# ARC

*A Computer Science Post-Baccalaureate Diploma Program that Appeals to Women*

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Abstract:    This paper describes the development of ARC, a two-year diploma program that was launched in 1998 at UBC and SFU. ARC aims to address both the low participation of women in IT careers, and the intense shortage of highly skilled personnel in this field. The goal of ARC is to provide a rapid path into IT careers for motivated individuals with a bachelor's degree in any field, an excellent academic record, but little or no programming experience. ARC was designed to attract women and provide a paid work experience in industry. The ARC program has encountered a variety of challenges but has been successful in most respects. The experiences and preliminary outcomes reported in this paper should be of use to others planning similar programs.

## 1.    INTRODUCTION

The information technology (IT) industry is predicted to continue to have a strong demand for highly trained people over the next decade. In the US, the Bureau of Labor Statistics predicts that the demand for workers in IT will grow more rapidly than in any other field [1]. Canada and the US are already experiencing a shortage of IT workers. However, despite many well paying job opportunities, current participation in IT by women is low. The percentage of female undergraduate majors in computer science (CS) has dropped from 30-40% in the 1980's to 15-20% today [2]. To address the skill shortage and low participation by women in IT, the University of British Columbia (UBC), Simon Fraser University (SFU), the IT industry, and the provincial government joined forces in December 1997 to develop a fast-

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track CS diploma program offering students academic and industry experience.

The first group of Alternate Routes to Computing (ARC) students started in September 1998 and the second group started in January 2000. Women comprised 70% of the first group and 60% of the second group. Academically, ARC students received higher grades than average for CS majors, and are doing well in their industry work terms. Funding for the second round of ARC was secured more easily than for the first. These successes however, mask the mistakes made and their emotional toll on students, instructors, and administrators.

## 2. WHAT IS ARC?

ARC is a two-year cooperative education diploma program composed of four four-month terms of university level courses, interspersed with two four-month terms of industry experience. Cooperative or co-op programs alternate academic terms with paid work terms, making university more affordable and offering valuable work experience. Employers submit job postings, students apply for positions, and employers select students to interview. The university manages the process.

ARC is intended for highly motivated individuals with a bachelor's degree in any field, a superb academic record, but little or no programming experience. ARC includes undergraduate CS courses, allowing students to continue on to complete a university CS degree. The typical schedule for ARC students is the following:

1. Eight months of first and second year CS and math courses. ARC students take the same courses and are taught as a cohort in small classes, receiving extra support from teaching assistants (TAs) to compensate for their lack of background in computing and math.

2. Eight months of paid work experience in a high-tech company or organization, most of which are financial sponsors of the ARC program.

3. Eight months of third and fourth year undergraduate CS courses, chosen with substantial flexibility and taken with the regular stream of CS students, primarily in large classes (100–200 students).

Table 1 shows the ARC schedule at SFU, the UBC schedule is similar. Students are also required to attend 'bridging' workshops that are designed to teach students to effectively transfer their skills from the university to the workplace.

Table 1: Typical ARC course outline

| Academic | Course or Topic | Credit |
|---|---|---|
| Term 1 | Principles of Computer Programming | 4 |
| | Introduction to Discrete Structures | 3 |
| | Calculus I | 3 |
| Academic | Intro to object-oriented design | 4 |
| Term 2 | Computer Design | 3 |
| | Discrete Structures part II | 3 |
| | Computers and Society | 3 |
| Work Term 1 | Paid industry co-op term | 0 |
| Work Term 2 | Paid industry co-op term | 0 |
| Academic | Software Engineering I (recommended) | 4 |
| Terms 3 & 4 | Operating Systems I | 3 |
| | Data Structures and Algorithms | 3 |
| | Database Systems I | 3 |
| | 4 more upper-level Computer Science courses | 12 |
| | 2 upper-level electives | 6 |

## 3.    THE STORY OF ARC 1998

The stimulus for ARC came from James Lau, Director of the IBM Canada Pacific Development Centre, who, in 1997, suggested the creation of an alternative computing program as an initiative for SWIFT (Supporting Women in InFormation Technology). The SWIFT project is centred around the NSERC/IBM Chair for Women in Science and Engineering for BC and the Yukon (for more information, please visit http://taz.cs.ubc.ca/swift). Mr. Lau was interested in increasing the number of IT workers who combined a significant level of knowledge and expertise in domains outside IT (e.g., biology, languages, and social work) with enough technical knowledge and expertise to contribute to software application development in those domains.

