Report of the Instrumentation Planning Group

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Members: Julie Bartley (Geology; co-chair), Mark Bjelland (Geography), Jeff Dahlseid (Biochemistry and Molecular Biology), Mike Ferragamo (Neuroscience), Colleen Jacks (Biology, co-chair), Jeff Jeremiason (Environmental Studies), Mark Kruger (Psychology), Jessie Petricka (Physics), Dwight Stoll (Chemistry), Bruce Van Duser (Health and Exercise Science)

Summary of Recommendations

- The College should establish an annual operating budget sufficient to provide for acquisition and replacement of scientific instrumentation. We believe funds of $250K annually would be sufficient to meet the current and near future needs of the College. With the availability of such funds, departments would initiate more complete planning, singly and jointly, for their instrumentation needs. The College advancement office should work to establish an endowed fund to offset the cost to the general budget.
- Maintenance and repair funds should be fully supported by through dedicated budget lines. In the interest of transparency, the availability and amount of these funds should be made known.
- A standardized reporting format for instrumentation inventory and costs needs to be developed and utilized by all departments and the Provost's Office.
- The technician position, vacant due to retirement, should be filled with a full time, non-teaching individual primarily responsible for turnkey instrument maintenance and repair. The hired individual should report to a single department chair, who works in consultation with all stakeholder programs and departments.
- The technician should be responsible for a budget containing the necessary funds to fulfill basic position responsibilities and provide for job-related training.
- Additional support for identified technology needs should be addressed as soon as practical.

Introduction

The scientific disciplines have become increasingly instrumentation-driven fields in the 21st Century. The questions scientists seek to answer require ever more complex means of making observations, quantifying measurable phenomena and analyzing results. As a national liberal arts college that prides itself on the "recognized excellence" of its programs and the strong preparation that students receive in their education for "lives of leadership and service," Gustavus must continue to develop its science curriculum to meet the needs of our students and the scientific community they will join. Increasingly, our graduates need instrumentation skills that are considered prerequisite to careers or graduate school. Additionally, our faculty must expand its capability to provide relevant, modern research experiences to students conducting research. For these reasons, the College needs to maintain and enhance its scientific instrument holdings to provide the best possible laboratory and investigational experience for our students, a strategy that requires stewardship of current instrumentation, replacement of aging instruments, and acquisition of new instrumentation that supports our science programs.

Representatives from departments and programs with significant scientific instrumentation and equipment needs* met during Fall 2010 to discuss these needs and to make recommendations for the College's planning and funding in support of these needs. The co-chairs met with each department included with this report to discuss instrumentation needs and ways by which those needs might be

met. Information regarding practices at colleges that are either formally or informally our 'sister' institutions was sought through professional networking activities. Information was collected at both the departmental level (e.g. department budget information and inventory lists) and the college level (records from the Provost and Finance Offices). All departments interviewed indicated that their top three instrumentation challenges were acquisition, replacement, and maintenance. There was unanimous agreement that these needs were immediate and acute, and that lack of material support for instrumentation adversely impacted teaching and student and faculty research capabilities. Therefore, our discussions mainly included the acquisition and replacement of scientific equipment used in teaching and research, the preventative maintenance and repair of equipment, and the need for a full-time technician dedicated to assisting with maintenance and repair. Due to the computer software-driven nature of much scientific instrumentation, technology support issues arose frequently in discussions. Finally, we discussed in a limited way the need to develop practices of collective decision-making regarding facilities and instrumentation, as well as instrumentation user policies, including cost charges for users and supplies.

For the purposes of this report, the terms 'instrument' and 'equipment' are used interchangeably. Therefore, this report addresses a range of lab-related items from expensive, computer-driven data collection instruments such as the chemistry department's NMR, to preparatory equipment such as refrigerated centrifuges with a mid-range cost, to smaller instrument/equipment items not inventoried by the College due to their lower original cost, such as pipettors, electrical power supplies and electrophoresis chambers. Also included is specialized software used for data collection and analysis, for example GIS, bioinformatics, data analysis, or specialty modeling software, that may require maintenance through updates and debugging ('repair'). Here, we summarize our findings on the current status of scientific instrumentation in the departments and programs utilizing scientific instrumentation, describe a technician position that meets the most critical of our maintenance and repair needs, and provide our vision for how the College should work to support these needs financially.

