, and Selection
Preparation and Negotiation of Contracts
Procurement
Supplier Selection, Management, and Relations
Costing and Cost Analysis
Implementation

Informatics Management:
Leadership
Strategy and Planning: Strategic and Tactical Business Planning, Strategic and Tactical Resources Planning, System Implementation Planning
Policy and Procedure Development and Application
Quality Management
Resources Definition, Allocation, and Organization
Resources Management: Staff/Team Management, Team Leadership, Project and Program (Multi-Project) Management, Staff Guidance and Development, Technology Management, System Capacity and Performance Management, Systems Operation Management, Service Delivery and Support Management, Asset Management
Systems Development/Customization Management
Financial Management
Supplier Management and Relations
Recruitment, Retention, and Termination
Progress Assessment and Outcomes Evaluation: Projects: Process Assessment, User Satisfaction, Benefits/Impacts Assessment; Systems: Systems Performance Assessment, System Audit; Staff: Staff Performance Evaluation

Personal Skills and Development:
Knowledge Research and Currency Maintenance: Knowledge Searching, Continuing Education methods
Professional Writing: Proposals, Business Plans, Documentation
Public Presentation

Staff/Management Education and Training
Time Management and Personal Organization
Productivity Tools Proficiency

Theory and Basics (Cursory overview, included for completeness only):
Mathematical Problem-Solving
Computing and Information Design, Problem-Solving, and Decision-Making
(e.g. in areas like: Structure and Theory of Information, General Computing, File Management and Database Systems, Programming and Software Engineering, Operating Systems and Languages, Artificial Intelligence and Knowledge-Based Systems, Human-Computer Interaction, Graphics and Image Processing, Communications and Integration, Security, etc.)
Healthcare Information Systems Selection, Application, and Decision-Making
(e.g., in areas like: HIS and Clinical IS, ACIS and Office Systems, Clinical Decision-Making and Decision-Support Systems, Medical Imaging, etc.)
Healthcare System Understanding and Re-engineering
(e.g., in areas like: Integrated Delivery Systems, Healthcare Funding, etc.)

It is important to note that most of the listed challenges (excepting the Theory and Basics Domain) can be characterized as challenges that require thinking skills, structured methods, and formal processes, all of which we will subsume under the term "Intellectual and Procedural Skills".

It is not our intention here to de-emphasize the importance of the Theory and Basics, which are essential for the building of a personal knowledge base. However, the dominant role of AHI is the application of this knowledge. The skills that enable application of the knowledge are at least as important as the knowledge itself. Without these skills, an Healthcare Informatician would be akin to a person with comprehensive physiological, biochemical, and anatomical knowledge, but lacking clinical and differential diagnosis skills. Such an individual would hardly be considered a physician.

TOOLS TO ADDRESS THE CHALLENGES

If we examine the AHIs face, and determine what is required to address these challenges, we come to the conclusion that methodological skills as well as domain knowledge (e.g., an understanding of healthcare processes, Computer Science and informatics concepts, principles and tools, heuristics, systems instances, etc.) are required. If we then articulate the set of methodological skills (see Table 2: Intellectual and Procedural Skills) required to address all of the challenges, it is clear that this set is reasonably circumscribed. In passing, it should be noted that the potential domain knowledge required is open-ended, and generalist Healthcare Informaticians face an ever-growing, ever-changing body of domain knowledge. Interestingly, this itself is a challenge whose redress requires a methodological solution.

TABLE 2: EXAMPLE INTELLECTUAL AND PROCEDURAL SKILLS

Thinking Methods:
Thinking Techniques[2]: CoRT Tools, Six Thinking Hats, etc.
Group Thinking Techniques: Nominal Group Technique, Consensus Mapping Techniques, Delphi Method
Memory Enhancement Techniques

General Procedural Methods:
Scientific/Experimental Method: Experiment Design, Clinical Trial Design, Survey Design, Change of Attention Techniques
Differential Diagnosis
Successive Refinement/Structured Breakdown Techniques
Decision Analytic Techniques
Stakeholder Analysis
Group Structuring and Management Techniques

Specialized Procedural Methods:
Business Planning Methods
Financial Methods
Management Methods
Personal/Time Management Techniques
Literature/Knowledge Search Techniques
Needs Determination Methods
Requirements Engineering Methods
Procurement Techniques
Negotiation Techniques
Educational Techniques
Software Engineering Methods
System Testing Methods
System Audit Methods
Structured Authoring Techniques
Presentation Techniques
Interpersonal Communications and Public Relations
Study and Currency Maintenance Techniques

