Saskatchewan Structural Sciences Centre (SSSC)

Self-Study for External Review

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# Saskatchewan Structural Sciences Centre (SSSC)
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1. Executive Summary

Introduction:
The Saskatchewan Structural Sciences Centre (SSSC) is an integrated multi-user facility with more than 20 advanced scientific instruments that provides service to a broad-based research community in the general areas of material science, molecular characterization, biotechnology, and structural biology. Major instrumentation includes: NMR (600 MHz with cryoprobe; 3× 500 MHz); mass spectrometry (two instruments: LC-MS/MS-ToF, high resolution, ESI and MALDI; double focussing, high resolution, EI & CI, FAB); x-ray crystallography (two systems: Proteum, Kappa CCD); optical spectroscopy (capabilities provided by two ultra-fast Coherent Ti:Sapphire fs lasers); EPR; Raman; AFM; SPR; etc. The Centre is now of crucial importance to many researchers in the basic sciences, but also serves as the foundation organization for multidisciplinary collaborations ranging from medicine to synchrotron science to agriculture and biotechnologies.

Mission:
To be a well-run, central, major instrumentation facility for structural sciences that serves: University of Saskatchewan researchers in the physical sciences, health sciences, and engineering; the Canadian Light Source (CLS); public-sector research organizations; private businesses.

Goals and objectives:
To stimulate research in priority and pre-eminent areas of pure and applied research and development at the University of Saskatchewan and beyond.

Types of activities undertaken:
The goal and objectives are achieved by providing:

- access to sophisticated equipment and procedures necessary to characterize biological and physical materials
- access to expertise and training in advanced techniques and procedures appropriate for research in these areas
- access to technical assistance for researchers on the selection, design, and execution of procedures appropriate for their research
- these services to academic users at as low a cost as possible, to users from public-interest research institutes at rates commensurate with operating costs, and to commercial users at appropriate market rates.

Governance:
The SSSC is the responsibility of the Vice-President Research (Dr. Karen Chad). An internal Management Board has the following membership:

- JAMES BASINGER: Associate Vice-President Research, Chair
- NICK OVSENK: Associate Dean (Biomedical Sciences), College of Medicine
• **Suzanne Abrams**: Research Director, National Research Council - Plant Biotechnology Institute

• **Nicolas Low**: User Representative; Department of Food and Bioproduct Sciences

• **Dale Ward**: SSSC Director; Thorvaldson Professor, Department of Chemistry

The Director is appointed by the Management Board and reports to the Associate Vice-President Research and has a range of responsibilities, including: to develop and adhere to budgets; for four ASPA employees (the SSSC Manager and three Research Officers); to organize and consult with User Groups with respect to policies developed around instrument use, including user fees, and who need to be involved in the on-going development of the SSSC.

The Manager (Dr. R. Sammynaiken) has responsibility for day-to-day managerial responsibilities for the Centre and general supervisory responsibilities for the Centre’s technical staff. Dr. Sammynaiken has also assumed operating and technical development responsibilities for one major suite of instruments in the Centre (EPR and Raman) and acts in a business development capacity interacting with and promoting use by external clientele.

**Current Staff:**

Director: Dale Ward, Thorvaldson Professor Dept of Chemistry  
Manager: Dr. R. Sammynaiken  
Research Officers: Drs. S. Brunet and G. Schatte and Mr. J. Maley  
Others: Dr. K. Brown (NMR) and Mr. K. Thoms (mass spectrometry) are employees of the Department of Chemistry who spend considerable time operating and maintaining SSSC Equipment. Emeritus Professor J. W. Quail has an office within the SSSC and collaborates with several researchers on x-ray crystallography of 'small' molecules.

**Current users:**

During 2010-11, there were ca. 155 active users (mostly graduate students, PDFs, and technicians) from 51 different research groups from across campus (Agriculture & Bioresources-7, Engineering-10, Medicine-5, Pharmacy & Nutrition-5, Arts & Science-21, Veterinary Medicine & VIDO-3) and 12 External client groups (Government Laboratories-6, Companies-2, Internal sub-contracts-2).

**Financial Performance:**

The SSSC is financed through a 'fixed' grant from the University (currently $255K/y) and from revenues generated from user fees (ca. $175K in 2010-11). In recent years, income from fees has been sufficient to offset all non-salary operating costs. However, the revenue/cost relationships vary widely when viewed on an individual instrument basis. The steady growth of salary and benefits costs due to University-negotiated increases compared to the 'fixed' grant has created a significant structural deficit (and accumulated debt) that threatens the existence of the SSSC.
Major Questions for Reviewers:

1. *Is the value added by the SSSC Concept Worth the Support Provided?*
   The major question for the Vice-President and Review Team to consider is the value of the SSSC concept. The presence of a University-supported multi-user core-facility for major scientific instrumentation is unusual among research intensive universities in Canada. For a small-to-medium sized research university, the benefits of a central facility are substantial, bringing open access to a diverse user group and economies of scale both to the physical space requirements and to the technical support needs. Over the past seven years, the SSSC has proven it can deliver these benefits. The SSSC has the capacity to evolve and expand its services into new areas over time. However, the existence of the SSSC requires coordinated University support (e.g., at the VP-R level). Are the benefits worth that support? If the conclusion is affirmative, then we need to work towards sustainability. If not, then all other questions are moot; an orderly exit plan is required where responsibilities for existing instrumentation are devolved to individual colleges, departments, or researchers.

2. *Is the Scope of SSSC Services Appropriate for the Researchers Served?*
   Access to sophisticated instrumentation is crucial to the success and competitiveness of any research intensive university. The specific collection of instrumentation in the current SSSC arose primarily from the needs of a core group of researchers in 1998-99. Some instruments serve large user groups while others have few users. Current SSSC equipment is no longer state-of-the-art. In due course, some equipment will require replacement or upgrading and other new equipment will become desirable as new research areas or groups emerge. For example, there is growing demand from UoSS PI's for access to instrumentation to support research in materials science (e.g. XPS, TEM, STEM) and the SSSC has the capacity to evolve to accommodate that research.

3. *Are SSSC Staffing Levels Appropriate for the Services Provided?*
   Most of the SSSC instrumentation is expensive and sophisticated and absolutely requires skilled technical support to ensure proper operation and maintenance. Although maintenance contracts can be purchased from instrument vendors, the costs are prohibitive. Expert staff allow much of the necessary maintenance to be accomplished 'in house' and, additionally, promote access to and utilization of sophisticated instrumentation by researchers inexperienced with these advanced research tools affording them the opportunity to compete with colleagues at major universities. Given the number and scope of instruments operated within the SSSC, current staffing levels are more than justified. Current staffing levels allow the SSSC to
contemplate evolution to support research in materials science (e.g. XPS, TEM, STEM). In contrast, reducing staff numbers is a complicated process and operating the Centre with fewer staff would require significant curtailment of activity.

4. Appropriateness of User Fees
   a) User fee rates for internal PIs funded by research grants (i.e. no overhead) are based on the principle of cost recovery of non-salary and routine maintenance expenses. We believe the resulting fees are reasonable and comparable to those charged at other institutions. *Is the current approach justified?*

   b) Internal PIs funded by research grants (i.e. no overhead) are not charged for Staff time. We believe it is unrealistic to propose that the salary costs of technical support staff can be covered from academic users’ research grants. Indeed, extreme user fees will not increase revenue but will prevent access and diminish research intensiveness. *Is the current approach justified?*

   c) Internal PIs funded by research grants (i.e. no overhead) that are major users have received discounts on their fees. This approach recognizes the importance of major users to the success of the SSSC and for participating in successful grant applications for new or upgraded equipment and the principle that, as with most goods and services, high volume clients pay less per unit that casual clients. *Is the current approach justified?*

5. 600 MHz NMR
    Consistent with the principle in 4a above, virtually every instrument in the Centre generates fees sufficient to cover the non-salary costs of operating that instrument. The annual non-salary operating costs for the 600 MHz NMR are $45-50K but revenues have averaged <$10K. Thus, this instrument operates with a very significant structural deficit. As an additional challenge, the instrument has a single major user. There is no realistic way that one academic user can provide in user fees more than a small fraction of the real operating costs. It is essential that alternative sources of funding, internal or external, be identified to address this structural deficit. *How can this be achieved?*