There were benefits to ARC being developed jointly by UBC and SFU. As the two major universities in the Vancouver region, industry and government respond more favourably to joint requests for funding. The two CS departments could collaborate on tasks such as fund-raising, program design, recruiting and selecting students. The steering committee to develop the program was formed with key representatives from both universities and industry. The university members included department chairs, faculty

members with responsibilities for undergraduate programs, senior staff from co-op offices, fund-raising units, student services, and the women students' office, and several female CS graduate students. Industry was represented by Mr. Lau, of IBM, and Sonja Norman, a senior partner at Sierra Systems Consultants. Representatives from government organizations with responsibility for joint university-industry initiatives in IT (the National Research Council and the BC Advanced Systems Institute) joined the committee later.

The steering committee designed the program and estimated the minimum levels of necessary funding. Aspects that were chosen to make the program attractive to women, especially those who had left the workforce to raise a family, included:

1. charging regular tuition fees (approximately $2250 CDN or $1500 US per year) and including a paid work term to lessen the students' debt load;
2. guaranteeing at least 50% female participation in the ARC 1998 group;
3. providing additional support and mentoring from TAs and at least one small class restricted to ARC students for each of the first two terms; and
4. requiring no mathematics or CS prerequisites.

These aspects were selected based on input from women who had entered IT programs after careers in non-technical areas, and from experts in areas related to helping mature women succeed in post-secondary education.

By early March 1998, the steering committee decided to plan for an initial group of 30 students in September 1998. The estimate of funding needed to handle these students was CAD$150,000 or US$100,000. The next step was to raise these funds and obtain student applications by mid May to provide sufficient time to select and register the students.

Advertising began in mid-March, with a May 15 application deadline. Although no advertising funds were available, the energetic efforts of the steering committee resulted in a variety of newspaper and magazine articles, TV and radio interviews, e-mails, posters, brochures, web pages, and seminars.

Parallel to the recruitment effort, the steering committee were fund-raising with the goal of having 80% of the funds committed by July 1. Major commitments came from the BC provincial government (the Ministries of Advanced Education and Women's Equality) and IBM. Each committed to provide approximately 20% of the total budget. The remaining funds were raised by asking companies to sponsor student places in the program; which entailed a cash contribution of CAD$3000, and a commitment to hiring an ARC student for the eight-month work term at a monthly salary of $2,500. Sierra Systems Consultants sponsored three places, a few companies

sponsored two places, but the majority sponsored one place. Some companies offered the cash contribution; this was accepted to ensure the funding goal could be met in time to commit to the program.

From a total of 205 complete applications, with over 60% coming from women, the steering committee selected 78 applicants for interviews, based on the application form, transcripts, a resume, and two reference letters. In addition to being interviewed, applicants took a standard IBM aptitude test to assess their ability to work with logic and symbolic patterns. The purpose of the interview was to assess communication skills, level of motivation, and maturity, and ability to succeed in a program demanding high levels of time commitment and persistence. Forty students were accepted into the program. While gender was not used as a factor in the selection process, over 70% of the accepted students were women. The accepted students' ages ranged from 22 to 51 with a mean age of 31.

In addition to the program aspects listed above, other possible reasons for the high number of women who applied to the program are the following:

ARC had an impressive list of sponsors that included two BC government ministries and several large IT companies, and was offered by two highly respected universities. These two factors led applicants to expect that they would be successful in getting good jobs after completing the program.

The advertising materials emphasized that ARC was aimed at individuals who had never considered a computer-related career but were creative, bright, hard-working, had excellent communication and people skills, and were able to take on challenges and learn to succeed in a new culture.

Although 40 students had been accepted, two withdrew for personal reasons. After a one-day orientation session, the students began their classes with half attending UBC and half attending SFU. In addition to other support, feedback sessions were held during which faculty members and TAs listened to student issues and suggestions. The steering committee continued to meet regularly to solve problems, complete the fund-raising, and plan the industry work term assignments. At the beginning of the second term, four student representatives joined the steering committee as full participants.

Despite enormous efforts, the first eight months were extremely stressful for all involved. ARC's rushed implementation left some details unresolved. A few students felt the level of difficulty in the courses was beyond them. Some students were upset with the instructors and organizers for difficulties they encountered, which in turn angered other students, who interpreted this as a lack of appreciation of the opportunity ARC offered. The small groups at each university were vulnerable to emotional dynamics resulting from a few students experiencing difficulties.

As the program continued nine students withdrew. Some decided they did not like CS and others could not cope with the workload. Of the 29 who started their work terms, 21 women remained, still over 70%.

# 4.    THE PROBLEMS WITH ARC 1998

In this section some of the main difficulties encountered by students and organizers are listed.