Problem-Solving Techniques:
Problem Understanding, Characterization, and Refinement
Prioritization and Weighting Methods
Solution Characterization and Comparison
Decision-Making Techniques
Significance Determination Techniques (e.g., statistical)

Evaluation Methods:
Quantitative Evaluation Methods: Return on Investment Analysis, Cost-Benefit Analysis

Despite the dynamic nature of the required knowledge base, Healthcare Informaticians must absorb a significant body of domain (healthcare, Computer Science, systems instance, etc.) knowledge. These domain knowledge elements are the conceptual objects (the components of the professional's elaborated knowledge[3] base; by "elaborated knowledge", we mean a conceptual network of knowledge elements wherein each element is linked to related elements) required to support reasoning about problems and solutions. This domain knowledge must be the deepest and most comprehensive to support the Innovator and Theoretician roles.

However, proficiency in the set of intellectual and procedural skills is essential if AHI is to be able to apply the domain knowledge at all. No AHI can survive and succeed without the ability to fully comprehend a challenge and to engage it efficiently and decisively.

Despite the needs of healthcare organizations for personnel with the both the skills and the knowledge, most Healthcare Informatics curricula focus on the domain knowledge component. This is especially true of those programs oriented to producing Theoretical Healthcare Informaticians.

Few, if any, courses, and no curricula, to our knowledge, emphasize and formally teach the complete set of intellectual and procedural skills that are infrastructural to the effective use of domain knowledge. Those aspiring to this field are either expected to have picked up many of these skills along the way prior to entering the program, are expected to self-learn them as a sideline, or are introduced to them in passing. Few programs have formal educational modules that teach all of these skills and that evaluate the student's proficiency in applying them. Finally, regardless of the attempts of the programs themselves, our experience is that few students leave the programs proficient in these skills.

MOTIVATION FOR A METHODOLOGY-FOCUSSED AHI CURRICULUM

We start from the premise that informatics-based solutions are essential to our healthcare system if it is to survive and thrive.

We have come to the conclusion that AHIs are the dominant type of IT professionals needed by healthcare organizations, as they are the finders and deployers of informatics-based solutions.

AHIs are, by their very nature, appliers, akin to practicing physicians, whose primary measure of success is the production of quality deliverables as perceived by healthcare system "needers". The AHI is driven by the needs of the healthcare environment. Similar to physicians, AHIs must be able to understand the problem and the need for solutions, consider alternate solutions and determine the optimal solution, and deliver the solution that addresses the need. We contrast this with Theoretical Healthcare Informaticians, who are fundamentally scientists, conceivers of new knowledge and creators of new tools, often driven by their own interests.

Healthcare needs effective solutions to the challenges it faces. Realizing these solutions requires understanding of the healthcare environment, knowledge of the capabilities and the limitations of technology, knowledge of a valid universe of relevant solutions, and processes for finding, selecting, acquiring, deploying, maintaining, and managing the optimal solution. The deployment of solutions is dependent on IT professionals with the requisite domain knowledge, but does not rest solely on that. The intellectual and procedural skills required to apply the knowledge are also critical qualifications.

Reviewing medical and healthcare informatics programs reveals that most target the development of Theoretical Healthcare Informaticians [4, 5, 6, 7]. These programs also appear to focus on the domain knowledge component.

We believe that, given the needs of healthcare, the emphasis of existing educational programs on producing Theoretical Healthcare Informaticians is misdirected. At the very least, greater emphasis should be put on the preparation of Healthcare Informaticians that are qualified to address the day-to-day challenges of the healthcare IT environment, i.e., that are steeped in the requisite intellectual and procedural skills of the deployment phase of the system life-cycle.

We have concluded that, ideally, new or modified curricula should be developed that address the need for these skills and that produce qualified AHIs.

DELIVERY MECHANISMS

The purpose of this article is not to promote a course or curriculum focussed strictly on the teaching of intellectual and procedural skills. It is however to incorporate them as an explicit infrastructural component in a curriculum suited to the production of AHIs.

We offer the following:

- Although many curricula introduce these skills, few do so formally and with the same level of emphasis and definitive presentation applied to theory and factual knowledge. These skills must actually be taught, and they must be exercised if the student is to become proficient with them. Getting them across is a teaching responsibility, not solely a student learning responsibility.

- To recognize their value and emphasize their importance, they should be named, distinct, and formal components that are woven into the fabric of the curriculum.

- Some, if not most, should be early requisites, as they are needed in the domain knowledge components of any curriculum.

