Richard Burns, Professor Emeritus

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Biography

Richard Burns is an Emeritus Professor of Operations Research and Management Science at the Smith School of Business, Queens University, Kingston, ON, Canada.

Normally a CV would list the following:

- published paper
- conference talks
- Professional activities
- University activities

In my case that would only give a partial understanding of my work. In addition to presenting my usual CV as an academic I will present some of my activities as a consultant and entrepreneur.

As a person interested in apply analytic methods to real world problems over the years I have incorporated four different companies, hired many people, and run successful businesses. Through the interaction with the business world I have developed many results that lead to published papers and topics for my graduate students to use as thesis topics. The practical experience made my course lectures better because I could add interesting topics to the class sessions. Sometimes the importance of a research papers are better understood when they appear in the context that they were developed. The following is an example of the benefit of grouping research work.

COMPUTER ADAPTIVE CONTROL FOR METAL REMOVAL

In 1970 I completed my PhD entitled Nonlinear Programming Without Differentiability. During that work I had developed and computerised a new algorithm for optimising a

multivariable situation where the functions were not differentiable. The results were presented in Berman and Burns[1]. Dr. Berman had been my thesis supervisor.

I was interested in applying this work to real-life situations. In the Engineering department at the University of Waterloo there was a group of faculty members working on the conversion of metal removing machines from being paper tape controlled to being computer controlled machines. I visited their lab several times to understand what they were doing. I realized that they were only using a computer to replace the set of instructions that had, in the past, been put onto paper tape. The goal was to be eventually able to cut more complicated pieces and to be able to program the machine faster. The operation of the machine would be the same as it was when the controller was paper tape driven.

The research and development ongoing at the time was just to install computer aided control, CAD, with no thought of optimizing the process. I decided that some form of optimization could be done by using the computer to adjust the machine settings as the cutting was progressing. The shape cut out would be the same but various parameters such as the tool speed and the rate of metal removal could be dynamically adjusted to improve the efficiency, and the quality of the end product. Accidents due to tool wear could also be prevented with the changing computer control of the machine to become adaptive CAD. A great deal of work was needed to develop digital feedback of specific control variables to let the computer alter the variables while the machine was cutting out the desired shape. To show the complexity of the work, the following are the variables that were used in my optimization methods in order to create a function to optimize.

NOTATION

a	Overhead rate
b	Tool depreciation rate
d	Depth of cut
f	Feedrate
q	Chip equivalent length
t	Time
v	Cutting speed
H	Index of performance
T	Tool life
W	Wear land
W_0	Maximum permissible wear land
β	Power developed at cutting tool
θ	Tool temperature
λ	Tool life
μ	Metal removal rate
ν	Tool wear rate
τ	Time for tool change

I published two papers on the subject, see Burns.[2,3]

My work also appeared in the refereed proceedings of the 11th Proceedings of Numerical control/computer aided Manufacturing Conference March 31-April 3, 1974. See Burns.[4]

At the end of that conference on “Numerical control/computer aided Manufacturing” a special panel discussion was organized featuring the three, world-wide, top experts on adaptive computer aided control. The three people were a Russian, a Ukrainian, and a Canadian. The Canadian was me, Richard N. Burns. The Panel presentation and ensuing discussion went very well. It was well attended and the question and answer part of the panel discussion went on for a long time. When the conference was over, I felt that my work had made a considerable impact on those who were designing and building the new generation of computer aided control systems for metal removing machines. The work was so advances that no other papers on adaptive control appeared in the literature for the next ten years.

DESIGNING A DATA BASE FOR INDUSTRIAL SERVICE PARTS MAINTENANCE

One of the projects that I did in the early 1970s led to me writing a book. I had a contract to visit Dofasco, a steel company in Hamilton Ontario, to review their service parts inventory. I visited the plant and did a complete search of the property including all the narrow basement hallways and hidden cubby holes. When finished I reported that they had about $6,000,000 worth of spare parts stored in various locations such as under work benches and in bins placed in cupboards. Management was astounded at the amount and decided that they needed a database to keep track of all the service parts. I started working on that for them.

Somehow a company based in New York City heard about my work and contacted me to write a book on what a database for service parts should look like. They were in the business of giving two and three day workshops across North America. They asked me to agree to give a two day workshop for them where all the participants would receive my book as the basis of the seminar’s content. The book, plus notes that the participants would write during the two days, were to be so detailed that they could return to the company that had sent them to the seminar and either build their own system, or be able to direct the project when a third party was installing a package. After I wrote the book I gave the talks about every three or four weekends in cities from New Jersey to Seattle and from Rochester to Mobile Alabama. I learned a great deal from interacting with the course attendees. For example the USA military were building a new facility in the south. They sent two participants to my course. They wanted to know how to insure that some spare parts would be available when needed with a 98% certainty. When I asked them why the statistical certainty was needed they admitted that the facility they were building was to neutralise all the biological warfare armaments that the US military had. I quickly revised my book to include how to use statistics in maintaining the supply of parts in inventory.