Scientific Instrumentation Needs

Background and Current Situation

Instrumentation to support teaching and research in the sciences represents a significant investment of College funds. Although establishing the total replacement value of this resource was not possible due to the variety of ways the instruments have been obtained and the difference in inventory records among departments, available data help describe just how significant the financial investment in scientific instrumentation has been. A total of $2,318,632 was spent by the College (about half from external sources) on instrumentation priced over $5,000 and purchased since the 2000-2001 fiscal year, as documented by Finance Office records kept to monitor depreciation for accounting purposes. In some cases, this total includes the initial service contract purchased by the College. This total does not include non-inventoried equipment purchases of less than $5000 per item, the category into which the majority of the instrument holdings of the science departments falls. This list also does not include functioning equipment more than ten years old, as these items have been fully depreciated from an accounting standpoint but many (if not most) are still in use. Members of the group also indicated that possible discrepancies existed on the Finance Office's inventory list as they knew of instrumentation they believed should be reflected on the list and was not (e.g. only 60% of the cost of the Zeiss laser confocal microscope seems reflected on this spreadsheet).

Maintenance of instrumentation also requires significant investment by the college. On average a combined total of $37 K is spent annually by Biology, Chemistry, HES, Physics, Geology, and the

Provost's Office for equipment repair and maintenance, and the Provost's Office has spent on average $35 K per year from discretionary funds for equipment purchase and replacement. We know that current expenditures are insufficient to properly maintain equipment; departments and programs indicated that maintenance was frequently deferred due to lack of funds.

The Chemistry Department's current instrumentation situation typifies that of all the science departments; much equipment is operating beyond its expected lifespan and some equipment is at the stage of critical failure. Chemistry's Nuclear Magnetic Resonance (NMR) spectrometer (installed in 1995), and their Fourier transform infrared spectrometer (installed in 2002) are of special concern. Both are used in extensive and essential ways by students in the large first- and second-year organic and inorganic courses (100-200 students each), as well as in student and faculty research. The most recent failure of the NMR spectrometer is irreparable – the workhorse probe has failed and a service inquiry revealed that the probe is obsolete and cannot be repaired or appropriately replaced. When the infrared spectrometer failed, shipment and repair cost several thousand dollars and deprived students (organic, inorganic, and research students) of its use for an entire semester. Every unit represented in the working group reported similar situations and challenges to maintaining usable, modern instruments for our students in classes and in research.

Our meetings with departments and our group's discussions indicated that typically inventoried equipment purchases were made using external funds, start-up money for new faculty, or by special request of funds from the Provost; departmental budgets either do not include funds for these purchases, or the amounts budgeted are wholly inadequate to meet the need. The lack of a formal mechanism or structure on campus for communication among departments regarding instrumentation has led to some purchase redundancies on campus. Repair and replacement of instrumentation also suffers from this lack of communication as several departments indicated that they did not know that it was possible to contact the Provost's office to obtain additional funds for instrumentation acquisition, repair and maintenance. Lack of any instrumentation support since Warren Bidwell's retirement is leading to atrophying equipment and an increase in time spent by faculty for maintenance – costly both from the perspective of decreasing the life span of equipment and by decreasing faculty time available to our students. The group also found that most departments had need for support of specialized software used for instrumentation control and data analysis that GTS is unable to provide.

