



University at Buffalo

The State University of New York

Report on the 2007 Faculty Research Computing Survey:
A Baseline Study

Center for Computational Research
Office of the CIO
Office of the Vice President for Research

Table of Contents

| | |
|---|----|
| EXECUTIVE SUMMARY | 3 |
| 1. Background and Demographics | 6 |
| 2. General Assessment of Research Computing Services | 7 |
| 3. Research Software Needs | 8 |
| 5. Research Data Needs | 14 |
| 6. Research Networking Needs..... | 19 |
| 7. Research Programming and Staff Support Needs..... | 22 |
| 8. Research Administrative Needs..... | 23 |
| 9. Additional Comments about Research Computing Needs..... | 30 |
| 10. Recommendations and Action Steps | 31 |
| Bibliography | 34 |
| Appendix A: Survey Instrument..... | 35 |
| Appendix B: Software Needs (Q1) and Software in Use (Q2)—Complete Set of Responses..... | 40 |

EXECUTIVE SUMMARY: 2007 Research Computing Baseline Survey

The 2007 Research Computing Survey was developed by Center for Computational Research (CCR), CIO, and Office of the Vice President for Research staff to assess faculty research computing needs and determine ways to provide improved services for faculty researchers. We also examined best practices in providing enterprise research computing services and resources at top research institutions and the national research agenda with respect to cyberinfrastructure and funding.

158 faculty, approximately 15% of assistant professor level or tenured faculty, responded to the survey. Thirteen faculty responded on behalf of their research groups, six for their centers, and two for their departments; all others responded as individuals. Faculty respondents came from all decanal areas. This report provides survey response frequencies and comments, with analysis and recommendations for action items to better support research activities.

The findings support the need to provide a portfolio of enterprise services that all researchers can access, including data storage, management, and analysis solutions; the provision of centrally negotiated volume software licensing discounts for needed software; tools for collaborative work, and programming and other technical support services. Researchers also need to have desktop computers with routine 3-4 year refresh cycles and, in the case of high-end technology users, access to high-performance computing resources and advanced networking infrastructure. Continued investments in the CCR and in networking initiatives need to continue to be a University priority. Investments in these areas will enable UB researchers to participate in national “big team science” projects and the multi-institutional projects that comprise the national research agenda and funding priorities.

Improvements can also be made to better meet the research administration needs of our faculty by providing tools and resources for grant proposal development as well as award management tools. Many researchers repeatedly specified their need for lab space in spite of the fact that we were asking them about research computing needs. As we add faculty in our strategic strengths areas with UB2020 faculty hires, the need for research computing resources, tools, and services will increase.

Major Findings:

- Response yield & quality of comments indicate high faculty interest in research computing.
- 65% of respondents indicated current research computing services meet or exceed their needs, however 75% of faculty respondents whose high-end technology needs “push the envelope” reported that current services do not meet their needs.
- Software licensing (volume discount negotiations by central IT with vendors) to help lower the cost of research computing software is needed.
 - Adobe Acrobat Professional is needed by all PIs on campus in order to comply with funding agency requirements.
- Many faculty use their workstations for compute cycles, raising concerns about aging or outdated faculty workstations.
- The CCR is relied on for many high-end compute needs.
- Department/school/research group compute systems are aging.
- Current data storage needs for research computing are being met, but there are concerns regarding future growth and data backup, with approx 30% of respondents indicating that their storage needs will grow to 500GB-100TB in the next 2 years.
- Collaboration tools are needed to allow connectivity and facilitate interactions with researchers at other institutions.
- Many faculty would like to see improvements to local networks around campus to improve connection speed to various compute systems, such as local clusters or to the CCR.
- There is significant demand for technical support in several key areas, with statistical support, scientific programming/modeling, interface development, database support, and visualization being dominant.
- A majority of faculty (77%) are satisfied with the funding opportunities as listed on the sponsored projects web site.
- Budget management at the local level is a problem for many faculty.

- Additional communication about existing research computing services and resources available to faculty is needed.
- Assistance from contract writers/editors for grant proposal development would improve success in acquiring external funding.

Specific recommendations based on these findings include the following:

Recommendation 1: Identify and prioritize IT projects that will enable UB faculty to compete for large, multi-discipline and multi-institutional research grants more effectively.

- Develop processes to regularly collect multidisciplinary research IT needs
- Charge the newly created Enterprise Research Computing Services group with the responsibility for collecting enterprise research IT needs and coordinating the development of services and deployment of resources to meet those needs
- Conduct focus group sessions to probe research computing needs further
- Communicate to faculty more effectively about existing services

Recommendation 2: Software Needs

- Negotiate volume software discounts for commonly needed research software packages.
- Software candidates to consider for volume licensing negotiations:
 - Matlab (negotiations underway)
 - Adobe Acrobat Professional

Recommendation 3: CPU/Compute Cycle Needs

- Continue to make investments in CCR hardware to increase available compute cycles a University priority
- Support the policy proposed by the UB2020 Workstation Standardization Initiative to refresh old, out-dated machines on a cyclic basis to help address desktop research computing
- Plan for increased compute cycle needs: As UB2020 hires come on board, it is likely that there will be an increased need for HPC resources
- Develop cost effective compute clusters that allow applications to migrate easily from small school based compute systems to larger CCR clusters. Whenever possible, insure that the computing environments of the small clusters are identical to that of the larger compute clusters in CCR, thereby providing a seamless transition for faculty researchers.

Recommendation 4: Research Data Storage Needs

- Provide an institutional data/storage repository to foster research activities of under-served segments of UB community, as well as researchers with high-end technology needs whose storage needs are increasing rapidly.
- Develop a data modeling/database support service for research data.
- Data archiving and backup needs: Provide data backup services and off-site storage for faculty desiring such services.

Recommendation 5: Networking Needs

- Continue to make investments in wired and wireless network infrastructure to increase speed and reliability (mUB, UBNet).
- Continue to make connectivity to advanced national research networks a UB priority.

Recommendation 6: Programming and Staff Support Needs

- Create a UB Statistical Support and Services Center.
- Provide additional programming and staff support for researchers with high-end technology needs.

Recommendation 7: Research Administrative Needs

- Collaboration Tools
 - Provide collaborative writing/document/office tools to researchers developing multi-site, grant applications (e.g., by site licensing Groove software).
 - Develop PI profile tools based on Cornell's VIVO (<http://vivo.cornell.edu/>).
 - Implement a wiki to help researchers share information regarding strategic strength areas.

- Provide faculty training for these tools.
- Continue to implement Coeus as a proposal development tool, streamlining the budget process and flagging potential proposal errors before submission. Consider developing a local grants.gov mirror, training site, or helpful materials as University of California-San Francisco and University of Washington have done.
- Provide contract grant editing services for grant proposal developers.

Recommendation 8: Address Other Research (Non-Computing) Needs

- Researchers repeatedly mentioned their need for lab space.

2007 Research Computing Survey: A Baseline Study – Results and Analysis

1. Background and Demographics

The 2007 Research Computing Survey was developed by CCR, CIO, and VP for Research staff to determine ways to provide improved research computing services for faculty researchers. We examined best practices in providing enterprise research computing services and resources at the top research universities. Many institutions have transformed how their research activities interact with institutional and enterprise IT. We believe that UB research computing services for faculty can be enhanced by providing enterprise/campus IT infrastructure and support services key to research that all researchers can access.

Faculty were invited to complete the survey via an email message containing a link to the survey. The survey was available from April 2-27, 2007, and was completed by 158 faculty (approximately 15% of faculty who are assistant professor level or tenured). 13 faculty responded on behalf of their research group, 6 for their centers, and 2 for their departments; all others responded as individuals. Faculty respondents came from all decanal areas. This report provides survey response frequencies and comments with analysis and recommendations for action items to better support research activities.

| DECANAL AREA | SURVEY RESPONDENTS COUNT | PERCENT OF TOTAL | FACULTY FTE IN DECANAL AREA - 2004 |
|---------------------------------------|--------------------------|------------------|------------------------------------|
| Architecture & Planning | 3 | 1.9% | 30 |
| CAS | 55 | 35.7% | 460 |
| Dental Medicine | 5 | 3.2% | 55 |
| Education (w/ Library & Info Studies) | 10 | 6.3% | 62 |
| Engineering | 20 | 12.7% | 111 |
| Law | 1 | 0.6% | 39 |
| Management | 4 | 2.5% | 51 |
| Medicine | 33 | 20.9% | 179 |
| Nursing | 4 | 2.5% | 14 |
| Pharmacy & Pharmaceutical Sciences | 2 | 1.3% | 17 |
| Public Health & Health Professions | 10 | 6.3% | 28 |
| Social Work | 5 | 3.2% | 13 |
| Other | 2 | 1.3% | |

Column four of the table displays 2004 Assistant Professor and Tenured Faculty FTE in UB decanal areas from the Office of the Provost *Mission Review II* report. Approximately 20 additional faculty have been hired since 2004. The School of Informatics faculty (20) have been merged with CAS and Education faculty FTE, i.e., the 20 faculty have been distributed to those areas.