6. External Users
   Currently, all income from external users (academic and commercial) has been combined with that from internal users to offset operating costs. We believe that it would be appropriate and desirable to separate the salary component of the income generated from external users to offset our salary costs or, better, to provide a budget for staff training (including attending conferences) and other improvements (software upgrades, computers, etc.). *Is this proposed approach justified?*
2. Introduction

Overview:
The Saskatchewan Structural Sciences Centre (SSSC) is a central University-supported core-instrumentation facility that occupies ca. 1,000 m² of space (completely renovated in 2000-2004) within the Thorvaldson Annex and basement level of the 1996 wing of the Thorvaldson building (see Appendix I for a detailed accounting of allocated space). The SSSC is an integrated multi-user facility with more than 20 advanced scientific instruments that provides service to a broad-based research community in the general areas of material science, molecular characterization, biotechnology, and structural biology. Major instrumentation includes: nuclear magnetic resonance (NMR: 600 MHz with cryoprobe; 3× 500 MHz); mass spectrometry (two instruments: LC-MS/MS-ToF, high resolution, ESI and MALDI; Double focusing, high resolution, EI & CI, FAB); X-ray crystallography (two systems: Proteum, Kappa CCD); optical spectroscopy (capabilities provided by two ultra-fast Coherent Ti:Sapphire fs lasers) including laser scanning confocal microscopy, two-photon excitation microscopy, fluorescence lifetime imaging, time-correlated single photon counting, fluorescence upconversion; electron paramagnetic resonance (EPR) spectroscopy; Raman spectroscopy and imaging microscope; atomic force microscopy (AFM); surface plasmon resonance (SPR); circular dichroism (CD); isothermal calorimetry (ITC); dynamic light scattering (DLS); etc. (see Appendix II for a detailed list of instrumentation).

As a central multi-user core-facility, the SSSC is open to all University of Saskatchewan researchers on an equal basis. During 2009-10, there were ca. 160 active users (mostly graduate students, PDF, and technicians) from 64 Research Groups from across campus (Division of Science-23; Colleges of Agriculture & Bioresources-5, Engineering-9, Medicine-15, Pharmacy & Nutrition-8, Veterinary Medicine-4) and 12 External client groups (University-2, Government-5, Companies-5). Since 2002, more than 350 publications have appeared that, at least in part, included data obtained at the SSSC. Experiments conducted at the SSSC have contributed to at least seven patent applications. Thus, the Centre is now of crucial importance to many researchers in the basic sciences, but also serves as the foundation organization for multidisciplinary collaborations ranging from medicine to synchrotron science to agriculture and biotechnologies.

Mission and Objectives:
The SSSC seeks to be a well-run, central, major instrumentation facility for structural sciences that serves: University of Saskatchewan researchers in the physical sciences, health sciences, and engineering; the Canadian Light Source (CLS); public-sector research organizations; private businesses.

The objective of the SSSC is to stimulate research in priority and pre-eminent areas of pure and applied research and development at the University of Saskatchewan and beyond. This goal is achieved by providing:
• access to sophisticated equipment and procedures necessary to characterize biological and physical materials
• access to expertise and training in advanced techniques and procedures appropriate for research in these areas
• access to technical assistance for researchers on the selection, design, and execution of procedures appropriate for their research
• these services to academic users at as low a cost as possible, to users from public-interest research institutes at rates to be negotiated, and to commercial users at appropriate market rates.

3. History
The appendices of this Self-Study document provide details on SSSC operations from 2007-2010. However, it is impossible to understand the SSSC of 2011 without considering a more complete history (1998-2010).

1998-1999 - The SSSC Proposal
The Centre was initially conceived by a large group of ca. 35 researchers from the physical and life sciences through a successful proposal developed in the inaugural round (1998) of the Canada Foundation of Innovation (CFI) Institutional competition. Crucial to the formulation of this proposal and its ultimate success was the contemporaneous approval of a major building project to replace the ancient (1924) facilities housing the undergraduate laboratories for organic and inorganic chemistry; thus by serendipity, the necessary matching funds were secured! The $9.6M proposal ($6.1M, equipment and installation; $3.5M, construction) requested $3.1M from CFI. The major pieces of equipment requested (ca. $4.1M of the $5.9M total equipment request) were largely driven by the research interests of the prominent researchers leading the proposal [lasers ($1.2M), R. Steer; x-ray diffractometers ($0.75M), L. Delbaere; protein NMR ($2.1M), B. Waygood]. The large group of co-applicants justified expansion of the requested equipment list to include AFM ($470K), EPR ($290K), confocal microscopy ($270K), CD-ORD ($210K), and a suite for biophysical characterization ($550K; phosphorimager, DLS, ITC, SPR, perfusion chromatography).

The diverse equipment list was tied together under the theme of a structural sciences centre; however, this title was more representative of an a posteriori designation rather than an a priori design. The proposal laid out a definite management structure for the proposed University-level instrumentation facility: a Manager (supervision of technical personnel and day-to-day oversight) reporting to a Director (volunteer' faculty member overseeing the work of the Centre, preparing budgets and annual reports) reporting to a Management Board (overall responsibility for the Centre) reporting to the Vice-President Research (institutional responsibility). A Users Group would have responsibility for ensuring safe, efficient and fair use of the Centre facilities including establishing procedures for use and access.

Sustainability for the Centre (after five years of operation) was addressed. The proposal included a University ongoing commitment of $217K/y to support the salary
and benefits of 2 existing technical positions in the Chemistry department and three new SSSC (Manager and two technical staff) line-budget positions. Thus, salary costs would be covered internally. Non-salary costs were estimated to be: operating, $112K/y; maintenance and upgrades, $400K/y. These costs would be offset by projected revenues from user fees [$350K/y: $150K (internal users), $150K (private sector users), $50K (Government labs)] and grants from NSERC and MRC (now CIHR) ($170K/y average).

In March of 1999, CFI announced the award of $1.874M; essentially, the expected 40% contribution for a project valued at $4.685M (cf. the $3.1M requested for a $9.6M project). Major equipment deleted from the original budget included: 700 MHz NMR ($2.1M), CCD detector ($250K), phosphorimager ($190K), some laser components ($160K), and a 20% reduction in the budgeted cost of all other equipment (ca. $500K). In response, the proposal leaders petitioned the Provincial Government to increase its original commitment ($3.1M) to $3.724M thereby increasing the budget available for equipment and components to $5.3M and allowing the project to proceed as originally envisaged. Eventually, a funding arrangement was negotiated whereby the Province provided $2.787M (CFI match of $1.874M + $0.913M) and the Western Economic Partnership Agreement (WEPA) provided $0.937M which together with the CFI funds ($1.874M) and some price reductions from vendors allowed all of the equipment in the original proposal (less the phosphorimager) to be purchased and installed.

1999-2000 - The 2nd CFI Proposal (Facilities for Biomolecular Research; FBR)

The 700 MHz NMR requested in the SSSC proposal was envisaged for biomolecular applications and was not well suited to serve the large number of existing NMR users (at that time). The 1985 vintage 300 MHz instrument in the chemistry department (the only NMR on campus) was heavily used and needed upgrading. The construction costs associated with the SSSC and the new chemistry building were not fully leveraged in the 1st CFI application and this gap provided a unique opportunity to utilize these construction costs as matching funds for a 2nd CFI application. The crucial importance of NMR and mass spectrometry to many research programs prompted a group of researchers (several in common with the 1998 CFI application) to develop a CFI proposal. The $4.13M proposal ($2.9M, equipment and installation; $1.2M, construction) requested $1.65M from CFI and included 2 NMR instruments (500 MHz and 400 MHz with autosampler) and a high resolution ToF LC-MS/MS mass spectrometer in addition to a laboratory for biomolecular research (autoclave, walk-in cold room, laminar flow hoods, etc.).