Addressing Acquisition and Replacement Needs

The consensus of our planning group is that the College needs to establish a dedicated funding stream for instrument acquisition and replacement. The funding model we describe here would be for on-going needs within the impacted departments; instrumentation needs of newly hired faculty would still be met through start-up funds provided separately by the Provost's Office. Initially, this would be a budget line within the Provost's Office with the expectation that a scientific instrumentation endowment would be fully funded during the next capital campaign. The expendable amount from this budget line or endowment fund should be carried over between fiscal years in the event it is left unused in any one year. The use of these funds should prioritize acquisition of instruments that will support our teaching and research programs. Departments and faculty will continue to pursue instrumentation through external funding sources (e.g. NSF, private donors). The group agreed that the distribution of College funds should be conducted using a process that makes transparent both the amount of money available and the decision process for distribution of funds

Several models for the source of funding (e.g., operating budget or endowment income) and for distribution of funds were considered by our group. We recommend the model used successfully by St.

Olaf College for funding through the operating budget until such time when income from a restricted instrumentation endowment is robust enough to take over this role. At St. Olaf, approximately $250,000 is spent annually on instrument acquisition and replacement; these funds are realized from the College's annual operating surplus. We believe that this dollar amount is appropriate for current and near future needs; appropriate future increases would need to occur due to escalating costs of scientific instrumentation, programmatic changes, and increased student numbers.

Distribution of funds relies on appropriate planning and replacement projections by each department and program. Although no department or program can predict with certainty when an instrument will completely fail and need to be replaced, the age and maintenance record of an instrument are strong indicators of when replacement will be necessary. Departments also need to plan for new acquisitions that reflect changes to their laboratories or their discipline. In our proposed model, funds to support instrument acquisition and replacement would be distributed in two ways:

1) Each department should have rotating access (full or partial) to $50K (assuming a total funding level of $250K annually) of the funds for acquisition and/or replacement of instrumentation they have determined necessary for their program. Initially, we recommend a 5-year rotation in order to facilitate realistic planning by the impacted departments and programs. We believe that a rotation cycle longer than five years would negatively impact planning. Such a rotation would combine 2 to 3 units (departments and programs) for funding during each year of the cycle. The stakeholder units will work with the Provost's Office to determine the specific rotation schedule. This rotation structure would be open to change as the size and needs of departments and programs altered over time. The units accessing funds will provide a budget that includes the purchase price of each instrument, its anticipated annual operating cost and a programmatic justification to the Provost's office to ensure accountability, but with the typical expectation that it will be approved.

2) A deliberative and collaborative process involving the stakeholder departments and programs will be used to distribute the remaining annual funds (e.g., $200K of a $250K budget), similar to the model used at St. Olaf. Each year, departments and interdisciplinary programs would develop their prioritized list of needs, with rationale and upper-bounded cost estimates to ensure the need is fully budgeted. A group including all chairs and program directors from impacted departments and programs would then meet to consider all requests and together negotiate a ranked acquisition list based on the expressed programmatic needs; all departments and programs would participate equally in this process. The list would be funded in ranked order as long as funds are available. Requests not funded would be rolled over for consideration with new requests the next year.

The implemented plan should be flexible enough to allow for non-standard acquisition or replacement requests. For example, departments or programs in mid-cycle of the standard rotation with an immediate need for fund access to replace a 'dead' instrument necessary for their program may submit a proposal specifying this need to the Provost's Office for consideration. This replacement may be counted towards their next allotment under 1) above. Departments and programs may combine funds to purchase shared instrumentation or choose to combine these funds with external funds for instrumentation acquisition. This process would encourage more shared use of instrumentation and reduce the chance that purchases will be redundant.

This acquisition and replacement fund should be separate from funding for maintenance and repair.

Addressing Instrument Maintenance and Repair Needs

The College has an excellent history of being good stewards of its scientific equipment. Most departments and members of the planning group could point to particular instances when instruments failed and the Dean or Provost approved the funds for necessary and immediate repairs (e.g. the chemistry department's NMR) or replacement of a failed instrument. The purchase of maintenance agreements on new acquisitions and for mission-critical equipment vulnerable to breakdowns (e.g. the biology department autoclave) has been approved when requested by individual departments. Although this strategy has been adequate for response to emergency repair needs, it is wholly inadequate to allow for proper stewardship by way of regular, planned maintenance, which would help reduce the frequency of catastrophic instrument failure.