In another class a senior officer in the United States Air Force was taking my course. He wanted to know how he could be sure that all the parts for a wing repair would be on hand when the airplane arrived at the repair center. He mentioned that there could be

as many as a thousand parts for the wing. Initially I had designed the data base to anticipate that a single part would be needed when something malfunctioned or was to be replaced in a preventative procedure. Now a whole collection of parts were needed all at once. This meant a change in the data base design. I had to rewrite sections of the book. By the time I stopped giving the workshops the USA military and many businesses had implemented a service parts inventory control system based on my book Burns[5]. The right to print and use my book belonged to the company that I worked for. I did gain a great deal of knowledge on data base designs for business decision systems which I used later.

SHIFT SCHEDULING

I first was introduced to shift scheduling in the first week of January 1976. A hospital in North Carolina had signed a scheduling contract with the nurse union and then discovered that they could not create any shift schedules that complied with the contract. Ken Baker, an operation research specialist at Duke University had tried to solve the problem and could not. He sent the problem to Mike Magazine, an operation research professor in the Management Science department at the University of Waterloo. He also could not solve the problem. Mike brought the problem to me and I solved it. I then created all the nurse schedules for the North Carolina Memorial Hospital at Chapel Hill, North Carolina.

After that experience I spent the next 45 years working on manpower scheduling problem with the emphasis on Nurse Scheduling. The first thing I did was to try to apply analytics to nurse scheduling to get a way to assess the cost of making alterations to an existing contract and calculating how many extra nurses would need to be hired to satisfy the new contract. The first paper I published was in INFOR and it won the CORS Gold Medal Plaque for the best paper in the journal that year. See Burns.[6]

After that paper appeared I was inundated with requests for consulting with hospitals. I formed a corporation and installed it in Richmond Hill, north of Toronto with 12 full time employees. I had a long running arrangement with Sunnybrook Hospital in Toronto. I transferred this work to my new company. The contract was to do the following:

1. Build a computer shift scheduling software package.
2. Revise all the nurse schedules for Sunnybrook Hospital
3. Install a nurse scheduling package in each unit.
4. Write an interface with the scheduling system to automatically relay to the payroll system exactly who worked what shift rather than what was scheduled.
5. Computerize the hospital’s daily patient assessment system. With that system every patient’s nursing needs were assessed daily to help the nurse managers plan how many nurses were needed that day and where would they be assigned.
6. Help to get all the systems working in K wing. K wing was a separate building for the long term care of veterans and was a long distance from the main computer. Special wire had to searched for to carry the data that far. It came from California and we assisted in having it installed and working.

When step one of the contract was completed it was adjusted to work for prison guard scheduling. The package was very successful and was sold to and installed in all the prisons in New Brunswick and in Alberta. It was also installed in some prisons in Ontario, including the Kingston Penitentiary.

Once step five of the contract, the patient assessment package, was completed it was sold to and installed in other hospitals, including Kingston General Hospital.

My company did considerable other work for Sunnybrook Hospital even after the initial contract was completed. For example after the patient classification system had been running for several years, management wanted to explore the large data base to look for trends in nursing care, and for other results that might be available in the caregiving for the K wing. The data had the nursing needs for every patient, for 365 days a year, for three years. Over that time span different things had been added to the data base so the individual data records were not uniform. I hired and assigned a full time person to go through all the data and reorganise it so it could be analysed. This analysis was an early example of large scale data analysis. The project was successful.

A special consulting job I was asked to do, had a very unusual long term after effect. I was asked to review the nursing situation for the operating rooms units at Sick Children's Hospital in Toronto. The reason for the request was that the unit was experiencing a one third turnover of nursing staff annually. The hospital had 21 operating theaters functioning daily and they were doing very complicated and innovated surgery on very young children.

I had a PhD student name Mike Carter who I knew was interested in applying operations research methods in practical situations. I took Mike with me to the initial interview with the head of nursing for that unit. When the interview was over I had Mike work with me to find solutions to the problem. We submitted our report which recommended many changes. We were told that there was no way that they could do the recommendations. In checking five years later, Mike found that they had implemented all our suggestions.