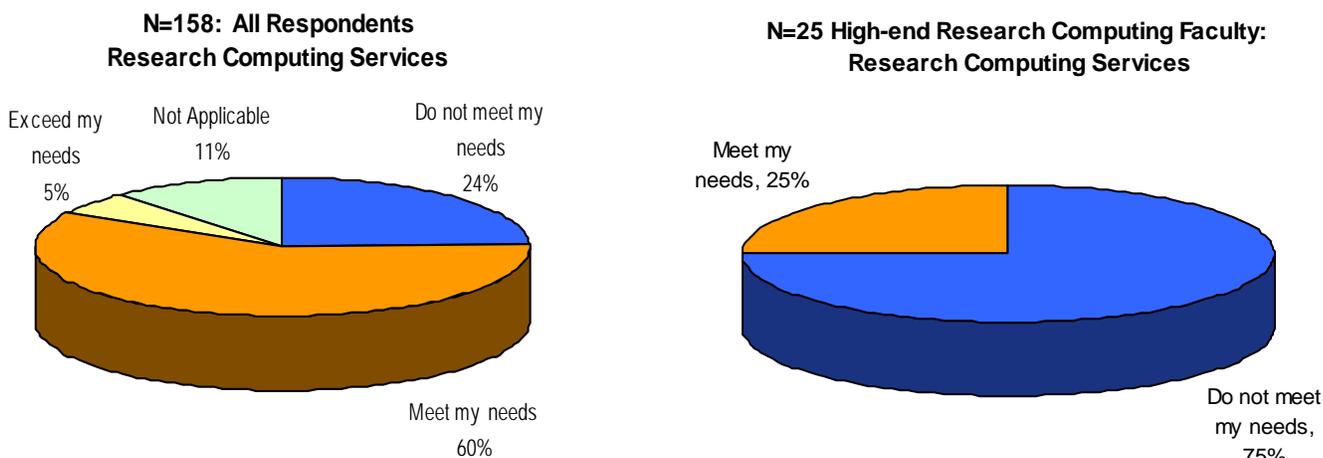
Since the survey respondents were a self-selected population, survey findings cannot be generalized to the entire population of tenured and assistant professor level faculty, however, we believe that the rich data offer insight into potential areas for follow-up with focus groups and support for our recommended action items.

The survey instrument is found in Appendix A.

2. General Assessment of Research Computing Services

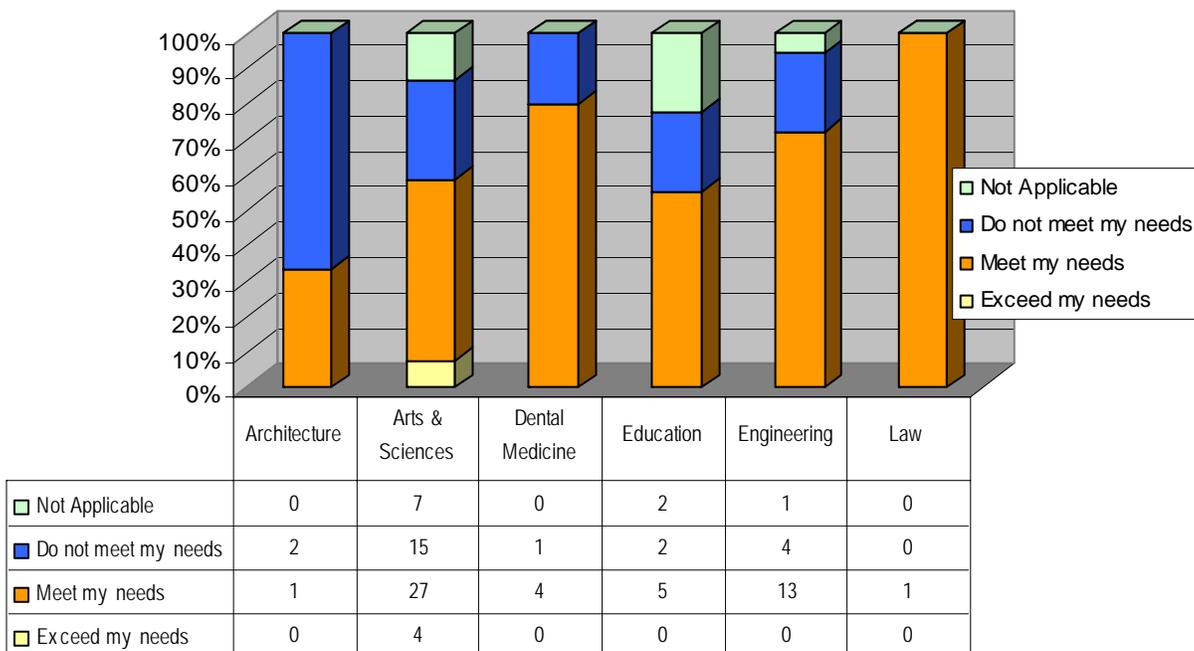
Q15: In general the research computing services (CPU cycles, storage, networking, and software engineering/programming services) provided by the University: Exceed, meet, do not meet my needs, not applicable

Almost two-thirds of survey respondents reported that, in general, the research computing services provided by UB met or exceeded their needs. However, when only the responses of faculty with the most high-end research computing needs were examined, the results were quite different. Faculty were identified as having high-end technology needs because they either provided their names in order to be contacted to participate in focus group sessions and were known to us as such, or they specified high-end technology needs in their responses. They included faculty from Chemistry, Physics, Nuclear Medicine, Management, Biophysics, Engineering, Structural Biology, and Math. 75% of these faculty reported that research computing services did not meet their needs; 25% reported that the services meet their needs; none reported that services exceeded their needs.

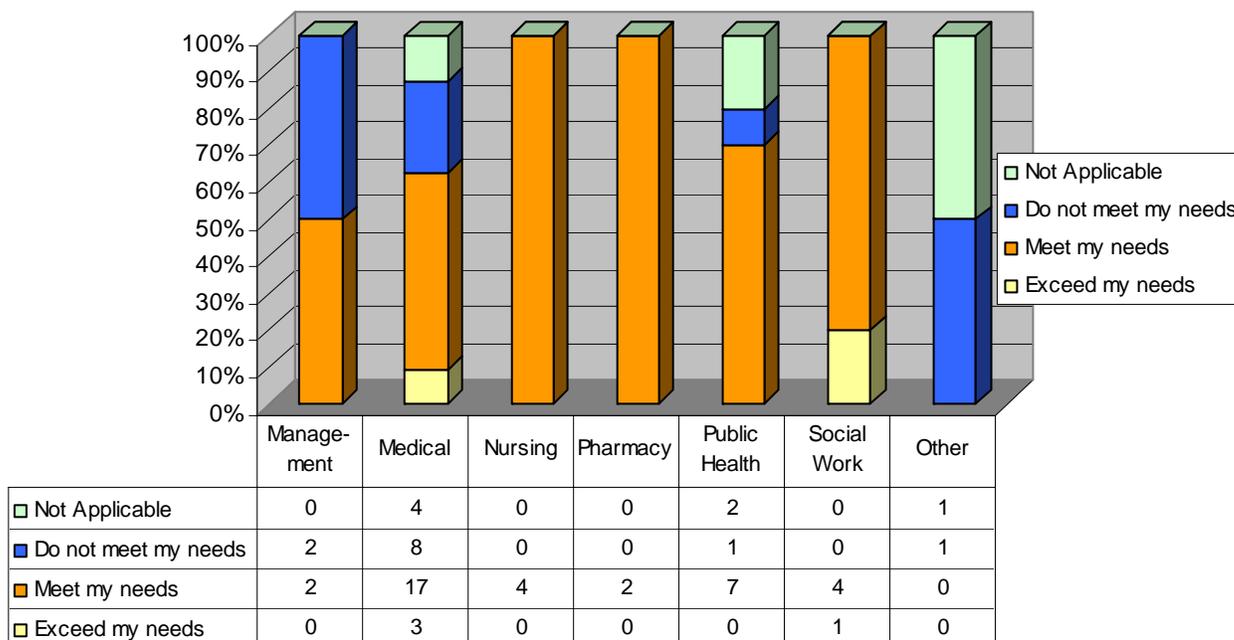


Survey responses across decanal areas also varied widely. The data tables below the bar charts show the numbers of survey respondents for each option: several decanal areas have very small numbers.

In General, the Research Computing Services Provided by UB:



In General, the Research Computing Services Provided by UB:



3. Research Software Needs

One of the best practices of central computing units at top research universities is to provide volume software discounts by having central IT negotiate campus software site licensing agreements for commonly needed research software packages. In order to identify software packages that are candidates for campus software licensing, we asked researchers to list software they need that is not currently available to them because of cost or other reasons, as well as to list the software they currently are using in their research.

Q1: Software Not Currently Available that is Needed for Research

The needs listed most frequently were: SPSS (12), SAS (10), Matlab (9), and Comsol (5). The complete list of the software responses to Q1 is available in the Q1 and Q2 software counts table in the Appendix.

Q2: Software Currently in Use for Research

Statistical and mathematical software were the most frequently cited packages in use: SPSS (38), SAS (22), Matlab (23), Maple (10), Mathematica (8). A complete list of the software responses to Q2 is available in the Q1 and Q2 software counts table in the Appendix.

Annual site licensing of the statistical packages (SAS, SPSS), Maple, and Mathematica are already in place (via UBMicro Sales) to provide discounted prices for the University community. Negotiations are underway to provide volume licensing of Matlab and Simulink, including the image processing, signal processing and blockset, statistics, and optimization toolboxes.