The proposal was unified under the title Facilities for Biomolecular Research (FBR). The NMR and MS equipment were to be managed under the SSSC [ca. $3.2M of the $4.13M project was S SSC-related (i.e., equipment plus construction)]. Sustainability for the SSSC-related equipment (LC-MS/MS and 2 high field NMR instruments) during the first five years of operation was addressed. The proposal included a University ongoing commitment of $133K/y to support the salary and benefits of two existing technical positions in the Chemistry department (the same two existing positions noted in the 1998 proposal) and a new NMR specialist position within the SSSC. Non-
salary costs were estimated to be $20K/y for operating and maintenance and these costs would be met from user fees. Additional revenue generated from external contracts and fees would be applied to future upgrades and post-warranty repairs. Noteworthy, is the combined university commitment (i.e., in the 1998 and 1999 CFI applications, see Appendix VII) to cover the salary and benefits costs for a manager and three technical positions within the SSCS.

In spring of 2000, CFI announced the award of $1,511,170; essentially 40% of a $3.78M project. The SSCS portion was ca. $3M (equipment, $2.1M; construction, $0.9M) and was sufficient to purchase all of the proposed equipment.

2000-2004 - The Establishment Phase
(construction, acquisition/installation of equipment)

The two CFI awards supplemented by additional funding from the Province of Saskatchewan and WEPA provided a budget sufficient to purchase and install virtually all of the equipment proposed in the original applications. Significant variations included:

- The 700 MHz NMR originally proposed in the SSCS CFI application was replaced by a 600 MHz NMR with cryoprobe plus a 500 MHz NMR (with triple resonance probe). This seemingly beneficial substitution brought significantly increased operating costs, a factor not fully appreciated by the proponents at that time.

- The surface force apparatus originally proposed in the SSCS CFI application (budget ca. $150K) was not purchased in part due to the impending retirement of the major proponent. Funds were redirected to cover shortfalls in other areas.

- The 400 MHz NMR instrument originally proposed in the FBR CFI application was replaced by a 500 MHz NMR with solids capability (everything but the probe); the autosampler was installed on the 2nd 500 MHz instrument.

- Prof. Delbaere, a co-applicant on the SSCS CFI application, was appointed to a Tier I Canada Research Chair position and the CFI component associated with that appointment provided funds to purchase a second x-ray diffractometer (Kappa CCD) for small molecule crystallography that was installed in the SSCS.

- An NSERC Equipment grant (R. Steer and co-applicants; $106,670K) allowed a significant upgrade to the Raman spectrometer-microscope.

In the summer of 2000, the interim Management Board appointed Dr. R. Samynenaiken as SSCS Lab Manager and a year later, Prof. R. Steer was appointed as SSCS Director. By the end of 2001, the University’s contribution to the SSCS operating budget had taken shape. The University would provide $217K/y for five years to the SSCS operating budget but SSCS staff positions were not base-budgeted. The Centre’s operations would be reviewed in year four and University funding beyond five years, if any, would be determined at that time. In reaching this decision, the President’s
Executive Committee (PEC) noted an expectation of full cost recovery by 2006-07 and consequently that, as a minimum, the cost of ongoing salary and benefit increases would be funded by non-base budgeted recoveries (memo from L. Kennedy to R. Steer, re: SSSC Budget, Jan 10, 2002; see Appendix VII). Even at that time it was clear that $217K/y would rapidly become inadequate to cover the cost of salaries and benefits for four SSSC staff because of University-negotiated increases in salaries and benefits. This funding arrangement is clearly at odds with that envisioned in the 1998 and 1999 CFI proposals (see Appendix VII for the Financial Resources for Operation sections of those applications); nowhere in those applications is the concept of a full cost recovery model (i.e., including all salary and non-salary expenses) proposed or envisaged. Nonetheless, statements that the SSSC was proposed as a facility that would ultimately operate without base budget support can be found in various documents after 2002; however, the origins and promulgation of that incorrect interpretation are unclear.

The initial proposal envisaged the SSSC to be fully functional by the end of 2001. However, numerous construction-related delays (resulting from a combination of bad luck, design, and management - to paraphrase the Director's report of 2003) resulted in a postponement of the 'official' opening to the fall of 2003 and achievement of full functionality to mid-2004. As a consequence of the requirement to spend the CFI awards in a timely manner, several instruments were purchased and either stored or installed in temporary space and then moved (with associated increased costs). For example, the two 500 MHz NMR instruments from the FBR award were purchased and installed in renovated space in the Chemistry Department in 2002 and then moved to the SSSC in early 2004. In consideration of those delays and the resulting additional costs, the University agreed that budget support provided to the SSSC prior to May 2001 would be absorbed centrally and the five year commitment of $217K/y would begin with the 2001-2002 budget year. Despite the Director's persistent recommendations, SSSC staff positions were not base-budgeted. The resulting structural deficit in the SSSC budget would have profound implications (vide infra).

In early 2002, the first Research Officer position was filled (Dr. P. Aich) with responsibilities for the biophysical characterization suite of instruments (many of these installed in temporary locations within the Biochemistry Department). The incumbent resigned in the summer of 2002 and by the spring of 2003, three new Research Officers had been hired (Mr. Maley and Drs. Brunet and Schatte). Prof. Steer's term as Director ended as of July 1, 2003 and identifying a replacement proved difficult. The term was extended to Aug 31 whereupon Dr. B. Waygood, the University's Coordinator of Health Research and member of the SSSC Management Board, became Acting Director of the SSSC.

2004-2007 - The Startup Phase

By early 2004, the SSSC had taken possession of nearly all of its space allocation and virtually all instruments had been installed and were operating. With the installation of the two x-ray diffractometers in the SSSC, Prof. Delbaere also 'transferred' the remaining part of his CIHR Equipment Maintenance Grant (ca. $37K/y) to support the operation of those instruments in the SSSC during 2003-05.
Establishing a reasonable schedule of user fees was a priority. During 2002-04, several instruments were purchased and installed in temporary locations and the collection of user fees was irregular. For example in the 2003-2004 budget year, users fees amounted to only ca. $31K (internal, $19K; external, $12K). Salary and benefits during that year (the first full year with all four SSSC staff in place) were $260K and non-salary operating and maintenance costs were ca. $130K. The deficit was near $120K essentially eliminating the contingency reserve that had accrued prior to hiring the full staff contingent (see Table 2 on page 21 for details).

Achieving consensus on user fees proved to be a significant challenge primarily because of the wide differences between the 'vision' of the Acting Director and that of several major users. Essentially, the Acting Director believed that the SSSC was proposed as a hybrid academic/business model; i.e., serving academic researchers and providing fee-for-service or contract research to external clients. This open-for-business requirement was interpreted to mean that academic user fees should be set at a level to cover not only operating costs but also anticipated costs for maintenance and repairs (including the salary component of SSSC staff). By contrast, many of the major users believed that the SSSC was proposed primarily for the benefit of academic researchers. This group felt that academic user fees should be as low as possible and comparable to those levied at other universities. Consistent with the 1998 CFI application, funding for significant repairs or upgrades would need to be generated by successful grant applications. Fee-for-service or contracts from commercial clients could, in principle, provide funds for repairs, to upgrade services, and/or subsidize academic fees; however, there was considerable skepticism about the potential to generate such revenue. In particular, several major users expressed vigorous opposition to the proposed academic user fees for 500 MHz NMR ($5/h) and small-molecule x-ray crystallography ($200/structure) [it should be noted that these services were effectively provided 'free' to users prior to 2004]. After considerable argument, debate, and negotiation, a compromise was reached [NMR, $3/h ($0.75/h evenings and weekends); x-ray crystallography, $90/structure] and a schedule of academic user fees was implemented May 1, 2004 (see Appendix III for this list of fees).