Upon graduation Mike was hired by the Industrial Engineering Department at the University of Toronto. Mike has had a wonderful career in solving problems for hospitals. On April 22, 2023, at the Engineering Institute of Canada's annual award night in Ottawa he was awarded the Julian C. Smith Medal for "contributions to Canada"). The contributions were mainly for doing work for hospitals.

Even though the company I had formed relieved me of a lot of work. I still had a lot of consulting to do. I was the expert consultant and financial analyst called for when contract negotiations between nurse unions and management reached an impasse. I did this many times in Ontario because in that province, at that time, each hospital negotiated its own contract. Other provinces negotiated one contact for all the hospitals.

On one occasion I was called to appear in Edmonton, Alberta, when there was a binding arbitration case before three judges. The nurse union had made proposals and the province would not accept any of them. My job was to present before the court what the increase in cost would be for each of the proposed shift schedules being considered. The outcome was rather strange. The arbitration board, who were not experts in scheduling, ignored all the presentations and all the cost analysis and, after deliberations, came back with a shift scheduling contract that had not been discussed, and no one wanted, because it would increase the cost for the province considerably. An additional problem with the new shift scheduling contract was that there were only two possible schedules for nurses that satisfied the contract. This restricted the daily scheduling of nurses by a considerable amount.

On another occasion the Province of Ontario hired me to review the operation of the maternity unit at the Trenton Hospital. My report recommended closing the unit for two main reasons. The first was that there was a maternity unit in Brockville a short distance away. The second was that given the fact that nursing has to be available 24/7, and that there were few births in the hospital. After examining the history of the unit I found that on average each nurse only participate in one and a third births per year.

I consulted on shift scheduling for many business and industrial companies that worked 24/7 such as Goderich Salt Mines, BC Hydro, and chemical companies. For nurse scheduling the work force is considered to be homogeneous. The shift schedules are only concerned with having the right number of nurses on each shift, each day. In places such as BC Hydro the workers are not homogeneous. The situation is to ensure that on each shift, there is a specified number of workers of each skill level. This is quite different from scheduling crews in the mining business. In crew scheduling the crew has the same people in it each day. This means that if you had four crews working it is the same as scheduling four people. At BC Hydro the members of the crew change but the coverage for each shift must have a complete crew of mixed skills working. See Burns.[21]

Every ten years the “Handbook of Industrial Engineering, Technology and Operation Management” is published. The third edition was published in 2001. The editor of the book, in this case Gaveriel Salvendy, would invite a world wide top expert in each subject to write a chapter for the book. I was asked to write the chapter on Personnel Scheduling which appeared as Chapter 64. I had my introduction to personnel scheduling 25 years before and now was considered a top expert in the field.

In the references at the end of this resume is a partial list of my published paper on shift scheduling Burns[6 to21].

SCHEDULING

I started working on job shop scheduling in 1972 and found the subject fascinating. I soon found myself very busy with consulting jobs in scheduling. I started a company called BCW Consulting Limited in 1974 to handle business and industry contracts. The

company was so successful that I ran it for 30 years and sold it in 2004 to an American firm.

I had been doing a lot of consulting for Consolidated Bathurst Paper and they asked me to create a computer production planning package for their many paper mills. They were unhappy with their current one. I wroite a computer program to schedule production in newsprint paper mills. The programme was very complicated and solved not just the cutting stock problem but optimized the whole manufacturing control system. I made sure that when the rolls were produced at the winder and moved to the wrap line it did not congest the wrap line. When the rolls came off the wrap line they went to the shipping area. The rolls that were being directly loaded onto a truck or a rail car had to be made close together on the winder in order to have shipping work smoothly. A truck could not take up a loading ramp for a long time waiting for the last rolls of the order set to be manufactured. The scheduling package had an expert meta-controller that controlled five different optimization methods so that all the many production restrictions were addressed. The program was very successful and was installed in paper mills as far east as Thailand, all across the USA and Canada, and in England.

After the Paper Mill Scheduling package was installed many opportunities for improving the Mill's productivity arose. This created many working papers, but I did not submit them for publication as it was an ongoing business. I list some of them in the reference section under Scheduling.

DATA BASE AND DECISION SUPPORT SYSTEMS

I had firsthand experience with creating a data base for the service parts management. The design for that data base was used for many manufacturing companies and for some United States military facilities. The book I wrote could not be sold or explained because it was an ongoing commercial venture. It was a typical flat data base, popular in the early 1970's because of the limitation of computers at that time.

The data base used for the paper mill production scheduling program was a relational data base which made it easier to add new reports as needed. Again this was a proprietary data base and could not be written about in papers.

Having created these major data bases I felt I knew a great deal about the subject. Some of the most interesting projects that I did for Data Base design and Decision Support Systems I did before moving the Queen's University. I wrote a paper Burns[25] in 1979. The last entries in the references of this resume are a section of interesting reports. Some of my data base work and DSS work that I did at that time is shown there.