- They are likely best introduced in the form of short, intense, and well-structured vignettes.

- They would probably ideally take the form of microcourses (modules of 1-3 hours) that are introduced via cases.

- Students should be formally evaluated on their understanding of each skill (the "theory" on which it is based or the rationale for it), and on their ability to apply it.

- If proper materials are developed, understanding these skills may be highly tractable to self-directed, multimedia education (via CD, video, or web-based means).

- It may be that an innovative re-orientation of an existing curriculum in Applied Healthcare Informatics could be accomplished by emphasizing these skills and employing a challenge-oriented approach to the teaching of all domain knowledge modules. This would be analogous to innovative medical curricula that introduce patient problems and teach systems subsidiary to these problems, rather than teaching on a system-by-system basis.

GRADUATE PRODUCT

The product we seek here is what we have called an Applied Healthcare Informatician. We believe that an educational program that imparts the intellectual and procedural skills, together with the informatics theory and practice knowledge classically taught within such programs, will address more closely and completely the needs of most healthcare organizations. We, as others, see the Healthcare Informatician as needing to be healthcare, computer science, and applications-knowledgeable. However, we believe that today's healthcare system demands superior methodological strength and problem-solving abilities from its informatics professionals.

One of us (HDC) thanks Dr. Paul Fisher of the School of Health Information Science for the opportunity he gave the author to experiment with some of the ideas expressed herein.

References

1. Canadian Information Processing Society. European Informatics Skills Structure. 1992.

2. de Bono E. Teaching Thinking. Penguin Books, 1976.

3. Bordage G. Elaborated Knowledge: A Key to Successful Diagnostic Thinking. Academic Medicine, Vol. 29, No. 11, November 1994: 883-885.

4. Braude RM. A Descriptive Analysis of NLM Funded Medical Informatics Training Programs and the Career Choice of Their Graduates. Symposium on Computer Applications in Medical Care, 1990: 504-508.

5. Glaser JP, Edgar J. Survey of Educational Programs in Medical Information Science. SIGBIO Newsletter, Vol. 8, No. 4, December 1986: 19-36.

6. Glaser JP. Survey of Graduate Programs in Medical Information Science. SIGBIO Newsletter, Vol. 9, No. 1, March 1987: 8-56.

7. Fright G. World Wide Web Survey of Medical Informatics Programs. Personal Communication January 1998.

APPENDIX 2: CAPSULE SUMMARY OF THE UVIC HINF PROGRAM

The attached summary was provided by the University of Victoria School of Health Information Science.

School of Health Information Science
University of Victoria

CAPSULE SUMMARY

HISTORY

In the late seventies, Dr. William Gibson, then Chairman of the Universities Council of British Columbia, envisaged a need for a new type of professional who had the knowledge and skills to effectively introduce information technology into Canada's health care system. His vision came to fruition in 1981 when the University of Victoria inaugurated a new four-year Bachelor of Science degree program in Health Information Science. The new program was added to the University's Faculty of Human and Social Development consisting of the Schools of Child and Youth Care, Nursing, Public Administration and Social Work. **The program was then and remains unique in Canada.**

In the fall of 1982 the initial curriculum was initiated and the first classes taught. The curriculum was based on international consultations and two different model curriculums prepared by the Association for Computing Machinery. In September 1983, the inaugural class of 15 students was admitted into the School. The May 1986 convocation saw the first group of Health Information Science students receive their degrees. In 1987, the Health Information Science program was granted "School" status. At the November 1992 convocation, the School was honoured when Dr. Roger Côté of the University of Sherbrooke was granted an honourary Doctor of Science degree by the University. In November, 1993 the School's first graduate student received her Master of Science degree.

MISSION

The mission of the School is to improve health care delivery systems by educating individuals to be effective developers, users and managers of health information resources; by advancing knowledge through research; and by providing a consultative service to the health care community. The School's view of health information encompasses clinical, sociological, epidemiological, administrative, legal, and economic perspectives. Health is seen from a community perspective and encompasses the full range of services including health promotion and disease prevention, home care, community health and occupational health, physician's services, institutional acute care, rehabilitation and extended care. As health information is increasingly being processed by computers and transmitted by communications technology, the School's programs have a significant technological component.

GOALS

The School's educational goals are to prepare broadly-educated individuals with a thorough understanding of the principles of information resource management and of the complexity of the health care systems, who:

- discover and implement innovative solutions to existing and emerging problems;
- are concerned with change and the management of change, particularly as it pertains to the introduction and enhancement of information technology in organizations;
- understand the ethical and sociological implications of information technology on individuals and on organizations.