Prof. M. Majewski was appointed SSSC Director as of Sept 1, 2004. The 2004-05 budget year was the first year of a fully functional SSSC. Although revenues from user fees were a modest $45K ($34K, internal; $11K, external), additional funds from Prof. Delbaere’s CIHR Equipment Maintenance grant (ca. $53K) brought the total non base-budgeted income ($99K) in line with the non-salary expenses ($105K). In 2003-04, the Federal Government launched the Indirect Cost Program (ICP) providing funding to universities (and other institutions) based on a formula that depended on success in securing tri-council funding. In 2004-05, the University of Saskatchewan allocated $35K from their ICP block grant to the SSSC in addition to the base-budgeted $217K; however, the salary expenses ($294K) exceeded the total University funding ($217K+$35K) resulting in a budget deficit of ca. $47K (see Table 2 on page 21 for details).
In July of 2005, Prof. Majewski was appointed Head of the Department of Chemistry and subsequently resigned as SSSC Director as of Dec 31, 2005. The current Director was appointed by Vice-President (Research) Franklin for a 3 year term effective Jan 1, 2006. The new Director’s mandate was to prepare a submission to the President’s Committee on Integrated Planning (PCIP) making the case for base-budgeted funding of SSSC staff positions and including a long term plan for sustainability.

The 2005-06 budget year again produced modest revenues from user fees; internal ($25K) and external ($11K). Although Prof. Delbaere’s CIHR Equipment Maintenance grant (for x-ray diffractometers) had ended, funds from the Molecular Design Research Group ($20K) and substantial fees collected via subcontracts from research contracts held by internal users (M. Reaney, $33K; R. Pegg, $15K) together with user fees were nearly sufficient to cover non-salary expenses ($117K). Despite the $35K funding from ICP, salary expenses ($293K) exceeded the total University funding ($217K+$35K) resulting in a budget deficit of ca. $46K (see Table 2 on page 21 for details).

From 2000-2006, the SSSC had an accumulated debt of ca. $120K and a growing structural deficit (ca. $48K in 2006-07: annual salary and benefits costs, $300K; annual revenue from University plus ICP, $252K). In the fall of 2006 a budget proposal that would place the SSSC on a stable financial footing and would repay the accumulated debt within 3 years was developed for consideration by PCIP (see Appendix V). The essential element of that proposal was the simple request that the University assume responsibility for the negotiated salary and benefits for the four permanent SSSC personnel (ca. $300K in 2006-07) Period. All other SSSC expenses would be met from fees and other sources (including $50K from the ICP). It was argued that, considering the $11M in sophisticated equipment, this was a reasonable and justifiable investment in a research-intensive university. Ultimately, PCIP did not formally consider the SSSC proposal but instead it was placed within a much broader context that eventually became the Strategic Research Fund (SRF). In March of 2007, the SSSC was informed that an allocation from the SRF of $255K/y for five years was approved. This funding replaced the $217K formerly committed by the University and the $35K/y from the ICP that had been forthcoming in 2005 and 2006. It can be noted that the resulting $255K/y allocation was ca. $100K/y lower than was requested ($300K from central funds and $50K from ICF) in the budget submission.

The 2006-07 budget year produced only $54K from user fees (internal, $28K; external, $25K). Non-salary operating costs increased to $144K ($117K in 2005-06) largely because this was the first year where a charge was incurred for the required annual maintenance of the cryoprobe for the 600 MHz NMR (ca. $28K; maintenance in previous years was covered as part of the purchase price). With salary expenses ($303K) far exceeding the total University funding ($217K+$35K), the budget deficit was ca. $138K (see Table 2 on page 21 for details). Thus, the accumulated debt for 2000-2007 was ca. $260K.

The SSSC was committed to seek external grant funds to support its operations. Two applications to NSERC (MFA program, 2005; MRS program, 2006) were submitted; each requested ca. $150K/y. Of course, various users were the actual applicants
(2005, L. Delbaere, PI; 2006, J. Tse, PI) for these grants but the S SSC coordinated this activity. These applications were unsuccessful. In both the 2006 and 2007 competitions, the review committees wrote that the S SSC did not meet the program's criteria; in 2006, they specifically commented that such basic research infrastructure should be a University-funded facility. However, it is noteworthy that the reviewer reports associated with these applications were very positive and specifically noted the uniqueness and positive benefit of housing and managing a diverse array of major instrumentation in a central facility (see Appendix VII for these review reports). Further applications were not submitted to this NSERC program; the analogous CIHR program has not accepted new applications in recent years.

2007-2011 - The Current Phase

In keeping with the 2006 budget proposal to PCIP, the S SSC fee structure was dramatically changed effective May 1, 2007 (increasing rates ca. 2-3×; see Appendix III for current user fees). The budget principles were:

1. Internal University of Saskatchewan academic users doing research funded by Research Grants (e.g., where overhead is not normally charged) receive the full benefit of any University of Saskatchewan research subsidies that accrue to the Centre. These users are not be charged for S SSC staff time and the fees are based on the non-salary operating costs for the instrumentation.

2. University of Saskatchewan internal researchers conducting contract research (i.e., where overhead is normally charged), external academic researchers, and researchers from not-for-profit research institutes/centers (e.g. A AFC, PBI, etc.) should not be directly subsidized by the University of Saskatchewan and are charged 1.5× the hourly rate applicable to internal users and $50/h for S SSC staff time. These rates reflect the actual costs (salary and operating) for running the instrumentation but do not include any depreciation, infrastructure, or related costs.

3. Commercial rates apply to fee-for-service work or research from for-profit organizations. These users should be charged at rates that reflect the real costs (salary, operating, infrastructure, depreciation, etc.) of the service. (a short-term contract is usually negotiated for this type of work; however, the rates are much higher than that applicable to external users; e.g., ×3)

To ease the burden of substantial fee increases on major internal users, a flat fee of $4,000 was offered for unlimited use of all S SSC instruments (except for the 600MHz NMR and RegA laser) for the 2007-08 budget year; ca. 18 PI's took advantage of this offer. With only minor adjustments, these user fees have remained in place to date. In 2008-09, three PI's received >$10,000 worth of service (one >$15,000) for the $4,000 flat fee. Because this was a greater discount than intended and some suspicion of subcontracting, the flat fee was not offered in 2009-10. Instead, a sliding discount (up to 50%) was offered to major users based on the amount of pre-paid fees; e.g., a prepayment of $5000 bought up to $10,000 of service and a 50% discount on any additional service).

During 2007-2011 (four budget years), fees from internal users (average of ca. $104K/y) and from outside users (ave. of ca. $64K/y) were sufficient to cover the non-salary operating costs (ave. of ca. $148K/y). Thus, the objective of meeting non-salary operating costs of the S SSC from fee-generated revenue was achieved. However, the salary costs during the same period exceeded the University's
contribution by an average of ca. $81K/y resulting in a overall shortfall of $255K. The cumulative 2000-2011 debt is ca. $490K (see section 6: Financial Performance for an analysis).

4. Organization and Management

The SSSC is the responsibility of the Vice-President Research (Dr. Karen Chad). An internal Management Board has the following membership:

- **JAMES BASINGER**: Associate Vice-President Research, Chair
- **NICK OVSENEK**: Associate Dean (Biomedical Sciences), College of Medicine
- **SUZANNE ABRAMS**: Research Director, National Research Council - Plant Biotechnology Institute
- **NICOLAS LOW**: User Representative; Department of Food and Bioproduct Sciences
- **DALE WARD**: SSSC Director; Thorvaldson Professor, Department of Chemistry

Board meetings are convened by the Chair, at least annually, with additional meetings scheduled as deemed necessary by the Chair or requested by the Director. The Director prepares an 'Annual Report and Proposed Budget' for presentation to the Management Board in a meeting, usually in April (see Appendix IV for the 2010-11 Report). The budget, major changes in operating policy, and new policy initiatives are presented to the Management Board for approval.

The Director is appointed by the Management Board, reports to the Associate Vice-President Research and has a range of responsibilities, including: to develop and adhere to budgets; for four ASPA employees (the SSSC Manager and three Research Officers); to organize and consult with User Groups with respect to policies developed around instrument use, including user fees, and who need to be involved in the ongoing development of the SSSC.

The Manager (Dr. R. Sammynaiken) reports to the Director and has responsibility for day-to-day managerial responsibilities for the Centre and general supervisory responsibilities for the Centre's technical staff. Dr. Sammynaiken has also assumed operating and technical development responsibilities for one major suite of instruments in the Centre and acts in a business development capacity interacting with and promoting use by external clientele.