Additionally, we found that the present ad hoc process for instrument maintenance and repair is not evenly applied and lacks transparency. Some members of the group were unaware that the Provost's Office would entertain such a request outside of regularly budgeted departmental funds, and these departments found themselves trying to decide whether they could give up other programmatic needs to finance a repair. Environmental Studies which has no departmental 'home' has no funds available for instrumentation repair. With department budgets being flat-lined year after year, inadequate monies are available for the maintenance needs of departments with aging instrumentation and new acquisitions – departments are discouraged from requesting the realistic funds they need. Finally, the coverage of repairs from a budgeted equipment repair line with an unknown dollar amount and 'possible' discretionary funds within the Provost's budget leaves departments and programs unsettled, not knowing whether funds will be available should a major instrument breakdown occur. Transparency is needed in the repair request and budgeting process.

We believe that maintenance and repair of an instrument is simply part of the "cost of doing business" in delivering a scientific curriculum at a premier liberal arts institution. These largely predictable costs should be handled through the regular college budgeting process and should appear in both departmental and Provost's Office budgets. It is important, however, that part or all of these budget lines roll over beyond the end of a fiscal year. Although predictable in aggregate, the distribution of maintenance and repair emergencies stubbornly refuses to follow a budgetary cycle. One potential solution is that the Provost's repair line remains beyond the fiscal year, but a department's does not.

We recommend the following;

- Extended warranty and service contracts (maintenance agreements) for critical equipment should be budgeted at the time of purchase. When the purchase comes from the instrument fund described above, the initial maintenance agreement is included in the cost.
- For each new instrument acquired, the College must evaluate the advisability of purchasing a service contract and develop a plan for post-contract maintenance. Department repair funds should be budgeted at an amount that will cover these maintenance agreements beyond the initial instrument purchase as well as reasonable repair costs based on actual department repair history and/or reasonable estimates of the same. To ensure accountability for increased repair budget lines, the movement of these funds to other department lines would not be allowed.
- The vacant technician position should be filled in the manner described below. The working group believes this model best maximizes cost efficiency while filling the needs of the greatest number of users.

- Additional support positions filling more needs (see below) should be pursued as soon as practical.

Technical Position Dedicated to Scientific Instrument Maintenance and Repair

The working group identified four support areas of significant need among the represented programs and departments, listed below in no particular order of importance:

1) Support for academic and research computing. The represented programs and departments all identified a critical need for individuals who have both computing (including basic programming) and scientific skill sets. Although detailed position descriptions were not developed, members of the group described possible positions, including a GIS lab manager; psychology computing expert; and someone to provide bioinformatics support.
2) Support for equipment construction and maintenance. The working group identified a need for an individual with the technical knowledge to handle mechanical and electrical needs, maintain a supply of electronic and other parts for immediate use by faculty in course and research laboratories, as well as to work with science faculty to construct equipment.
3) Teaching and research instrumentation troubleshooting, maintenance, and repair. A third identified need requires an individual to work with faculty to maintain existing turnkey (instruments intended for a specific use and ready "out of the box" for that purpose) instruments.
4) New instrumentation support. This group also identified a future need for support of instruments acquired as a result of new building projects, grants, and endowments.

After much discussion, the group felt that need area (1) fell under the auspices of the Academic Technology Committee (ATC), which has been grappling with issues surrounding academic and research computing. While we believe these needs to be critical, we did not think that a single individual could meet all of the academic computing needs across several departments. However, we feel it is important to stress that these computing/technology needs must be addressed, and we include a summary, based on our discussions, of these needs in a separate section (see "Technology Support Issues" below). Thus, we decided to limit our discussion to need areas (2-4), with the expectation that unmet needs regarding academic computing are currently being discussed by ATC.