The School's research goal is to investigate how data and information are used in clinical, management and administrative decision making in health care and to explore new ways of applying information technology and information systems within health care organizations to support that process. Applied research is conducted and models are built to test fundamental hypotheses. Given the multi-disciplinary characteristics of the field, a wide variety of research modalities and methods are used.

FACULTY AND STAFF

The School's team consists of 4 full-time faculty, 2 professional, 2 secretarial staff, and 5 part-time faculty. The majority of the faculty have health backgrounds, totaling 120 person-years of practicing health care experience. The School's faculty have published over 150 papers and given over 400 presentations to scientific and community groups. Two of the School's faculty were the first Canadians to be elected to the American College of Medical Informatics. All of the School's faculty serve on international professional and scientific associations.

In addition to its full-time and part-time faculty, the School makes extensive use of guest lecturers; over 300 professionals from organizations in Victoria, Vancouver and across Canada have come at their own expense to participate in the School's classes.

STUDENTS

Seventy five percent of the undergraduate students come from British Columbia, ranging in age from 18 to 50; the average age upon admission has been 26 years old. In addition to recent high school graduates, over 40% have previous degrees or diplomas, and 60% have over 5 years of work experience. About 25% of the students come from health-related disciplines such as nursing, dietary, medical imaging, health records, laboratory and physiotherapy.

Since 1991, the School has had eleven graduate students by special arrangement; nine enrolled in Masters programs and two in a Ph.D. program. A number of foreign students from Brazil, Germany, Mexico, United States and India have come to study in the School for periods of up to one year.

The School has a number of scholarships and bursaries, which are awarded annually to outstanding students in various stages of their studies. The Barbara Thornton Memorial Bursary is a $3500 award given annually to a person entering the School who has a demonstrated financial need.

UNDERGRADUATE DEGREE PROGRAM

The School offers a Bachelor of Science degree in Health Information Science. It admits students who have completed one year of university-based studies at a B level or higher. Applicants write a statement of intent and are interviewed prior to being admitted. To complete the degree a student must complete 40 courses and 4 co-operative education work terms over a 52-month period. Admission to the School is at the second year level. Students with previous degrees and/or university credit are given advanced placement.

As a foundation to the courses offered by the School, students take at least 11 courses from the departments of English, Mathematics, and Computer Science. They also choose 8 elective courses to complete their degree. Of the School's 22 courses, thirteen are health-oriented with over 90% of their content related to health care. The health care system is studied and taught from a multi-professional perspective and all health disciplines are introduced and discussed. The remaining courses are information technology based, though each course has 10 - 70% of its content specifically related to health care

Health Information Science students complete four 4-month Cooperative Education work terms where they are employed full-time in informatics positions in the public or private sector. Co-operative Education formally integrates academic studies on campus with related work experience in industry, business and government. As a result, Co-op students receive a superior, well-rounded education; employers have a cost-effective means of completing special projects and evaluating prospective permanent employees; the University receives valuable feedback on the quality and relevance of its programs.

Health care administrators and providers are now realizing that efficiency of health care services and the efficacy of health care delivery can be improved by implementing appropriate data and information management systems. Virtually 100% of the graduates are employed in rewarding positions directly related to their Health Information Science degree.

Since 1983, over 350 different employers have hired Health Information Science students to fill over 1,000 work term positions across Canada and around the world. These work term placements have been in government ministries, community health agencies, hospitals, extended care facilities, computer hardware and software companies, private laboratories and non-profit agencies. A few of the organizations that have hired the School's graduates are: Alberta Health, BC Ministry of Health, Calgary General Hospital, Capital Regional District (CRD), Coopers & Lybrand, Chilliwack General Hospital, Ernst & Young Management Consultants, Harley Street Software, St. Michael's Hospital, Sierra Consultants Ltd., SYSTEM-PRO (Indonesia), Site Werks Inc. (Seattle), Stevenson Kellogg, The Toronto Hospital, Total Care Technologies, and Vancouver Hospital and Health Services Centre,

In addition, the School has had tremendous success placing students overseas. India, Australia, U.S.A., Scotland, Sweden, Germany, Hungary, and Switzerland are some of the countries where Health Information Science students have had CO-OP work term experience. This broad international recognition and support of the School is highly valued in providing quality learning experiences for students.