**Current Staff:**

**Director:** Dale Ward, Thorvaldson Professor, Department of Chemistry  
**Manager:** Dr. R. Sammynaiken  
**Research Officers:** Drs. S. Brunet and G. Schatte and Mr. J. Maley  
**Others:** Dr. K. Brown (NMR), Mr. K. Thoms (mass spectrometry), and Mr. G. Parry (electronics technician) are employees of the Department of Chemistry that spend considerable time operating and maintaining SSSC Equipment. Emeritus Professor J. W. Quail has an office within the SSSC and collaborates with several researchers on x-ray crystallography of 'small' molecules.
**Job Functions of Staff:**

Each staff member of the SSSC has primary responsibility for a suite of instruments and secondary responsibility that overlaps with another staff member’s primary responsibility. This mode of operation allows for staff development on multiple instrumental techniques and continued support for researchers during staff vacation and other time off work. Each staff member is responsible for maintenance and safety in their primary suite of instruments. Staff members routinely advise the manager on instrument status and research. They are active in research to develop their respective areas of responsibility and are involved in collaborative research with other researchers. Each staff member offers training workshops and seminars (e.g., "SSSC Discovery Series") for their primary suite of instruments. Staff members are available to conduct experiments for academic and industry users as required and also participate in preparing grant applications for new acquisitions and instrument upgrades. Staff members liaise with vendors and service engineers related to their primary suite of instruments and have billing responsibility for non-automated systems.

**Dr. Dale Ward,** SSSC Director, is the current Thorvaldson Professor in the Department of Chemistry. The SSSC Director position is ‘voluntary’; however, a small stipend equivalent to the amount required for one 3-CUE course of teaching relief are provided to support the position (ca. $6,000/y). Primary responsibilities include: to develop and implement policy for the operation and future development of the SSSC; to develop and adhere to budgets; for four ASPA employees (the SSSC Manager and three Research Officers); to organize and consult with User Groups in respect to policies developed around instrument use, including user fees, and the on-going development of the SSSC. An Annual Report and Proposed Budget are prepared and presented to the Management Board in a meeting, usually in April. The Director meets regularly with the Manager, at least annually with Management Board, at least annually with Staff, annually with users, and as required with specific user groups.

**Dr. R. Sammynaiken,** SSSC Manager, is a **1.0 FTE SSSC** employee (ASPA, phase MN3). He has primary responsibility for the day-to-day management of the centre (personnel, fiscal, and operations management); business development (e.g., seek and negotiate contracts with external users, identify and develop new instrumental methods); policy development (provide recommendations on: the establishment and evaluation of user fees; the purchase of major equipment items; the development of the Centre’s annual budget). He has broad expertise in a variety of instruments and techniques and serves as the scientific officer for some of the Centre’s instrumentation. His initial responsibilities for the biophysical suite, Raman, ESR, and AFM have been largely devolved to staff (see below); however, he continues to have primary responsibilities for the ESR and new developments such as XEOL and Dielectric Analysis.

**Dr. Sophie Brunet,** Research Officer, is a **1.0 FTE SSSC** employee (ASPA, phase SP2). Dr. Brunet has primary responsibility for the laser laboratory (setting up and training researchers on all aspects of confocal microscopy). She maintains the Laser Scanning Confocal Microscope, the TCSPC and assist with the Up-conversion apparatus. Dr.
Brunet works with researchers to develop laser-based experiments that are not standard offerings in the SSSC. Dr. Brunet has secondary responsibility in the Biophysical laboratory for optical instruments such as the CD, SPR and DLS.

**Dr. Gabriele Schatte**, Research Officer, is a **1.0 FTE SSSC** employee (ASPA, phase SP2). Dr. Schatte has primary responsibilities in the NMR and X-ray laboratories. She is the primary crystallographer and is responsible for maintaining and managing the crystallography laboratory. She jointly maintains and manages the NMR laboratory with Dr. Brown. Her secondary responsibility is ESR spectroscopy. Dr. Schatte has primary responsibility for the PCard, air compressors, the water circulator system, and for acquiring and assembling new computer hardware.

**Mr. Jason Maley**, Research Officer, is a **1.0 FTE SSSC** employee (ASPA, phase SP2). Mr. Maley’s has primary responsibility for the Biophysical instruments (CD, DLS, SPR, ITC, Perfusion Chromatography) and the Materials instruments (AFM and Raman). Primary responsibilities are shifting from the Biophysical to the Materials instrument suites. Over time, the workload balance has shifted as demand and usage of the Biophysical instruments has become more routine, whereas usage of the AFM and Raman instruments have increased. Mr. Maley maintains and instructs users on all instruments under his primary responsibility and partakes in new developments. He has secondary responsibility for the Laser Scanning Confocal Microscope.

**Dr. Keith Brown**, Research Officer, is a full-time employee (ASPA, phase SP2) of the Chemistry Department with both teaching and technical responsibilities. Dr. Brown is seconded to the SSSC for approximately **0.5 FTE**. He is the senior NMR spectroscopist in the SSSC with primary responsibilities to: maintain the operation of the NMR spectrometers; instruct researchers on use of NMR spectroscopy; offer theory workshops on NMR spectroscopy; maintain NMR software including implementation of new pulse sequences; function as the general IT consultant. Dr. Brown oversees accuracy of NMR billing and liaises with the chemistry department on issues related to NMR spectroscopy. Dr. Brown works together with Dr. Schatte and Mr. Parry on the smooth operation of the NMR suite of instruments.

**Mr. Ken Thoms**, Technician, is a full-time employee (CUPE, phase AP6) of the Chemistry Department with technical responsibilities primarily in the area of mass spectrometry. Mr. Thoms is seconded to the SSSC for approximately **0.7 FTE** to work on the Q-TOF instrument. He manages the mass spectrometry facility, assists with other instruments when needed and plays a significant role in instrument fabrication. Mr. Thoms is also the primary vacuum technologist in the SSSC. He has secondary responsibilities with the water circulator and air compressors. Mass Spectrometry is mainly a closed door facility, so Mr. Thoms is responsible for data acquisition and experiment development for most experiments. Researchers trained to use the mass spectrometer work under the guidance of Mr. Thoms.

**Mr. Garth Parry**, Technician, is a full-time employee (CUPE, phase AP6) of the Chemistry Department with technical responsibilities in the area of electronics. He seconded to the SSSC for approximately **0.1 FTE** assisting with technical (electronic
and mechanical) needs of the NMR spectrometers, mass spectrometers, and other instruments as needed.

**Dr. J. Wilson Quail**, Professor Emeritus in the Department of Chemistry, is an honorary member of the SSSC. He functions as an employee of the SSSC. He assists with small molecule crystallography, collecting data and solving structures in collaboration with researchers at the University of Saskatchewan and from other Universities. Professor Quail has secondary technical responsibility in the crystallography laboratory. The SSSC provides a small stipend for these services.

### 5. Users and Usage

The SSSC is a facility of crucial importance for the basic sciences, but also serves as the foundation organization for multidisciplinary collaborations ranging from medicine to synchrotron science to agriculture and biotechnologies (see Appendix VI for letters of support from users). During 2007-11, there were >200 active internal users (mostly graduate students, PDFs, and technicians) from >70 different research groups from across campus (Agriculture & Bioresources-8, Engineering-9, Medicine-15, Pharmacy & Nutrition-8, Arts & Science-24, Veterinary Medicine & VIDO-8) and 17 External client groups (University-5, Government Laboratories-5, Companies-7) (see Appendix III for list of users). Bar graphs showing the distribution of internal users according to the amount of fees paid in 2006-07 (initial user fee schedule) and 2010-11 (current use fee schedule) are shown below.