Collaborative and inter-disciplinary work are essential to many research programs today. Faculty suggested that UB provide the collaborative writing and other shared document tools researchers need for interdisciplinary/multi-institutional grant proposal/report and research paper development via the licensing of software such as the MS Groove collaborative Office software package. Researchers can also

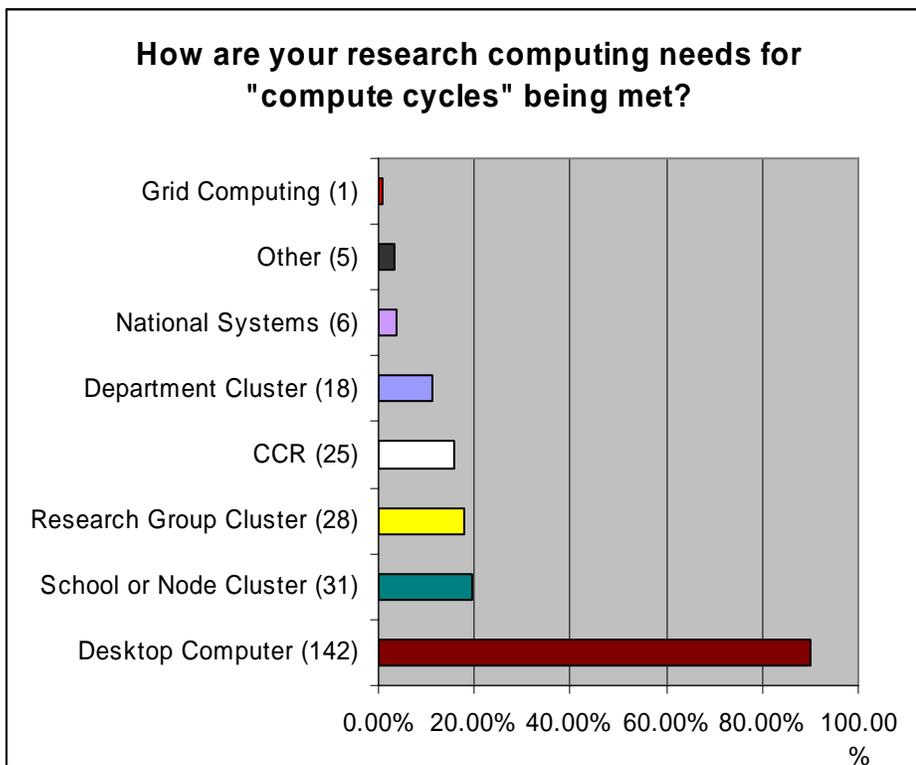
benefit from additional IT support for videoconferencing and web portal design and hosting as collaborative work increases and dissemination and presentation of work become increasingly digital.

Further analysis of Q1 and Q2 survey responses and additional probing of software needs at planned focus group sessions may lead to additional campus volume licensing opportunities. One individual respondent responding on behalf of a research group of 6 doctoral level MD, PhD, or MD/PhD individuals noted the need for multi-user licensed software for statistical analysis, image analysis and document management. Development of a process to gather research software needs annually is also needed.

4. Research Computational Capacity: CPU/Compute Cycle Needs

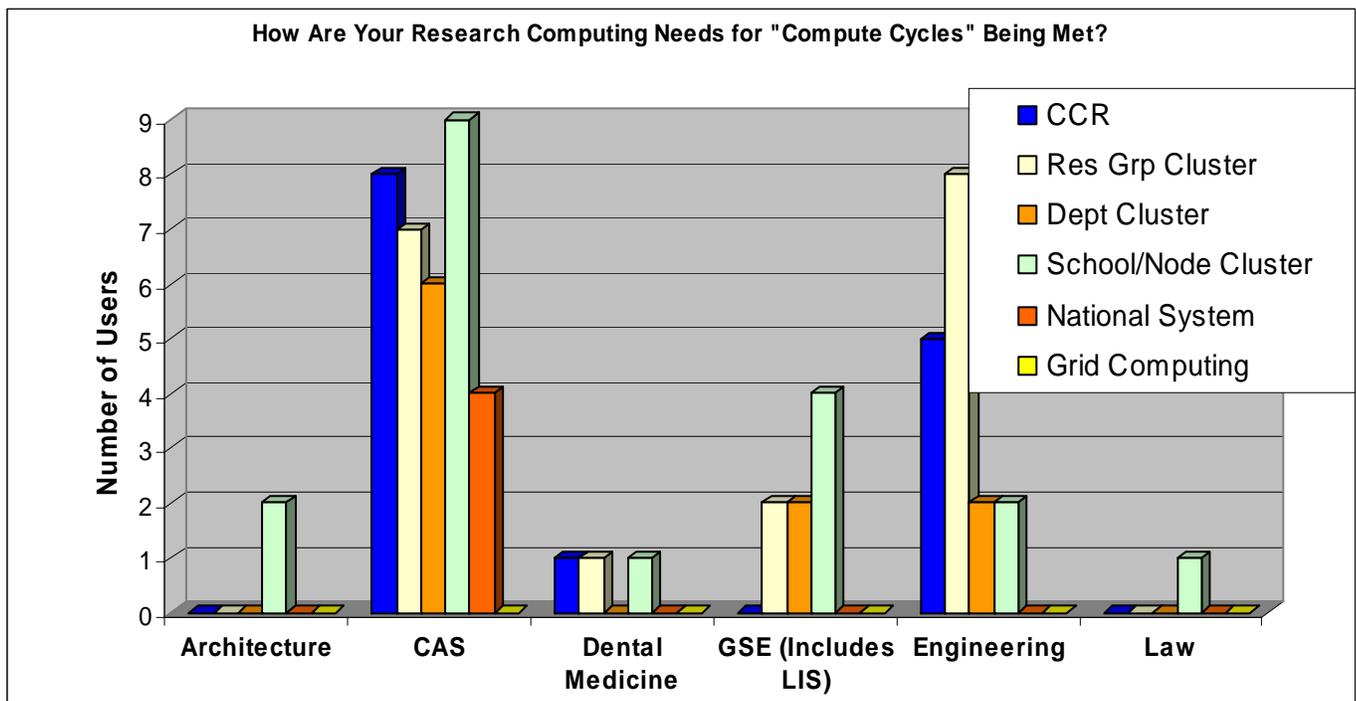
As the chart below illustrates, most survey respondents reported using their own desktop systems for CPU/compute cycles for research. Respondents were able to select as many options as applied.

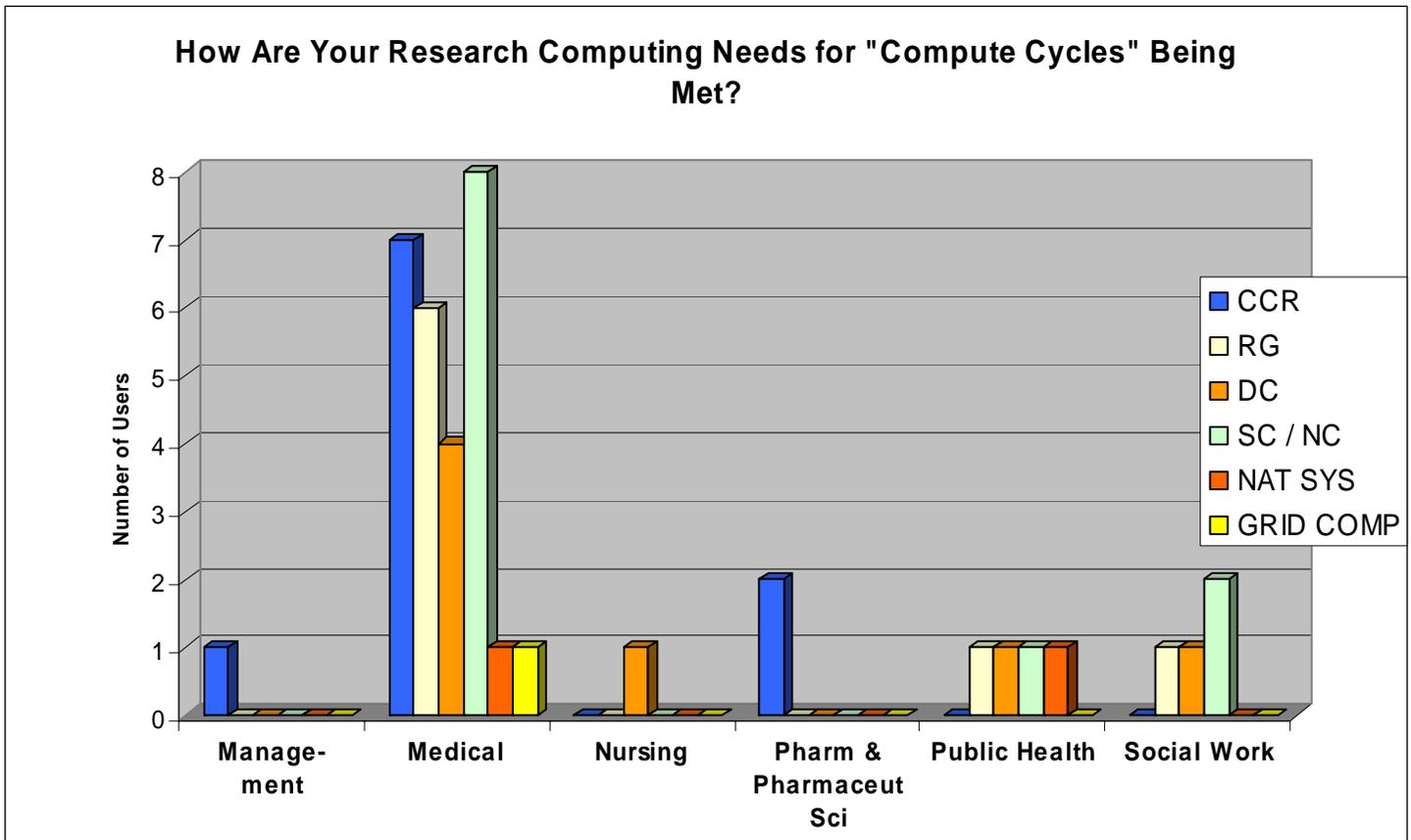
Q4: Compute/CPU Cycle Needs



Distribution across decanal areas for survey respondents reporting use of other CPU resources for research follows:

| | CCR Resources | Faculty Research Group Clusters | IT Node or School Clusters | Department Clusters | National Systems' Resources |
|-------------------------------|---------------|---------------------------------|----------------------------|---------------------|-----------------------------|
| Architecture & Planning | | | * | | |
| CAS | * | * | * | * | * |
| Dental Medicine | | * | * | | |
| GSE (includes LIS) | | * | * | * | |
| Engineering | * | * | * | * | |
| Law | | | * | | |
| Management | * | | | | |
| Medical School | * | * | * | * | * |
| Nursing | | | | * | |
| Pharmacy & Pharmaceutical Sci | * | | | * | |
| Public Health & Health Prof | | * | * | | * |
| Social Work | | * | * | * | |





Faculty were also asked to specify unmet CPU/compute cycle needs. The areas that generated the most comments were (1) respondents using CCR resources (approximately 16% of survey respondents), (2) those with needs for local faculty/research group clusters or labs, and (3) those with inadequate desktop computers. The UB2020 Workstation Standardization initiative underway should help to address faculty desktop CPU needs by providing a standard refresh cycle and standards for workstations. As one faculty respondent noted, "Most [UB] peer schools keep to a 3-year [refresh] cycle, and we're falling behind a four year cycle."

The following table contains faculty comments on unmet needs.

Q4: Please specify unmet research needs for "compute/CPU cycles"

| UNMET NEEDS | |
|---------------|--|
| CCR Resources | <ul style="list-style-type: none"> o Queue length: jobs submitted are queued for too long before being executed (2 responses) o Need a timeshare machine with 1 or 2 processors at the CCR that is available without the requirement for parallel execution o Need a replacement for Lennon o Need a cluster for MPI programs with >32 nodes o Need support from CCR o Continued investment in hardware for CCR to increase compute cycles offered should be a priority |

Research Group Clusters, Labs

- o Very old research group cluster is failing, need up-to-data resources
- o Need a cluster for the math department
- o Need a faculty/research group cluster in a central location available to faculty and grads
- o Need lab space for experimental computing systems-based research
- o Need an experimental computational lab

Individual Workstations

- o Need up-to-date workstation
- o Desktop systems in my department are old, out-of-date; we have no hope of updating systems
- o Desktop system needs more memory to run most software
- o Difficult to do large-scale analysis of US Census data because of limited storage and CPU power on desktop and severely limited storage on ubunix
- o Refresh cycle for local personal computer does not meet research needs
- o Need an SGI Altix with Acclerys software for linux that can run the simulations I currently run in a fraction of the time
- o Need a big RAM machine
- o The funding for computer refresh is insufficient to us on a four-year cycle as promised. Ours peers have a three-year cycle. As UB grows and the funding remains static, the computer refresh program, at least within CAS, will become more and more problematic

Faculty High Performance Computing (HPC) needs were also probed by an Office of the VP for Research email survey. Key research faculty were probed on their HPC cluster use and needs, software, and programming needs. Approximately 8 faculty using HPC in their research responded on behalf of their research groups and departments

| PROBE AREA | NUMBER RESPONDING | RESPONSES |
|---|-------------------|---|
| What HPC clusters do the users have access to? On what clusters do the users have accounts? | N=8 | <ul style="list-style-type: none"> o CCR clusters, including U2, Lennon, thewho: N=5 o LMVA Clusters, N=1 o CCR faculty clusters “Muddywaters, “Clearwater”: N=1 o CCR SGI Altix (Lennon), Sun Cluster: N=1 o Keck Center Cluster: N=1 |
| If you have a departmental HPC cluster, how is it maintained and what resources are in place to support it? | N=3 | <ul style="list-style-type: none"> o LMVA cluster supported by SENS node. LMVA resources are supported by user fees and equipment purchases and upgrades are funded by equipment grants o Geology does not have a departmental HPC cluster, but does have a high-end server for research maintained by SENS in their server room o Physiology and Biophysics HPC cluster maintained by researchers with help from departmental sys admin/scientific programmer |

| PROBE AREA | NUMBER RESPONDING | RESPONSES |
|--|-------------------|--|
| What programming support do users have access to? | N=8 | <ul style="list-style-type: none"> ○ CCR staff assistance with performance, parallelization, and high level programming ○ CEB has provided funding for an entry level programmer ○ Graduate students in Mechanical and Aerospace Engineering and Math supported by research grants provide support |
| Do users utilize computational software that has been obtained as UB site licenses? What UB unit maintains the license? Are there current software needs that users do not have access to because of high single user cost? | N=8 | <ul style="list-style-type: none"> ○ Need for campus license for SAS may be needed in the future ○ Turbomole: Can't afford to update 100% from research budget (was purchased by research group and CCR) ○ Utilize UB's RedHat Linux site license ○ At present have only single seat licenses for SEQUEST: Intent is to address the single seat issue and to levy charges for access ○ We would like to move to a full set of licenses for the DS molecular software from Accelrys, but don't have the money to do so. Have 20 licenses of Insight/Discover (Accelrys) but cannot afford to pay maintenance. Have Genetics Computer Group software: Accelrys, SYBYL (tripos): 12 copies ○ Matlab and MathCAD licenses are maintained by SENS. Pool licensed image analysis software (ENVI) used in remote sensing (and medical analysis). Some software is supported by grants, including software to manage data from HPC output. Software needs: for visualization of HPC data output and HPC codes that are too expensive for single uses applications and resources ○ Users utilize UB licensed Maple and MS Office ○ ABAQUS maintained by SENS, an upgrade may be needed. CPLEX, maintained by SENS—currently have only multiple single user licenses |

| PROBE AREA | NUMBER RESPONDING | RESPONSES |
|---|-------------------|---|
| <p>What HPC capabilities do users need that they do not have access to at this time?</p> | <p>N=8</p> | <ul style="list-style-type: none"> ○ It is important to us that the resources currently present at CCR remain available and up-to-date ○ I sometimes need a shared-memory machine like CCR's lennon (SGI Altix) for large ab-initio band structure computations. Linux clusters are everywhere and cheap, but one can't do all types of computations on such clusters. I have access to lennon, but that is the only machine of that type I have access to. I have heard that SGI now has similar hardware at more competitive pricing.\I need access to virtual reality and augmented reality equipment and software ○ We currently have access to adequate resources WRT hardware and software. Personnel attached to the CCR have been incredibly helpful, enabling us to pursue some avenues of work that would have been impossible otherwise. Our group is still in need of some dedicated programming support: Programming support capabilities remain at the top of our wish list ○ We very much need additional SEQUEST licenses. Once benchmarking is completed on SEQUEST at 16 nodes, we need to look seriously at high performance hardware dedicated to this package and potentially additional nodes (at approx. \$10,000/node) ○ Since CCR has moved most of the staff off campus and has been reduced in staffing, this already limited service has greatly diminished. Facilities are good but not particularly well managed. Often large clusters are occupied by users running single processor jobs. It would help to have a help desk at CCR. ○ More programming time |