Many students had difficulty with the math component of the program. A math refresher taken before beginning ARC would have been beneficial.

Students with no prior experience using computers initially had difficulties with basic computer operations. This engendered a lack of confidence and a feeling of being behind which persisted throughout the first two terms. Students felt a computer literacy course taken before starting ARC would have been beneficial.

Students felt they were not adequately informed of the time commitment needed for ARC.

Program information stressed that ARC was designed to help each student succeed, rather than emphasizing the students' responsibility for their own success. As a result some students assumed that the difficulties they encountered were due to an inadequacy in the program design.

There did not appear to be any correlation between performance on the aptitude test and performance in the program.

Due to a lack of space, several students were enrolled in evening classes, which was particularly difficult for parents of school age children.

The ARC web page had stated a minimum salary for the work term of CAD$2500 per month. The ARC sponsors who had committed to hire ARC students had agreed to this minimum; however there were 24 ARC sponsored spaces, compared to 29 ARC students.

ARC sponsors had been told that they would have the first opportunity to hire the ARC students, necessitating running a matching process before the regular co-op process. Due to the shortage of ARC sponsored places, this caused worry among the students, and extra work for the organizers.

Because the commitment for ARC sponsorship in some cases had been made by a senior executive in the company without the human resources staff being informed, some companies found it difficult to offer a work term placement corresponding to the skills and abilities of ARC students. Some employers had unrealistic expectations of students' knowledge about specific programming environments, while other work terms lacked challenge.

Splitting the ARC students into small, separate groups at each university left both groups vulnerable to negative group dynamics which had negative consequences for both instructors and students. Having two groups also necessitated the expensive duplication of effort and resources.

Overall, the staff resources needed for selection, advising, administration, and work term placement process and supervision was under-estimated.


## 5.    THE POSITIVE OUTCOMES OF ARC 1998

Despite the problems, virtually everyone involved in creating ARC feels the program is a great success. The 29 students remaining in the program have done well academically, achieving a grade-point average about 6% higher than the average achieved by students in the regular, already selective, CS programs. The ARC students are doing exceptionally well in their work terms and almost all are finding the work experience enjoyable, rewarding, and less difficult than the two previous academic terms. Employers are delighted with the students' performance; they appreciate the students' maturity, willingness to take on challenges, enthusiasm, and ability to learn. The ARC organizers find it most rewarding that the majority of students feel that ARC has changed their lives for the better. The ARC 1998 students will return to UBC and SFU for academic courses in January 2000. They will be outstanding mentors for the new group of ARC 2000 students behind them.


## 6.    MOVING ON TO ARC 2000

Due to demand and the success of ARC 1998, the ARC steering committee accepted another group of ARC students in January 2000. Several changes were made to the program to address the previously mentioned problems, including the following:

1. A $100 application fee to help cover administrative costs.
2. The web page emphasizes the intense level of challenge and time commitment involved in the program.
3. All work term placements will be handled through the regular co-op process, with no promise of a minimum monthly salary. ARC students are required to take bridging workshops to help them succeed in the co-op process, and in transferring their skills to their new working environment.
4. More adequate funding is provided for staffing resources needed for the application, advising, and work term placement components.

5. All ARC 2000 students will attend classes at UBC for the first academic term and SFU for the second, making the program more efficient. The larger group will be potentially more cohesive overall, and hopefully minimize problems with group dynamics.
6. Applicants who do not have credit for four university math courses must complete a grade 12 math refresher within the two year period prior to their acceptance into the program.
7. Applicants must enter the program having a familiarity with basic computer operations.

ARC 2000 received 89 applications, 50% from women. Of the 62 students accepted, 56% are women. The applicants' age range was 23 to 52 with an average age of 32 years. Although the number of applicants is less than in 1998, their qualifications are significantly higher. The lower number of applicants may be due to the timing of the announcement and advertising, and to the changes to the program. These changes may also be responsible for the lower percentage of women applying.

## 7.    CONCLUSION

Two years in the making, and involving over 100 people, ARC has gone from a proposal to offer computer training to a few students from areas other than IT, to a CS diploma program training talented and enthusiastic people with little prior experience in computing. Despite some significant challenges, 29 people who never previously considered computing as a career are now headed to join the Canadian IT work force. The most significant change made to the program is the raised admission requirements. Though reducing the number of potential applicants, it is unavoidable; ARC relies on sponsorship from government agencies and IT companies, which necessitates a high quality of students to ensure the success and continued funding of ARC. It is hoped that this description of the evolution of ARC, and the obstacles that ARC faced, will assist other universities and companies who are planning to develop similar programs.

## REFERENCES

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