![Distribution of Academic Users fees 2006-2007](image1)

![Distribution of Academic Users fees 2010-2011](image2)

The Table below shows the usage, revenue, and expenses for each instrument for 2007-11. Virtually every instrument in the Centre generates fees sufficient to cover the non-salary costs of operating that instrument. Several 'smaller' instruments (e.g. SPR, ITC, DLS, CD, perfusion chromatography) have low annual operating costs and irregular maintenance requirements but generate sufficient revenue over time to cover those irregular costs. Other instruments (e.g., 500 MHz NMRs) have significant continuing operating costs but also generate sufficient revenue to cover those costs.
### Table 1. Summary of Operating Income, Revenue, and Hours of use by Instrument, 2007-2011

<table>
<thead>
<tr>
<th>Instrument</th>
<th>2007-2008&lt;sup&gt;a&lt;/sup&gt;</th>
<th>2008-2009&lt;sup&gt;a&lt;/sup&gt;</th>
<th>2009-2010</th>
<th>2010-2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Income</td>
<td>Expense</td>
<td>Hours</td>
<td>Income</td>
</tr>
<tr>
<td>NMR 600 MHz</td>
<td>$10,696</td>
<td>$40,563</td>
<td>713</td>
<td>$7,820</td>
</tr>
<tr>
<td>NMR 3x500 MHz</td>
<td>$42,935</td>
<td>$27,254</td>
<td>4799</td>
<td>$42,700</td>
</tr>
<tr>
<td>Proteum X-ray</td>
<td>$5,077</td>
<td>$11,067</td>
<td>254</td>
<td>$12,000</td>
</tr>
<tr>
<td>Kappa CCD X-ray</td>
<td>$9,200</td>
<td>$6,684</td>
<td>1470</td>
<td>$4,200</td>
</tr>
<tr>
<td>QTof Mass Spec.</td>
<td>$8,980</td>
<td>$12,146</td>
<td>728</td>
<td>$9,320</td>
</tr>
<tr>
<td>Lasers and Confocal</td>
<td>$11,577</td>
<td>$10,943</td>
<td>337</td>
<td>$19,200&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>SPR (Biacore)</td>
<td>$12,825</td>
<td>$7,784</td>
<td>427</td>
<td>$4200</td>
</tr>
<tr>
<td>Raman</td>
<td>$10,554</td>
<td>$0</td>
<td>226</td>
<td>$14,900</td>
</tr>
<tr>
<td>ESR</td>
<td>$16,149</td>
<td>$4,468</td>
<td>807</td>
<td>$19,650</td>
</tr>
<tr>
<td>AFM</td>
<td>$8,759</td>
<td>$1,339</td>
<td>292</td>
<td>$12,400</td>
</tr>
<tr>
<td>DLS</td>
<td>$1,746</td>
<td>$421</td>
<td>175</td>
<td>$800</td>
</tr>
<tr>
<td>ITC</td>
<td>$1,314</td>
<td>$572</td>
<td>263</td>
<td>$350</td>
</tr>
<tr>
<td>CD</td>
<td>$1,795</td>
<td>$458</td>
<td>96</td>
<td>$1,600</td>
</tr>
<tr>
<td>Perfusion chrom.</td>
<td>$3,969</td>
<td>$533</td>
<td>794</td>
<td>$1653</td>
</tr>
<tr>
<td>Other&lt;sup&gt;e,&lt;f&gt;&lt;/sup&gt;</td>
<td>$23,129</td>
<td>$10,961</td>
<td>-</td>
<td>$31,400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$168,705</td>
<td>$135,193</td>
<td></td>
<td>$182,193</td>
</tr>
<tr>
<td><strong>Total from CFPOAL</strong></td>
<td>$168,831</td>
<td>$135,358</td>
<td></td>
<td>$182,049</td>
</tr>
<tr>
<td><strong>Variance</strong></td>
<td>$(126)</td>
<td>$(165)</td>
<td></td>
<td>$144</td>
</tr>
</tbody>
</table>

<sup>a</sup> Income approximated by prorating the flat fee contributions.
<sup>b</sup> Annual cryoprobe maintenance (ca. $30K) deferred to 2010-11.
<sup>c</sup> Instrument modified for diffraction of small molecules
<sup>d</sup> Includes staff contract service to Steer group
<sup>e</sup> Lab expenses including repairs, consumables, computers, software, travel, phone, copy etc.
<sup>f</sup> Includes mainly FTIR, XEOL, Magnetic susceptibility, surface tension and other non-SSSC instruments for industry income
There are two significant exceptions to this situation: 600 MHz NMR and X-ray diffractometers.

**600 MHz NMR.** The annual non-salary operating costs for the 600 MHz NMR are ca. $45,000-$50,000. In 2007-11, the instrument was used for ca. 4850 hours (ca. 20% of capacity based on 6000 h/y) generating $40K from user fees compared to non-salary operating expenses of ca. $150K. In 2010-11, a significant increase in use of the 600 MHz NMR occurred (ca. 2000 h); nonetheless, revenues (ca. $16K in user fees) were far lower than costs (ca. $50K). The discrepancy between revenues and costs accumulated for this instrument over the past 4 years ($110K) represents ca. 43% of the accumulated debt of the SSSC during this period. The outstanding challenge is that our 600 MHz instrument has but a single major user and one significant minor user. The major user was hired under the Priority Determination initiative (i.e., the Biomolecular Structure Teaching and Research Program) specifically for his research expertise in biomolecular NMR and the presence of the 600 MHz instrument (with cryoprobe) was a significant factor in recruiting him. Without an external grant specifically for this purpose, there is no realistic way that a single academic users can provide in user fees more than a small fraction of the real operating costs. Academic researchers using this instrument must be subsidized, either externally or internally (as is the case with similar facilities elsewhere); however, the SSSC does not have resources to provide that subsidy nor does it have the mandate to allocate such a subsidy to a single instrument and user group.

**X-ray Diffractometers.** Both diffractometers are currently down thus temporarily resolving the discrepancy between revenues and operating costs. However, a more carefully planned solution to address researchers' need for both small molecule and protein x-ray crystallography is required. The Kappa CCD instrument has not been operational since late 2008. A series of problems with the cryojet, the CCD, the power supply, the computer, etc. were encountered; ca. $40K was invested trying to repair the instrument but without acceptable success. Only a major upgrade to this instrument will solve these issues. An NSERC RTI (submitted Oct 2010; ca. $140K; J. Mueller, Principal Applicant) was unsuccessful but will be resubmitted. A successful grant would allow the demand for small molecule crystallography to be met. The Proteum instrument (rotating anode; Cu-Kα radiation) is costly to operate ($10-20K/y) and was being used very infrequently for protein crystallography once the protein beamline(s) at the CLS became available. This instrument was modified in-house to allow use for small molecule crystallography and was often used for this purpose during 2008-2010. A meeting with protein crystallographers in May 2010 concluded that essentially there was no current or anticipated future demand for use of this instrument. It was agreed that SSSC would continue to operate the instrument until a major maintenance was required. Decommissioning of the Proteum instrument started on Dec 20, 2010 after the ferro-fluidic seal failed. Consequently, the group of researchers requiring small molecule crystallography have no current access to this technique. The impending arrival of a new Canada Research Chair (CRC) in protein crystallography will rekindle interest in having access to protein crystallography.
outside the CLS. Similarly, as access to the CLS becomes more competitive, protein crystallographers will require off-line access if only to screen crystals prior to collecting synchrotron data. This new CRC has expressed and interest in underwriting the costs of maintenance from other sources and taking responsibility for those costs in lieu of user fees. Such a developments could justify the SSSC’s continued operation of the Proteum.

As a possible alternative for small molecule crystallography, an option to collect data sets at the CLS was explored. Preliminary experiments were successful and data could be collected from crystals almost an order or magnitude smaller than required for standard instruments. The disadvantage of the absence of an automated kappa angle option has since been resolved by installation of new equipment at the CLS and this is waiting to be tested.

Clearly, the SSSC has demonstrated considerable success in its mission to be a central, major instrumentation facility for structural sciences that provides open access to: a wide range of University of Saskatchewan researchers in the physical sciences, health sciences, and engineering; the Canadian Light Source (CLS); public-sector research organizations; private businesses. Access to SSSC instrumentation enhances the research from numerous academic, government, and commercial labs and is essential to the research programs of several pre-eminent UofS faculty.

The SSSC also contributes to teaching and enhancing the 'student experience'. Access to modern sophisticated scientific instrumentation providing high quality research and training opportunities. Literally hundreds of students (undergraduate and graduate) and research personnel (postdoctoral, RAs, technicians, etc.) have received ‘hands-on’ training on the use of advanced instrumentation from SSSC personnel. In addition, numerous students have received training via the SSSC Discovery Series. The series consists of short courses on various experimental techniques available in the Centre. Each ‘course’ is divided into ‘modules’ (introductory, advanced, etc.) with each presented in a ‘workshop’ format. Currently the SSSC is providing crucial laboratory resources for courses in the Biomolecular Structure Studies program (4Y and honours B.Sc.) and to several other courses (e.g., CHEM 801.6, 242.3, 353.3, 354.3, 369.3).