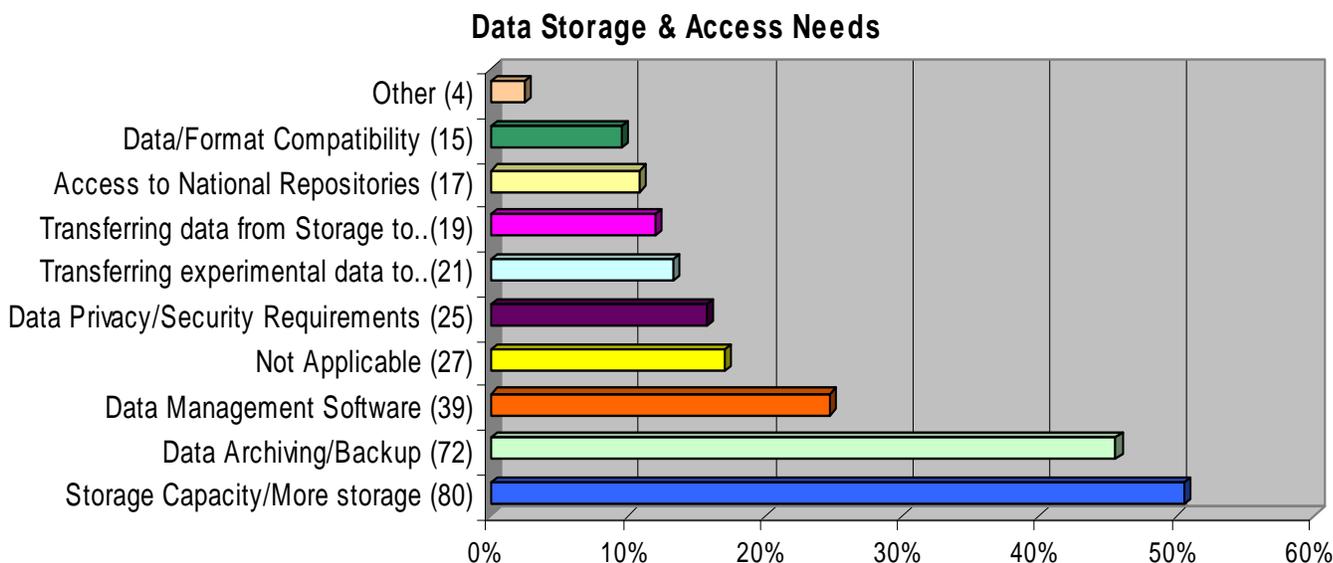
5. Research Data Needs

A second leading best practice of top research institutions is the provision of enterprise data solutions for the campus. These solutions include data collection, storage, access, long-term archiving/backup, formatting, transfer, metadata, analysis, and management solutions. This is an area where we believe we can better serve segments of our research community, providing state-of-the-art technologies to foster research activities of both high-end faculty technology users and those who currently do not have sufficient access to this technology.

Some research trends worth noting include the following:

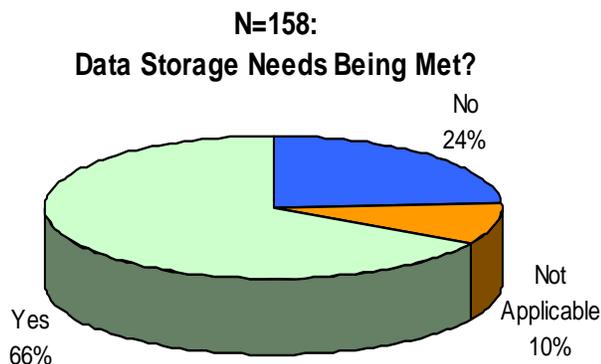
- The amount of data created and stored each year continues to grow exponentially
- Simulations and modeling, generating large volumes of data, are increasingly used in research.
- Collaborative, multidisciplinary, multi-institutional research is growing, placing an increasing demand on existing networking, storage, and visualization resources.
- There is a desire to increase knowledge/data reuse: The NSF is now stimulating development of new uses/reuse of existing data.

Q5: What are your greatest data storage and access needs? Select as many as apply



“More storage capacity” and “Data archiving/backup” were selected most frequently, followed by “Data management software.” Additional comments about data storage and access needs echoed the need for space and the need for an institutional storage repository.

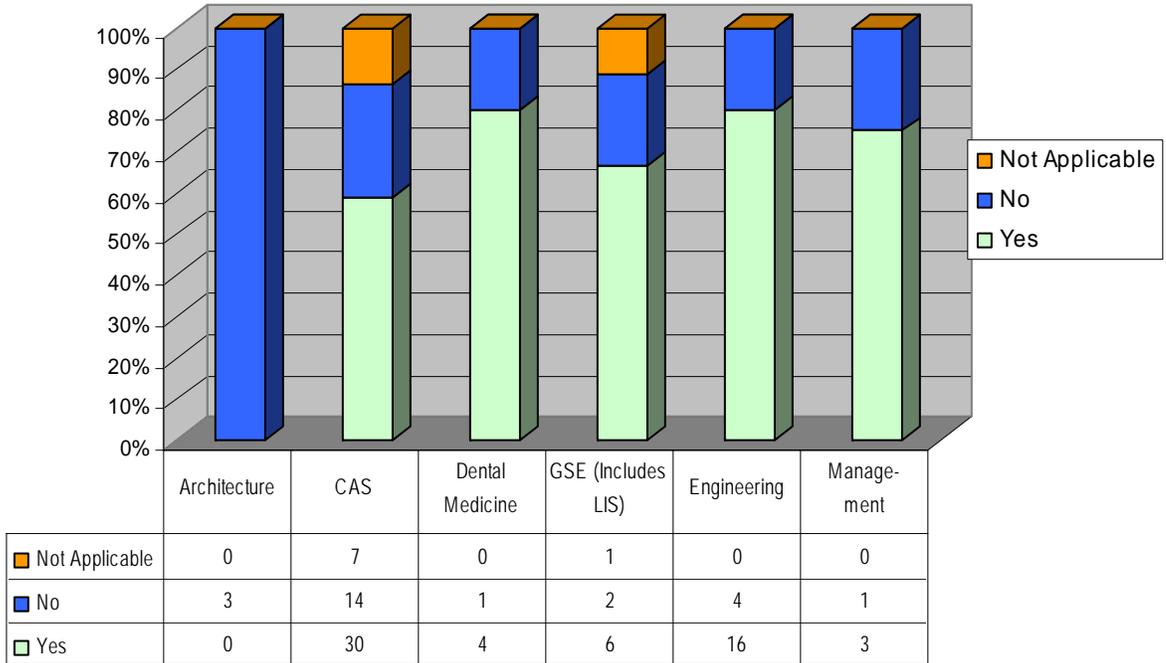
Q6: Are your current research needs for data storage being met?



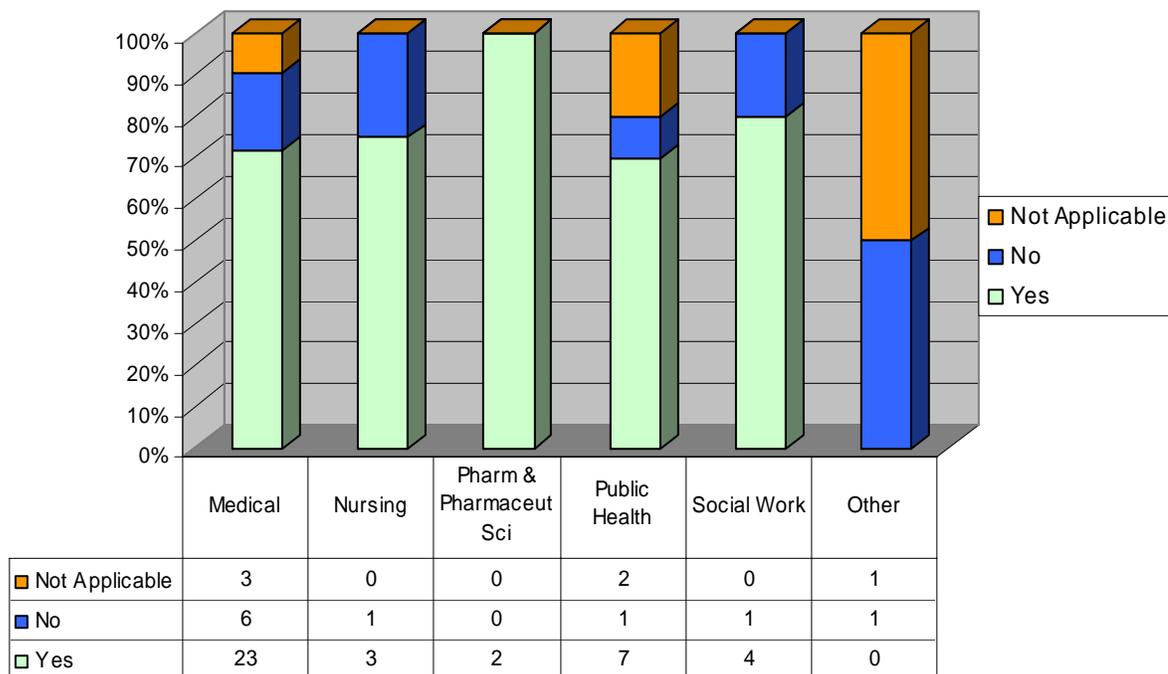
66% of Q6 respondents said their current research needs for data storage are being met. Many of the comments to Q6 indicated that while needs are currently being met, faculty believe they will need more data storage space very soon (within one year). Faculty also commented on the need for backup systems, including off-site storage of backups; the need for accessing data from several access points (access from anywhere); unmet student needs for storage; and HIPAA

compliance issues affecting local data storage. The following charts show the distribution of responses to Q6 across decanal areas.

Data Storage Needs Being Met?



Data Storage Needs Being Met?