Of the remaining need areas, (2) is most like the role fulfilled by Warren Bidwell prior to his retirement. Several departments have need for this style of technician; Warren principally supported traditional electronics and machinery needs, and this need persists. It, however, was not a full-time need and would likely remain so. Additionally, need area (4) represents a likely area in which we will require support over a 5+ year time frame. A technician primarily answering to need area (3) would more completely address the most significant and immediate scientific instrumentation support needs across the greatest number of users, and this is the need we recommend filling with a technician. It is our expectation that any individual hired for the technician's position would have the ability to add expertise on a subset of new instruments (need area (4)) as they were acquired through targeted training opportunities, and would be able to provide support to the overlapping areas of need area (2) (in addition to a primary role in area (3)) that has been provided historically.

Finally, a technician who supports turnkey instrumentation will support both faculty needs and cost efficiency, as described below.

Faculty needs – As the inventory of scientific equipment on campus has grown, so too has the demand on faculty time to maintain, calibrate, and troubleshoot these instruments. Time better used working

with our students on course-related concepts and experiments is currently spent setting up instruments, checking whether they are operating, performing initial diagnosis, and arranging for their repair if necessary. Malfunctioning instrumentation limits the experience we can provide our students and thus limits their preparation for their post-Gustavus pursuits. As our research capabilities expand, so too does the research "overhead" associated with maintaining the laboratories that support these capabilities. Toward that end, a technician shared across the instrumentation-intensive departments* would enable faculty to shift time toward laboratory teaching and research, including pursuit of external funds, and away from instrument maintenance. Under this model, faculty would retain responsibility for oversight and operation of instrumentation, but a technician would help substantially with troubleshooting, regular maintenance, and communication with off-campus technical support when attempting to identify problems.

These three items are particularly important for faculty-directed research facilities, because these tasks combine to take up a significant portion of a faculty member's research time. Typically, faculty members use research instrumentation intensively during times when their teaching and service workloads might be lower (e.g., summer and January). Instrument maintenance and troubleshooting, similarly, require blocks of uninterrupted time. For this reason, instrument maintenance tasks compete with research time for most faculty members to the detriment of their overall research and teaching efforts. During times of peak teaching, it is frequently impossible for a faculty member to devote the necessary time to instrument repair. A technician, without formal teaching responsibilities, could manage instrumentation needs during times when faculty members are unable to devote time to the instruments.

Cost efficiency – Often, troubleshooting, repair, and even maintenance of equipment requires a visit from a vendor service engineer, at significant cost to the College. Many of the simpler tasks could be handled on site by a trained technician. Colby College, who employs a technician of the sort we propose, reports that that the combined positive effects of regular maintenance and initial diagnostics by an in-house technician, rather than by an outside service engineer, saves on repair costs both to individual departments and to the College. We would expect a similar cost benefit from a technician.

Based on the needs of the programs and departments in the working group, we propose the following responsibilities, qualifications and compensation for such a position.

Responsibilities:

- Perform regular maintenance on a variety of small and large instruments supporting research and teaching.
- Identify and troubleshoot instrumentation problems.
- Work with off-campus service professionals to diagnose and repair instruments.
- Assist faculty by ensuring that instruments are prepared for laboratory courses.
- Train and supervise student workers who help with maintenance and repair.

Qualifications

- Strong mechanical and technical background in operation and maintenance of scientific instrumentation.
- Expertise with one or more of the major instruments at Gustavus which include a Varian NMR, Agilent ICP/MS, Agilent GC/MS, Agilent LC/MS/MS, Zeiss Confocal Laser Microscope and ability to expand expertise to other instruments.

- Master's degree in a scientific discipline preferred; Bachelor's degree considered. As an alternative model, we might consider post-docs looking for alternative career trajectory. The committee was intrigued by this possibility, but recognizes the limitations of a temporary appointment.