**Grants.** SSSC equipment has been upgraded with the assistance of several NSERC equipment grants (>750K, 2003-2011):

- 2010 NSERC RTI - *Improving Scanning Probe Microscopy for Imaging Nanoparticles* ($52,819; R. Evitts with I. Burgess, R. Chibbar, A. Hirose, R. Sammynaiken, J. Yang)

In addition, Prof. Dmitriev received a 2007 CFI-LOF grant - *Microvolume Nuclear Magnetic Resonance Probe for High-efficiency Analysis of Protein Interactions with Small Molecules* ($60,000; installed in 2009). In 2008, Dr. Barbara Cade-Menum of Agriculture and Agrifood Canada purchased a 10 mm broad band probe for 500 MHz NMR that is available for use by other researchers.

**Publications.** From 2002-2010, >350 publications have appeared that, at least in part, included data obtained at the SSSC.

### 6. Financial Performance

Table 2 (page 21) shows a summary of revenues and expenditures during the period 2000-2011. The data for 2000-2005 are taken from reports prepared by B. Geib (Financial Analyst with UofS Human Resources) and submitted to the Director. Data for 2005-2011 are taken from CFOPAL (UofS financial management system) and corrected by checking the individual items on a line-by-line basis and ensuring that charges and credits are assigned to the appropriate budget year (i.e., the year the cost or service occurred). The resulting summary totals are extremely close to those in the CFOPAL system; the major variance concerns the Molecular Design Group’s (MDG) Nov 2009 removal of $20K from the SSSC operating account reversing the payment made by the MDG in July 2005 (we are currently disputing this reversal).

As detailed in Section 3 above, the Establishment Phase of SSSC (2000-04) produced a nearly balanced budget (debt of ca. $26K on expenditures of $824K). This was achieved despite negligible revenue from users fees during this period (ca. $65K) because of the contingency reserve that had accrued prior to having the full staff contingent in place. In contrast, during the Start-up Phase (2004-07) a significant accumulated debt ($232K on expenditures of $1,256K) was realized. This debt can be attributed to two different structural deficits. Firstly, the income generated from users during this period ($265K) was insufficient to cover non-salary operating costs ($366K). Secondly, University support ($759K over 3 y) was increasingly insufficient to cover salary and benefit costs ($890K over 3 y). In the Current Phase, fees from internal users (average of ca. $104K/y) and from outside users (average of ca. $64K/y) were sufficient to cover the non-salary operating costs (average of ca. $148K/y). Thus, the objective of meeting non-salary operating costs of the SSSC from fee-generated revenue was achieved. However, the salary costs during the same period exceeded the University’s contribution by an average of ca. $81K/y resulting in an overall shortfall of $255K. The cumulative 2000-2011 debt is ca. $460K. The actual debt might be higher if one considers that in three the last four years (2007-11), the University contributed more than the promised $255K/y. The extra amount (ca. $45K) originated from the Indirect Costs Program and could be interpreted as a mechanism to partially write down the SSSC debt rather than an increased contribution to the SSSC operating account.
Table 2. SSSC Financial Summary 2000-2011 (with carry over to 2012)\(^a\)

<table>
<thead>
<tr>
<th>Year ending</th>
<th>Internal Income</th>
<th>External Income</th>
<th>Central Contribution</th>
<th>Non Salary Expense</th>
<th>Salary/benefits Expense (^b)</th>
<th>Total Income</th>
<th>Total Expense</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 30, 2001</td>
<td>$0</td>
<td>$0</td>
<td>$65,630</td>
<td>($20,328)</td>
<td>($59,872)</td>
<td>$65,630</td>
<td>($80,200)</td>
<td>($14,570)</td>
</tr>
<tr>
<td>April 30, 2002</td>
<td>$0</td>
<td>$5,762</td>
<td>$231,570 (^b)</td>
<td>($36,043)</td>
<td>($79,579)</td>
<td>$237,332</td>
<td>($115,622)</td>
<td>$121,710</td>
</tr>
<tr>
<td>April 30, 2003</td>
<td>$8,532</td>
<td>$175</td>
<td>$217,844</td>
<td>($88,558)</td>
<td>($154,724)</td>
<td>$226,551</td>
<td>($243,282)</td>
<td>($16,731)</td>
</tr>
<tr>
<td>April 30, 2004</td>
<td>$50,368 (^c)</td>
<td>$54</td>
<td>$217,844</td>
<td>($133,009)</td>
<td>($260,128)</td>
<td>$268,266</td>
<td>($393,137)</td>
<td>($124,871)</td>
</tr>
<tr>
<td>April 30, 2005 (^d)</td>
<td>$88,301 (^e)</td>
<td>$11,000</td>
<td>$252,000 (^f)</td>
<td>($104,749)</td>
<td>($293,531)</td>
<td>$351,301</td>
<td>($398,280)</td>
<td>($46,979)</td>
</tr>
<tr>
<td>April 30, 2006 (^g)</td>
<td>$93,260 (^h)</td>
<td>$18,300</td>
<td>$252,000 (^i)</td>
<td>($117,404)</td>
<td>($292,274)</td>
<td>$363,560</td>
<td>($409,768)</td>
<td>($46,118)</td>
</tr>
<tr>
<td>April 30, 2007 (^i)</td>
<td>$28,393</td>
<td>$25,394</td>
<td>$255,000 (^j)</td>
<td>($143,872)</td>
<td>($303,855)</td>
<td>$308,787</td>
<td>($447,327)</td>
<td>($138,940)</td>
</tr>
<tr>
<td>April 30, 2008 (^k)</td>
<td>$111,757</td>
<td>$57,074</td>
<td>$284,000 (^l)</td>
<td>($135,358)</td>
<td>($334,681)</td>
<td>$452,831</td>
<td>($470,079)</td>
<td>($17,208)</td>
</tr>
<tr>
<td>April 30, 2009 (^m)</td>
<td>$112,575</td>
<td>$69,474</td>
<td>$284,000 (^n)</td>
<td>($172,239)</td>
<td>($342,466)</td>
<td>$466,069</td>
<td>($514,705)</td>
<td>($48,656)</td>
</tr>
<tr>
<td>April 30, 2010 (^o)</td>
<td>$78,407</td>
<td>$69,454</td>
<td>$273,455 (^p)</td>
<td>($121,257)</td>
<td>($373,492) (^q)</td>
<td>$421,316</td>
<td>($494,749)</td>
<td>($73,433)</td>
</tr>
<tr>
<td>April 30, 2011 (^p)</td>
<td>$112,565</td>
<td>$62,419</td>
<td>$262,000 (^q)</td>
<td>($142,863)</td>
<td>($367,033)</td>
<td>$436,984</td>
<td>($509,896)</td>
<td>($72,925)</td>
</tr>
</tbody>
</table>

2011 Transfer \(^n\) | $20,518 |

May 2000- Apr 2011 Total | ($458,190) |
May 2005- Apr 2011 CFOPAL Total = ($344,355); corrected total ($324,355) \(^o\)

\(^a\) Establishment Phase, Startup Phase, Current Phase

\(^b\) Includes $14,570 transferred to cover the 2000-01 deficit.

\(^c\) Includes: $20K (L. Delbaere’s CHI Equip. Maint. Grant); $12K (subcontracts from internal clients’ external contracts); $19K (internal user fees).

\(^d\) First year of operation of SSSC (fully functional and with user fees).

\(^e\) Includes: $33K (L. Delbaere’s CHI Equip. Maint. Grant); $34K (internal user fees).

\(^f\) Includes $35K from the Indirect Cost Program (ICP).

\(^g\) Includes: $20K (Molecular Design Group; MDG); $48.3K (subcontracts from internal clients’ external contracts); $25K (internal user fees).