Q6 Comments: Are your current research needs for data storage being met?

| CURRENT DATA STORAGE NEEDS COMMENTS | |
|-------------------------------------|--|
| Data Backup | <ul style="list-style-type: none"> ○ Backup systems for PCs in lab is a major shortcoming ○ Automatic off-site backup is very desirable ○ I have a backup drive which is difficult to use ○ No clue what is available to me re old data |
| Data Storage Requirements | <ul style="list-style-type: none"> ○ I am limited by storage for Molecular Dynamics experiments ○ Soon we will need more data storage space on CCR's SAN ○ But need is always increasing and it is hard to keep up with changing need ○ [Provided] by the Medical School, but University storage would be useful ○ We had to buy our own hard drives. ○ Will run into problems within 1 year. ○ I am just in the process of needing to request this. ○ Mostly needed for students. SENS has generally been accommodating but normal student accounts are insufficient ○ [Data storage needs being met] at a price |
| Data Security & Encryption | <ul style="list-style-type: none"> ○ I collect data at the VA (Syracuse and Buffalo). I had encryption software installed on my UB laptop, but then was informed that I could not transfer data to the H drive at UB. The data may be secure, but my research support is at UB. |

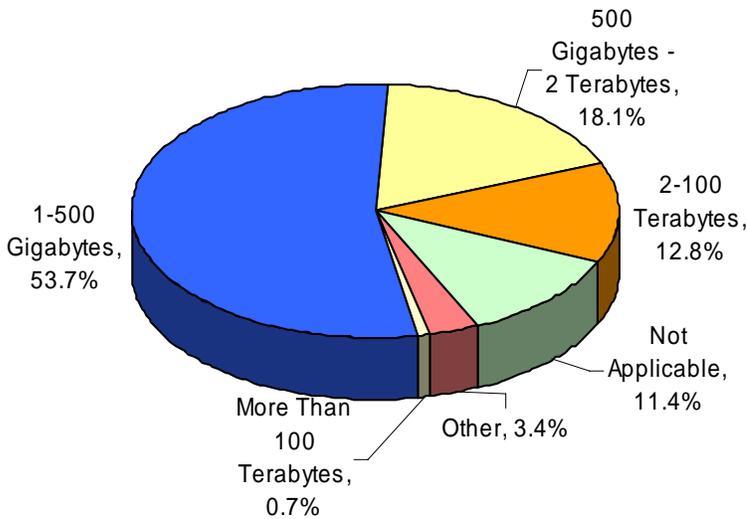
CURRENT DATA STORAGE NEEDS COMMENTS

| | |
|-------------------------|---|
| <p>Data Migration</p> | <ul style="list-style-type: none"> ○ We still get much of our research in on paper records--storing these is a problem (we're maxing out current facilities) but we don't have the resources to scan it all in electronically ○ |
| <p>General Comments</p> | <ul style="list-style-type: none"> ○ Need lab space for computing, data, networking, and visualization *research* ○ But there is not much IT support for this [data storage needs], I'm exploring option to switch database. |

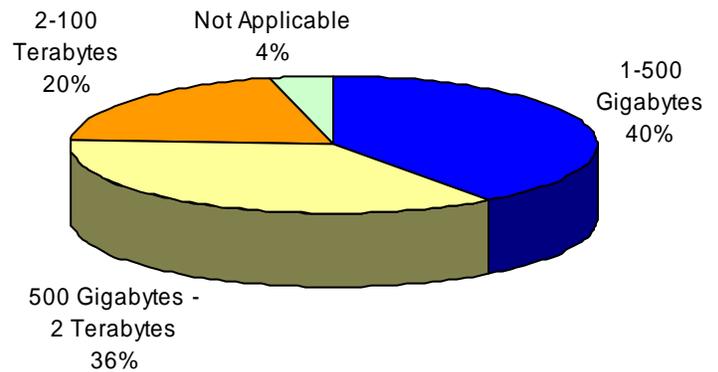
Q7: What do you anticipate your research data storage requirements will be for the next 2 years?

Survey respondents were asked to estimate their future data storage needs: More than 50% of respondents selected the lowest storage capacity specified: 1-500 Gigabytes..

N= 158 Anticipated Data Storage Needs for Next 2 Years



N=25, Users with high-end technology needs: Anticipated Data Storage Needs for Next 2 years



6. Research Networking Needs

Q8: What are your greatest networking needs for your research?

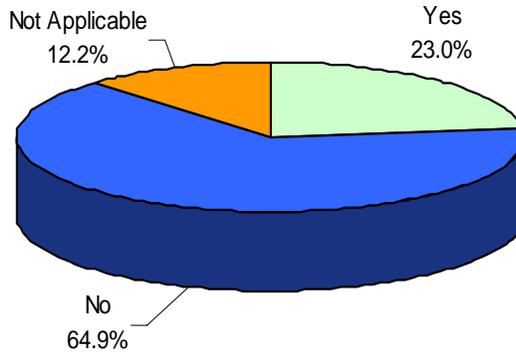
Researchers were asked to comment on their greatest networking needs for research.

| Area | Greatest Networking Needs |
|--|---|
| Network connectivity, infrastructure, data transfer | <ul style="list-style-type: none"> o Better response speed when running graphical apps on U2 or Zappa from desktop computer o Fast and reliable o Fast connection o Need gigabit in Fronczak o Network speed across campus to the CCR facility from Parker Hall is very poor: Max transfer rate is 1-2MB/sec. This impedes large transfers and interactive work o Better connection between cluster nodes on my cluster. Fast connection between office and CCR machines o Network infrastructure is complex. Node people are helpful resolving issues but not a permanent solution o Communication among lab computers and imaging facility and to collaborators elsewhere o Network backups, file storage on network server o Ability to access and download large data files from COE and RPCI o Communication with and access to data and analysis software by multidisciplinary research team in Nursing SPHHP, SMBMS o Data transfer to storage and computers o Ability to send out large amounts of data o Fast data transfer o Sending large files to collaborators elsewhere – many images are too large for email servers o Faster speeds for data transfer o Bandwidth for transfer of large audio files; relatively small-scale web services o Fix the VPN so you can access the library from home o File access and software access from server o Ability to access office computer from home o Real-time deterministic network for synchronized parallelized computation – e.g., Myrinet Firewire with Opal-RT, etc. o I have recently upgraded the lab to a gigabit Ethernet switch with 24 ports; most lab computers are connected via cat5e Ethernet cables, but the faster workstations are connected by cat6 so they can be used as a cluster at night when needed. Lab funds were spent to obtain the cat6 cables, but I believe SENS should be providing cat6 cables standard (rather than cat5e). o Instrument networking to servers o Multiple lab computers sharing central HDD o Network drive for storing data o To have all my lab computers)20) networked so they can connect to project servers |

| Area | Greatest Networking Needs |
|----------------------------|---|
| | <ul style="list-style-type: none"> o Need 20 Gbps to the desktop and an experimental lab where we have 1-40 Gbps available to our computational, data, and visualization systems. Internal connectivity within computational clusters is also a significant concern. Simulation data exchange and storage, visualization clustering (private network), visualization display (KVM over fiber). o Access to Oak Ridge National Lab o Wireless network for research and education o Methodological support: Building core team to position for Center Grant |
| Collaboration Tools | <ul style="list-style-type: none"> o Work on grants with researchers at other universities requires document sharing and collaboration tools. A site license for MS Groove virtual office software would be very useful for researchers o Networking collaboration o Videoconferencing o Connectivity with colleagues at another university o Collaborations o Need easy collaboration environment that does not require setting up UB IT names for them |
| Security | <ul style="list-style-type: none"> o Data sharing among participants: researcher at UB and Kaleida: Security issues o Remotely accessible private network o Firewall prevents data transfer |
| Other | <ul style="list-style-type: none"> o Need lab space so I can experiment with networking and its impact on computing |

Q9: Does your current or near-term future (next 2 years) research require connectivity to any national labs or research centers?

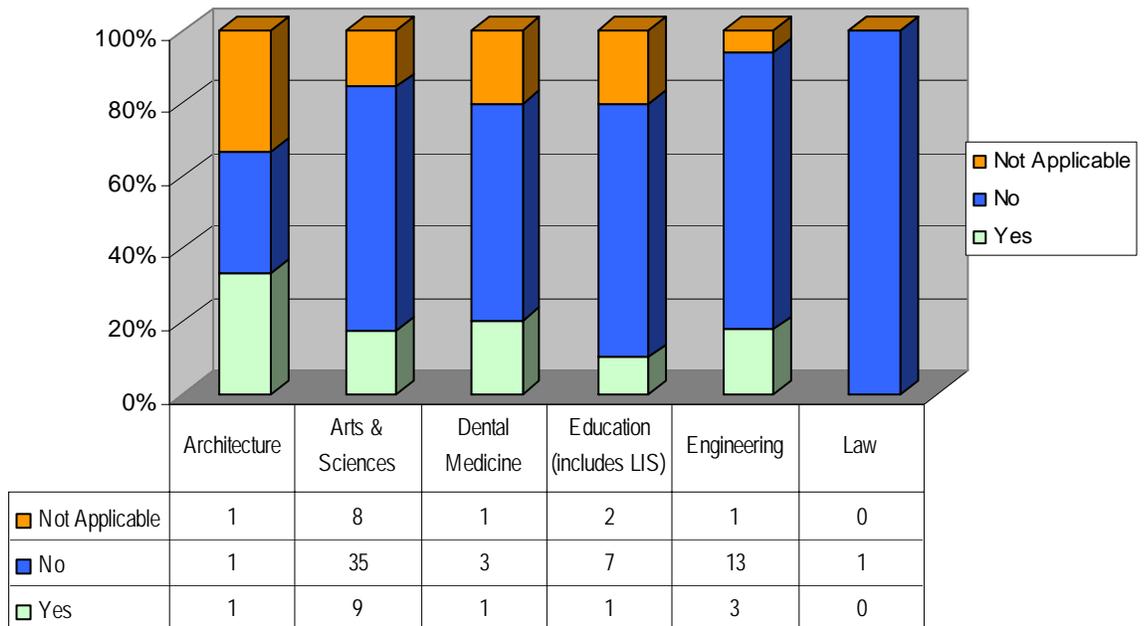
Need for connectivity to national labs or research centers?