GRADUATE STUDIES

The School has initiated the planning process for a formal graduate program and expects to have one in place in the next few years. A critical aspect of the planning is the definition of the type of graduate program. There appears to be a need for a program, which will prepare the future teachers, and, as such, a traditional research-oriented and thesis program would be in order. On the other hand, there is a known demand for a professionally oriented program, which would be primarily course-based and would lend itself to distance education. In addition, the planning is addressing the varying entrance qualifications of applicants from the undergraduate program in Health Information Science and from other health professions. Health Information Science is a multi-disciplinary field. The challenge of a graduate program will be to integrate these disciplines in an effective manner.

RESEARCH ACTIVITIES

The School's research focus can be captured in three words: Communication, Integration, and Appropriateness. The School's research programs are built on the premise that Health Information Science research is the investigation of the nature of information, its processing, utilization, and impact in a health care system. One example is the School's involvement in HEALNet, the Health Evidence Application and Linkage Network. Dr. Jochen Moehr is the theme leader for Health Informatics and is leading the research efforts in the areas of :

- Enabling computer systems to interact through standardized 'languages' and security features to electronically link various health care providers – improving the efficiency of constructing adaptive, usable system.
- Examining how humans interact with computers so that applications are more flexible and user-friendly – more responsive to how people really search for, and process, information.

COMMUNITY SERVICE

In addition to teaching and research, the School provides resources and expertise to the community through faculty consultations. It also fosters interaction with health professionals by providing a neutral forum, particularly through colloquia devoted to issues in health care delivery.

Annually since 1985, the Partnership in Productivity Colloquium has brought together senior corporate and hospital executives, physicians and Ministers of Health to discuss the issues and trends facing Canada's health care industry. Since 1986, the School, the Canadian Public Health Association and the BC Ministry of Health have regularly co-sponsored a Conference on "Information Technology in Community Health" (ITCH) to identify the impact of information technology on public and community health. It attracts medical health officers, information systems and community health professionals from Canada and many other countries.

In May 1989, the School, assisted by 80 volunteers from the University and the community, organized a very successful International Symposium on Medical Informatics and Education for over 350 delegates from 23 countries.

AFFILIATIONS

The School has excellent working relationships with numerous organizations through co-op work terms, guest lecturing, site visits, committee participation, and collaborative research. From the inception of the program, the British Columbia Ministry of Health and the Capital Health Region has actively supported the School; senior staff from the organizations have been involved in teaching each year. The Ministry is the School's largest CO-OP student and graduate employer.

In March 1997, the School signed a formal affiliation agreement with The Toronto Hospital. This agreement provides a framework for collaborative efforts that will benefit the School's students and faculty as well as the staff of the hospital. At about the same time, President Strong concluded an agreement with the National Yang Ming University, Taipei, Taiwan, on behalf of the School. Under this agreement, the two institutions have agreed to engage in collaborative educational, research and professional activities including developing of research proposals, exchanging faculty, staff and students, and providing access to training and research facilities.

ALUMNI

As of May 1997, the School has 203 alumni, 65% of whom are working in British Columbia. The remainder are primarily in Alberta and Ontario; 5% are working outside of Canada. Forty percent of the alumni work in management consulting firms, software houses, or computer hardware firms; 40% work in government departments and community health agencies; 20% percent work in hospitals and extended care facilities. They work as systems/project analysts, health information systems consultants, research assistants, planning analysts, system support staff, trainers/developers and client account representatives. Some are already in senior management positions. Over 15% of the School's alumni have already completed or are completing a graduate degree in Canadian and American universities in areas such as Public Administration, Epidemiology, Environmental Health, Medicine, and Business Administration to name few. As of May 1995, the School has 157 alumni, 65% of whom are working in British Columbia. The remainder are primarily in Alberta and Ontario; 5% are working outside of Canada. Forty percent of the alumni work in management consulting firms, software houses, or computer hardware firms; 40% work in government departments and community health agencies; 20% percent work in hospitals and extended care facilities. They work as systems/project analysts, health information systems consultants, research assistants, planning analysts, system support staff, trainers/developers and client account representatives. Some are already in senior management positions. Over 15% of the School's alumni have already completed or are completing a graduate degree in Canadian and American universities in areas such as Public Administration, Epidemiology, Environmental Health, Medicine, and Business Administration to name few.

FOR FURTHER INFORMATION

SCHOOL OF HEALTH INFORMATION SCIENCE, UNIVERSITY OF VICTORIA
PO BOX 3050, VICTORIA, BC CANADA V8W 3P5, PHONE (250) 721-8575; FAX (250) 721-1457; HIS@HSD.UVIC.CA
WEB SITE: http://www.hsd.uvic.ca/HIS/his.htm

r:\his\capsule.doc
September 29, 1999