\(^h\) Entries for budget years ending 2006-2010 were checked line-by-line against CFOPAL data; table entries reflect several changes vs. CFOPAL resulting from assigning revenue/expenses to the correct budget year (i.e., the year the cost or service occurred).

\(^i\) Funding from the Strategic Research Fund (SRF); ca. $220K from central operating funds with remainder from ICP.

\(^j\) First year of user fee schedule based on the principle of cost recovery of non-salary expenses.

\(^k\) Includes a one time payment of $18,454 from OVPR for a sessional instructor to provide teaching relief for Director for 2007-2010.

\(^l\) Includes $17,379 of salary and benefits for a research assistant during 2007-2010 (in lieu of sessional instructor for Director).

\(^m\) These entries are projected; final numbers not yet available for 2010-11.

\(^n\) Excess fees (i.e., for services not rendered) collected from internal users in 2010-11 were carried over to 2011-12.

\(^o\) CFOPAL total includes $20,000 removed by MDG in 2009.11 (reversing their 2005.07 contribution); the SSSC is disputing this transfer.
As detailed in Section 3 above, the Establishment Phase of SSSC (2000-04) produced a nearly balanced budget (debt of ca. $26K on expenditures of $824K). This was achieved despite negligible revenue from users fees during this period (ca. $65K) because of the contingency reserve that had accrued prior to having the full staff contingent in place. In contrast, during the Start-up Phase (2004-07) a significant accumulated debt ($232K on expenditures of $1,256K) was realized. This debt can be attributed to two different structural deficits. Firstly, the income generated from users during this period ($265K) was insufficient to cover non-salary operating costs ($366K). Secondly, University support ($759K over 3 y) was increasingly insufficient to cover salary and benefit costs ($890K over 3 y). In the Current Phase, fees from internal users (average of ca. $104K/y) and from outside users (average of ca. $64K/y) were sufficient to cover the non-salary operating costs (average of ca. $148K/y). Thus, the objective of meeting non-salary operating costs of the SSSC from fee-generated revenue was achieved. However, the salary costs during the same period exceeded the University’s contribution by an average of ca. $81K/y resulting in an overall shortfall of $255K. The cumulative 2000-2011 debt is ca. $460K. The actual debt might be higher if one considers that in three the last four years (2007-11), the University contributed more than the promised $255K/y. The extra amount (ca. $45K) originated from the Indirect Costs Program and could be interpreted as a mechanism to partially write down the SSSC debt rather than an increased contribution to the SSSC operating account.

7. Strengths, Weaknesses, Opportunities, Threats

**Strengths:** A successful SSSC is important to the University of Saskatchewan for many reasons. The SSSC provides fundamental infrastructure for a research university as evidenced by the number and diversity of users (see Appendices III and VI); this user group continues to grow. The unique organizational structure of the SSSC guarantees access to all academic users and this access has been an important component in recruitment of new faculty. The SSSC provides crucial resources to the Biomolecular Structure Studies program (4Y and honours B.Sc.) and other several other courses (e.g., CHEM CHEM 801.6, 242.3, 353.3, 354.3, 369.3). Several hundreds of students (undergraduate and graduate) and research personnel (postdoctoral, RAs, technicians, etc.) have received ‘hands-on’ training on advanced instrumentation from SSSC personnel. The Centre provides a nucleus of cross-disciplinary activity and collaborations. The SSSC complements the CLS and can provide core facilities (e.g., laboratory space for sample preparation, preliminary measurements, etc.) to visiting scientists and/or for contracted projects. Little of the above would be possible without the SSSC.

Access to sophisticated instrumentation is crucial to the success and competitiveness of any research-intensive university and obtaining new or replacement equipment on a regular basis is essential. Funds for such initiatives must be obtained from external sources, almost exclusively from competitive grant applications. Success in such competitions for major and expensive instrumentation requires prominent research-
active users as applicants. The presence of large user groups is a decided advantage and this reality places researchers from small to medium size universities at a disadvantage. The SSSC as a centralized multi-disciplinary multi-user facility can help improve competitiveness by bringing users together and promoting growth of the user groups.

**Weaknesses:** The relatively small research groups at the University of Saskatchewan dictate that operation of major scientific instrumentation will be more expensive because the significant fixed costs associated with the operation of sophisticated instrumentation must be shared by fewer researchers. It is a fact that most of the SSSC’s instrumentation is expensive and sophisticated and therefore requires skilled technical support to ensure proper operation and maintenance. Although this type of support can be purchased from the instrument vendor (i.e., maintenance contracts), the cost is prohibitive. The SSSC cannot exist without technical support staff. In almost every research-intensive university in Canada, such instrumentation is supported by technical staff whose salaries (in whole or in part) are base-budgeted.

**Opportunities:** In major universities, large user groups facilitate the establishment of many instrument labs (typically department-based), each dedicated to one type of instrument. For a small-to-medium sized research university, the benefits of a central facility are substantial. Centralization brings economies of scale to both the physical space requirements and, importantly, to the technical support needs. Although most of the individual instruments within the SSSC are not unique, the integration of several types of major instrumentation in one center is novel and advantageous. This organizational structure of the SSSC facilitates and promotes access to advanced instrumentation for researchers in disciplines or groups that are too small to justify a dedicated 'local' facility. Additionally, expert SSSC staff promote access and utilization by researchers inexperienced with these advanced research tools affording them the opportunity to compete with colleagues at major universities. The SSSC as a centralized multi-disciplinary multi-user facility can help improve competitiveness by bringing users together and promoting growth of the user groups.

**Threats:** The lack of base-budget support for salaries of core personnel threatens the very existence of the SSSC. Access to SSSC equipment is of demonstrated and crucial importance to the research programs of many University of Saskatchewan faculty; consequently, it is assumed that abandonment and/or sale of equipment is not an option. An alternative would be to phase out the Centre and devolve fiscal and management responsibilities of individual (or groups of) instruments to individual faculty, departments, or colleges. Of course, this arrangement will not change the fundamental requirement for technical support to efficiently operate and maintain sophisticated instrumentation. In fact, the integrated operating costs would increase because of the loss of any economies of scale. Decentralization would also create a significant barrier to access (e.g., consider the barriers to 'outside' users of almost any department or college managed facility). Indeed, the Centre was created, in part, to guarantee access to a central facility.
8. Future Directions

Access to sophisticated instrumentation is crucial to the success and competitiveness of any research-intensive university and obtaining new or replacement equipment on a regular basis is essential. Funds for such initiatives must be obtained from external sources, almost exclusively from competitive grant applications. Success in such competitions for major and expensive instrumentation requires prominent research-active users as applicants. The presence of large user groups is a decided advantage and this reality places researchers from small to medium size universities at a disadvantage. The SSSC as a centralized multi-disciplinary multi-user facility can help improve competitiveness by bringing users together and promoting growth of the user groups.

The specific collection of instrumentation in the current SSSC arose primarily from the needs of a core group of researchers in 1998-99. Some of these instruments serve large user groups while others have few users. Much of the current SSSC equipment is no longer state-of-the-art. In due course, some equipment will require replacement or upgrading and additional equipment will become desirable as new research areas or groups emerge. For example, there is growing demand from researcher at the University of Saskatchewan for access to instrumentation to support research in materials science (e.g. XPS, TEM, STEM) and the SSSC has the capacity to evolve to accommodate that research.

It is recognized that researchers applying for major instrumentation will almost always prefer to have all necessary support facilities in or proximate to their labs. With sufficient resources, that preference can be accommodated. However, the operation and maintenance requirements of major instrumentation will always pose an enormous sustainability challenge to small user groups. Indeed, the SSSC was formed not because of the desire of researchers for a centralized facility but rather because the CFI requirement for matching funds catalyzed the University level decision to centralize the space, management, and technical support requirements. Nonetheless, the SSSC has now clearly demonstrated that this centralization brings economies of scale to both to the physical space requirements and, importantly, to the technical support needs. The SSSC has proven that it can operate and maintain a diverse collection of major instruments cost effectively (cf. maintenance contracts) will open access and reasonable user fees. The University investment in the SSSC has provided superb space and excellent technical personnel required for the operation of major instrumentation. The full potential of that investment will only be realized with a University level commitment to install new instrumentation in the SSSC wherever possible.