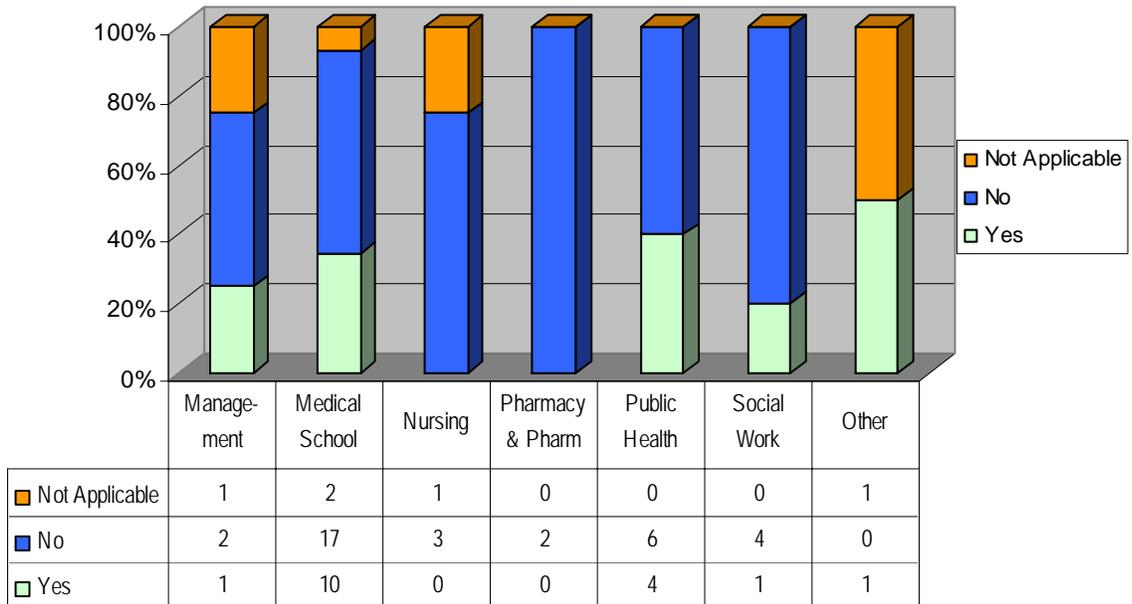
A relatively large number of survey respondents (23%) reported the need for connectivity to national labs and research centers. Open-ended comments on collaborative work needs included connectivity to PNNL and CERN, a pathway to the TeraGrid, as well as connectivity to enable several multi-site grants and to support a Digital Humanities Center.

The distribution across decanal areas for Q9 follows.

Need for connectivity to national labs or centers



Need for connectivity to national labs or centers

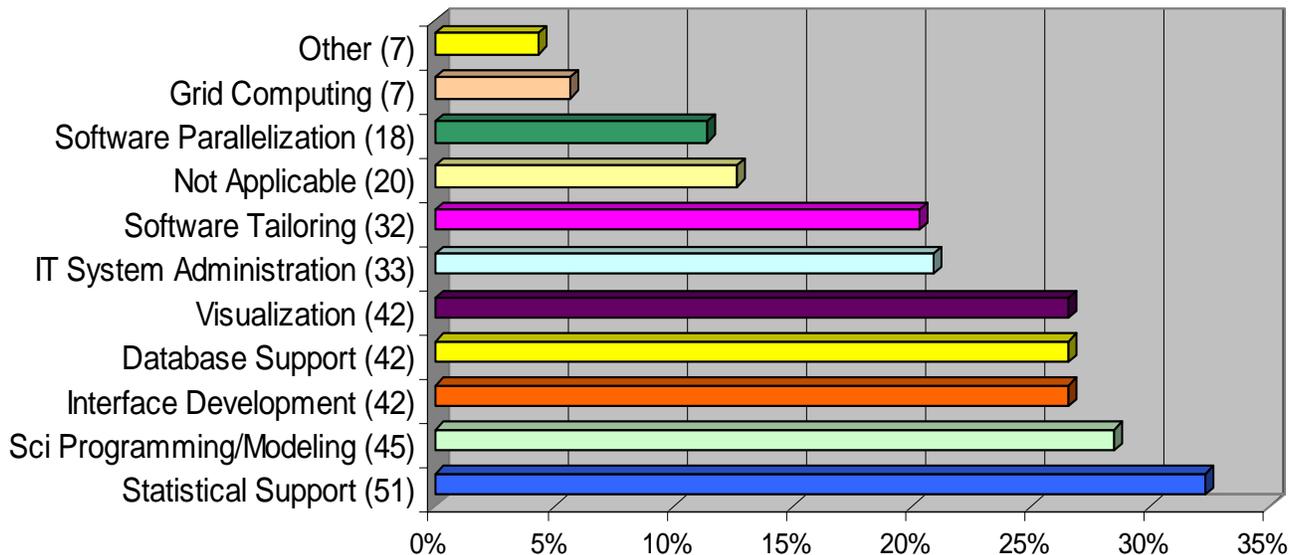


7. Research Programming and Staff Support Needs

Q10: What are your greatest programming and staff support needs for your research? Select as many as apply

Statistical support emerged as the most frequently cited programming and staff support need (32%) with scientific programming and modeling (28.5%), interface development (27%), database support (27%), and visualization (27%) cited frequently as well. Many research universities provide an enterprise statistical support and services center and this has been proposed at UB recently.

Programming & Staff Support Needs



Comments on programming and staff support needs included the following:

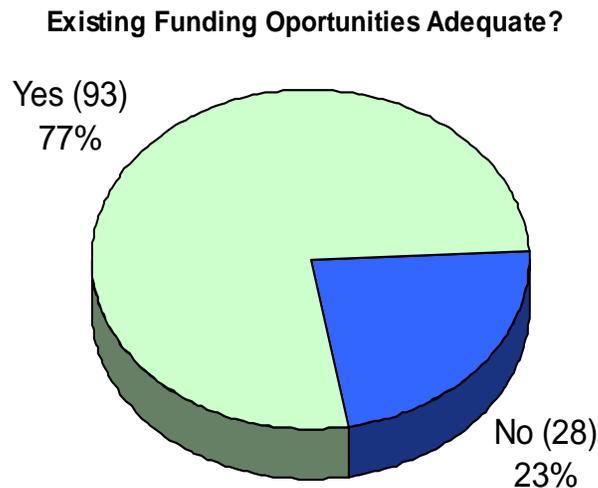
- o There is an appalling lack of biostatistics consulting support
- o Need: [help] tracking down strange bugs in scientific software and interplay with operating systems, queuing system, and parallelization software
- o Need advice on the text encoding initiative for the humanities
- o Trained grad students perform these functions [for my group]
- o School IT staff help with all needs
- o Permanent RA lines would be sufficient to support these needs
- o Need: consultation on XML and the program Oxygen
- o Visualization and database support are provided in-house, if free [enterprise] services existed, would out-source
- o Need space for my research team which I had to let go (students, staff, and post-docs)
- o Need: space for my lab
- o Need on-site support
- o Inadequate support is provided for Macs
- o Need web page design and support
- o Lab's focus is scientific programming/modeling and software parallelization, uncertainly analysis
- o Need support for retrieving and formatting ICPSR data

The lack of sufficient lab space and lab space needs were mentioned repeatedly by faculty in comment areas for several different questions.

8. Research Administrative Needs

Q11: Are the existing funding opportunities on the sponsored projects services web site adequate?

Most faculty responded that the funding opportunities on the Sponsored Projects site were adequate.