Compensation

- Dependent on experience. Bachelor's degree approximately $40-50 K; Master's degree $50-80 K. The College will ultimately "get what it pays for" – a higher salary may attract a service technician from a major instrumentation company who seeks a different life style (e.g. no travel), while a lower salary may result in a less formally trained individual.
- Current College benefits package.
- On-going training at workshops, on-site user schools, etc. leading to maintenance/service certification on specific instruments.

The technician would have as a direct supervisor a single department chair, expected to be either from 1) a department that would utilize the largest amount of the technician's time; or 2) a department that has room to house the technician. Relative to work load, the technician should be housed in Nobel Hall, but Nobel has no available office or work space. Olin Hall (Physics) may have the greatest ability to house this individual for the foreseeable future.

Technology Support Issues

As stated earlier, members of the group all identified a critical need for technology support not currently available through GTS. Although we know that this topic is one actively under discussion by ATC, we add a brief summary of our discussions, because technology support and instrumentation support are inextricably linked in conversations about keeping Gustavus current in terms of scientific research and teaching capabilities.

Several departments have (or have need for) software used in teaching and research within particular disciplines. For example, the Geography and Geology departments use GIS (Geographic Information System), Remote Sensing, and Image Processing software. The Psychology Department uses specialized software for recording and processing data. In Biology, bioinformatics software fulfils a similar role. In chemistry, nearly every 200- and 300- level course requires the use of specialized data analysis software to support modern laboratory instruction. These programs require a level of specialized experience not possessed by the broadly trained GTS professionals. Several departments indicated that their strategic plans included specialized technology support (e.g., Geography articulated a high-priority need for a GIS lab manager).

In addition, most of the complex research instruments include data acquisition and processing software. Most departments have need for an individual who can load, run, and debug software used to drive instrumentation and who can perform basic programming in support of teaching and research needs. GTS frequently assists with network connectivity and sometimes with basic installation, but has neither the time nor the training to provide more than the most basic assistance.

The MCS department has had a dedicated computer support specialist for many years (Charles Pastor and now Aaron Nienow). They strongly believe that the efforts of these individuals have made a significant impact on their ability to utilize computing resources in teaching and scholarship. These individuals have advocated for the department, explored and implemented a wide variety of hardware and software, and fixed classroom computer malfunctions at the drop of a hat. Similarly, the Physics Department has an individual (Jim Miller) who serves as a physics instructor/lab manager. Part of Jim's

job description includes computer troubleshooting and management. The Physics department has benefitted from housing a technology support individual within its department. In contrast, the Chemistry Department has less well-defined technology support. An adjunct lab instructor (Todd Swanson) has part of his responsibilities assigned to technology support; however, these responsibilities are not as clearly defined as they are in MCS and Physics and teaching needs often take precedence over technology duties. Chemistry reports less success with their model than do MCS and Physics with their more clearly defined technology support positions. We strongly believe that departments would benefit from hiring technology professionals with clear technology responsibilities to support the specific computer-related needs of their discipline.

Instrument User Policy

Traditionally at Gustavus, instrumentation has been made available to all users at no cost as instrument and faculty oversight time has permitted. Proposals for external funding of new instruments are now expected to include a user fee plan, specifying, for example, cost per sample, procedures for scheduling, and mechanisms for schedule priority to demonstrate that the institution has the financial ability to run the instrument it hopes to obtain. A group of faculty whose professional experience includes such user policies should be established to discuss and establish user policy guidelines for the campus, including mechanisms for scheduling and fees for off-campus and on-campus users and mechanisms for supporting classroom work and research projects without external funding. The group should also include the Assistant Vice President for Corporate and Foundation Relations and the guidelines developed should be linked prominently at this web site.

*The following departments and programs were represented in the working group: Biology, Biochemistry & Molecular Biology, Chemistry, Environmental Studies, Geography, Geology, Health and Exercise Science, Physics, and Psychology. Mathematics & Computer Science was invited to participate, but felt their instrumentation needs were limited to computing and software needs, rather than the kind of research instrumentation we were discussing.