When I was at Queen's University I met Alan Dennis who had been a student of mine in the MBA program at Queen's. When he completed the degree he worked for my company, BCW Consulting, for two years. He became interested in the design principles of special data bases. He and I wrote two joint author papers on the subject,

Burns[26, 27]. When we were writing a third paper I was too busy to give it my full attention so we asked Brent Gallupe to assist with the project, Burns[28].

Combinatorics, Graph Theory, and Computing

When I was at the University of Waterloo I taught courses in combinatorics, graph theory, and combinatorial optimization. I wrote several papers in those fields, Burns.[29-33] Interestingly one of the more abstract ones in graph theory as just the method I needed for a consulting contract in Australia.

There is a very large dry flat area between the mountains to the west of Canberra and Adelaide. There are a series of wells that produce the water needed to farm this land and supply water to scattered communities. There was a need to extend this piping system to a new broad area. They wanted to know the best way to develop this pipeline. In graph theory that would be equivalent to finding the optimal cost spanning tree. There is a known polynomial time algorithm for doing that. However, in this case the optimal cost solution might not be the best solution due to political and social consideration. The people in charge of doing the project wanted to know several solutions, ranked in order or cost. Then they would choose one to implement. The paper Burns[31] did exactly that.

OPERATIONS RESEARCH IN HEALTHCARE

After being retired for more than 20 years I decided to return to research. I started by applying operations research to healthcare. I wrote papers, Burns[34-37] and published them in the Canadian Journal of Medicine. My current interest now is in showing how operations research can be used in healthcare for the elderly, particularly for those with mental health issues.

I formed another company called Prappdar Incorporated, to develop apps in healthcare. The app MedsReducer, physicians version, and the app MedsReducer, patient version were created by Prppdar. They are available for Android and Apple tablets and smart phones in the computer stores on the internet. These apps allow lithium doses to be reduced in steps less than the minimum pill strength, which is needed for elderly bipolar patients. The apps can be extended to work for other drugs.

INVITED LECTURES AND TALKS PUBLISHED IN AUSTRALIA

I spent all of 1975 in Australia as a visiting research fellow in the Computer Science department of Canberra National University. In addition to doing research, my time there was to visit many universities to present seminars and assist them with local consulting work. The Australian government arranged all these visits and paid all my expenses for them. I also was asked to write a series of papers that were published

after being edited. The works were printed and distributed to others in my fields of research. See Burns.[38-44]

Many of the conference talks I gave and the working papers I wrote during my academic career could have been published paper but were not. Some could not be because they were work done for an ongoing business and were not to be disseminated abroad. Other were not published because I was too busy supervising PhD students, performing my University Departmental duties, participating in my professional activities, and doing consulting.

PROFESSIONAL ACTIVITIES

I joined The Canadian Operational Research Society, (CORS), in 1967 and remained an active member of the organization for 53 years.

In the 1970's I was president for many years if the South West Ontario Section.

When I moved to Kingston I discovered there was no Kingston Section so I founded one and became its first president.

CORS had no **practice prize** of any sort when I joined the national executive so I started the first one. I wrote the goals and rules for the new initiative. One of the initial rules was that there would be three judges and at least one would not be an academic. The first contest went very well and a non-academic submission won the first prize. I continued to run the contest for two more years until it was well established. I then turned it over to others to continue running it.

For several years I while I was on the national executive I was chairman of several different CORS committees.

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Russian, a Ukrainian, and a Canadian. The Canadian was me, Richard N. Burns. The proceedings were published.

Invited talks and written reports:

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SERVICE PARTS MAINTENANCE DATA BASE DESIGN BOOK

6. Burns R. N., A book giving detailed instruction on designing and building a data base for service parts maintenance, BCW Consulting Limited.

Working presentations:

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Academic Degrees

Ph.D. Mathematics,
University of Waterloo, Faculty of mathematics (1970)

M.A. (Mathematics)
University of Waterloo, Faculty of mathematics (1967)

B.Sc. (Science)
University of Toronto (1961), Medal winner in graduating class.

Academic Experience

Smith School of Business, Queen's University, Ontario
Emeritus Professor (1999 - Present)
Professor (1981-1999)

Faculty of Mathematics, University of Waterloo
Associate Professor, (1976-1981)
Assistant Professor, (1970-1976)
Lecturer, (1965-1970)

Visiting Fellow for the year 1975 in the Computer Science Department of the research division of the Australian National University in Canberra.

Taught High School Mathematics at ODCVI in Orillia Ontario. (1961-1965)