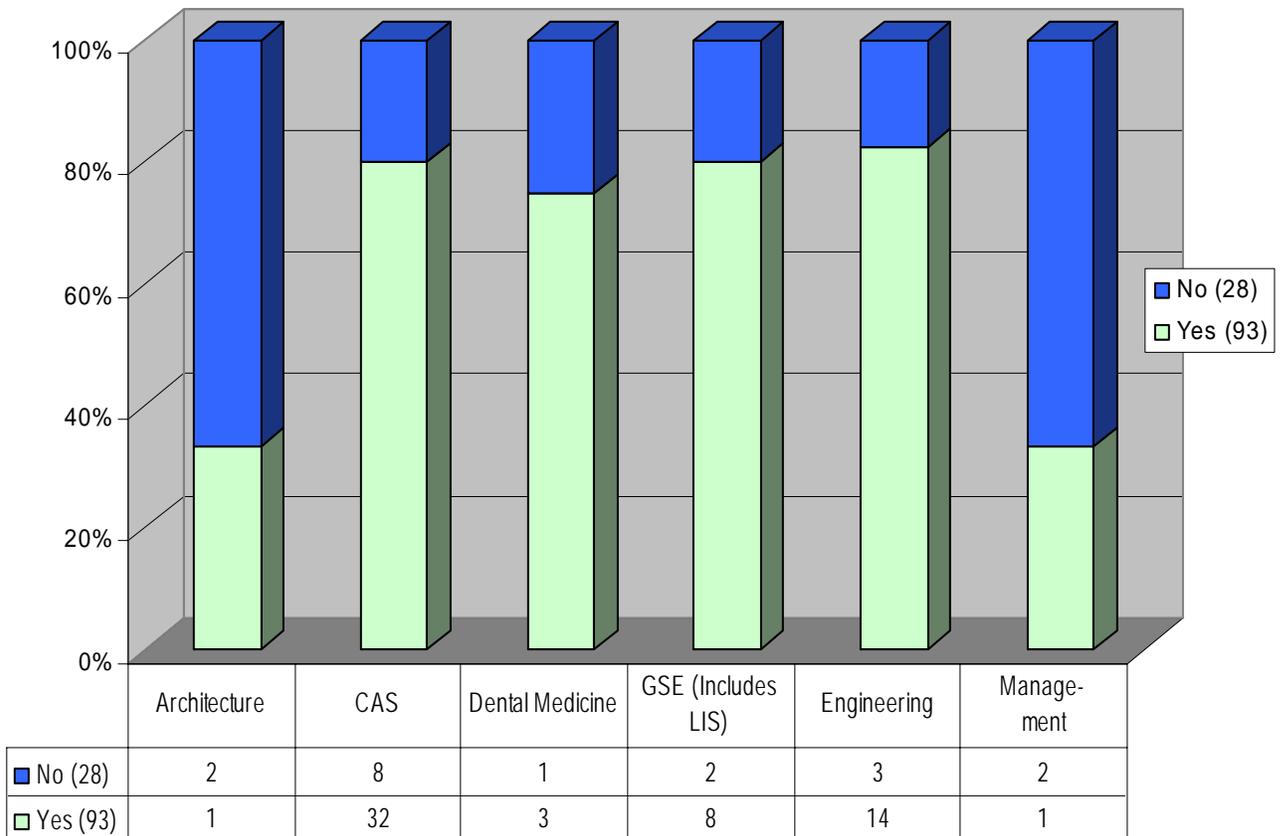
Comments and suggestions included the following:

- o Sending timely alerts to individuals is needed
- o The communication flow is not consistent based upon the work flow of Sponsored Programs. Need a grant development and submission support system based on the recent electronic format for NIH Grants

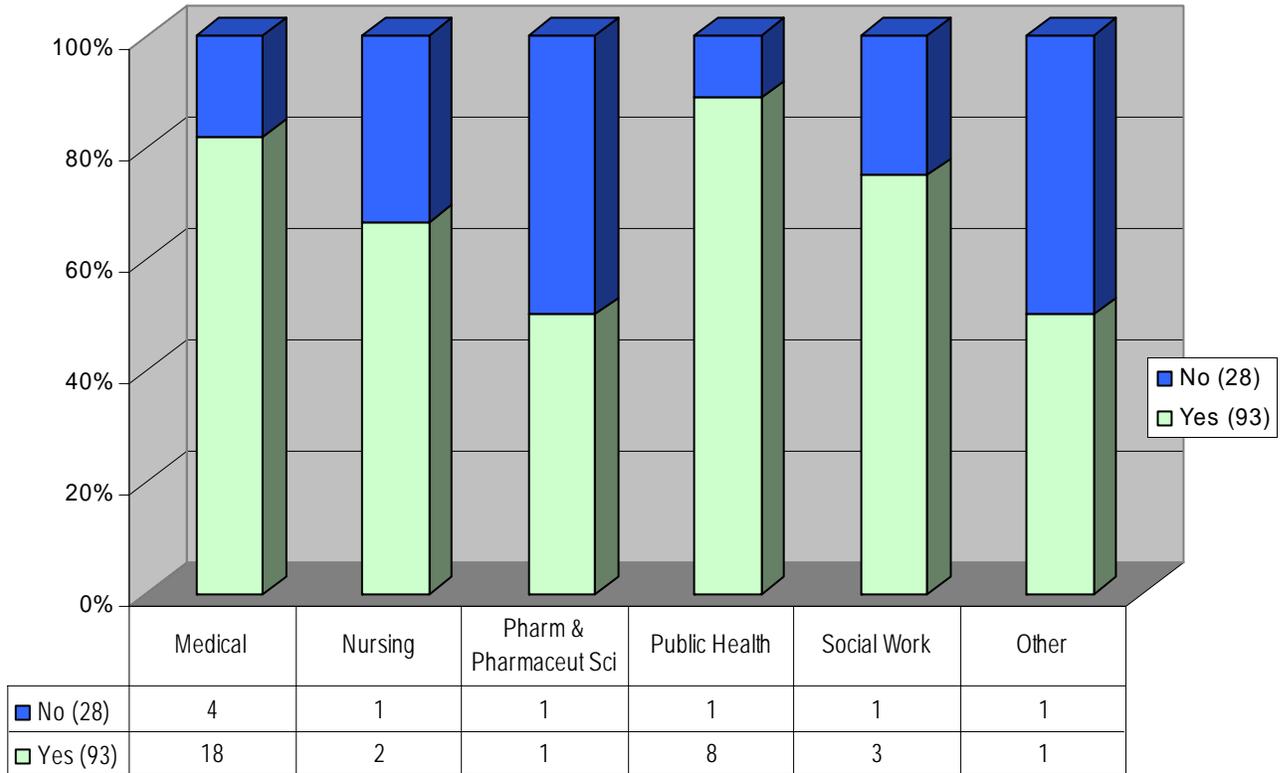
- o Need to be able to search the extensive listings in an effective & productive manner; Need a key word search
- o Examples are always more helpful than abstract examples
- o I don't use this resource since there are so many RFAs online
- o Don't pay much attention to the web site: these are usually too out-of-date by the time we are notified, to successfully apply; rely on my own scoring for agencies/foundations
- o Send out email in non-text format so I cannot use it
- o Sent in unreadable format
- o No assistance from staff
- o There are inadequate matching funding from UB
- o The NIH pay line is too high
- o There can never be enough info on funding sources

Responses distributed across decanal areas follow.

Existing Funding Opportunities Adequate?



Existing Funding Opportunities Adequate?



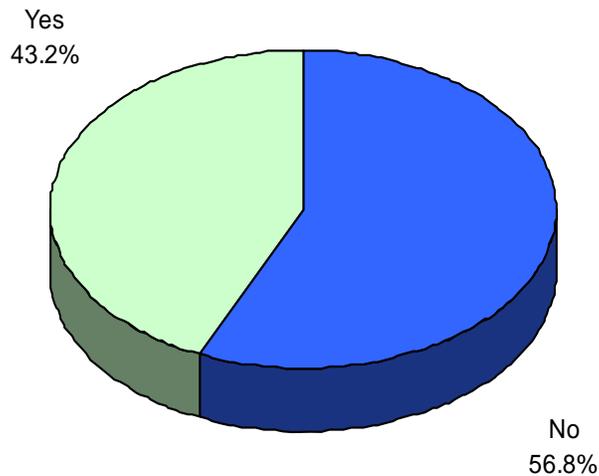
Q12: Please specify any specialized software (aside from word processing software) you use to develop your grant applications. If there are tools that could be purchased or developed that would assist you in the grant application process, please specify those as well. Similarly, are there software tools that could be purchased or developed that would assist you in managing your proposals and awards?

Faculty specified tools needed in the grant application development process, in managing proposals and awards, and general tools they use.

| Grant Development | Proposal & Award Management | General Tools |
|--|--|--|
| <ul style="list-style-type: none"> o Groove virtual office would be helpful for multi-site grant applications | <ul style="list-style-type: none"> o The current grant budget management process is so compartmentalized and inefficient that purchasing does not interface with budget, so spreadsheets are not accurate for 6-8 weeks | <ul style="list-style-type: none"> o SPSS, o Statistical power analysis software |
| <ul style="list-style-type: none"> o Grant document editing/sharing tools would help faculty pursuing interdisciplinary proposals | <ul style="list-style-type: none"> o Monthly award reports are not easy to understand; need tools to see easily for each budget category how much one is over/under budget at a given time | <ul style="list-style-type: none"> o Adobe Acrobat full version for all PIs, required for grants.gov o TeXShop, Pepper + OzTeX o Captioning software |
| <ul style="list-style-type: none"> o Help in preemptively discovering (i.e., before submission deadline) troubles in the research exposition pages that grants.gov or Fastlane would flag | <ul style="list-style-type: none"> o Budgeting tools that are tied to the Pure Edge application o NIH's Pure Edge | <ul style="list-style-type: none"> o Project management software |
| <ul style="list-style-type: none"> o There are contract editors for grants that can make a big difference. It is used at Univ Alabama, one of the highest NIH-funded schools | <ul style="list-style-type: none"> o Everything is good except for Oracle. What a mess that system is: difficult to use and access. I think running all of RF with excel spreadsheets would be more efficient | <ul style="list-style-type: none"> o Better graphics and photo modification tools o A versatile graphics program o Spreadsheet and graphing tools o kaleidograph, excel o Photoshop o Easier, more flexible graphing program o MS Visio |
| <ul style="list-style-type: none"> o NIH's Pure Edge plus other similar software that other funding agencies use | <ul style="list-style-type: none"> o A good local client to manage funded grant info – make student appointments, manage budgets | |

Q13: Have you used the new electronic (online) approval form on the Sponsored Projects Services web site?

This question was asked to gauge usage and to inform researchers of the existence of the online approval form.

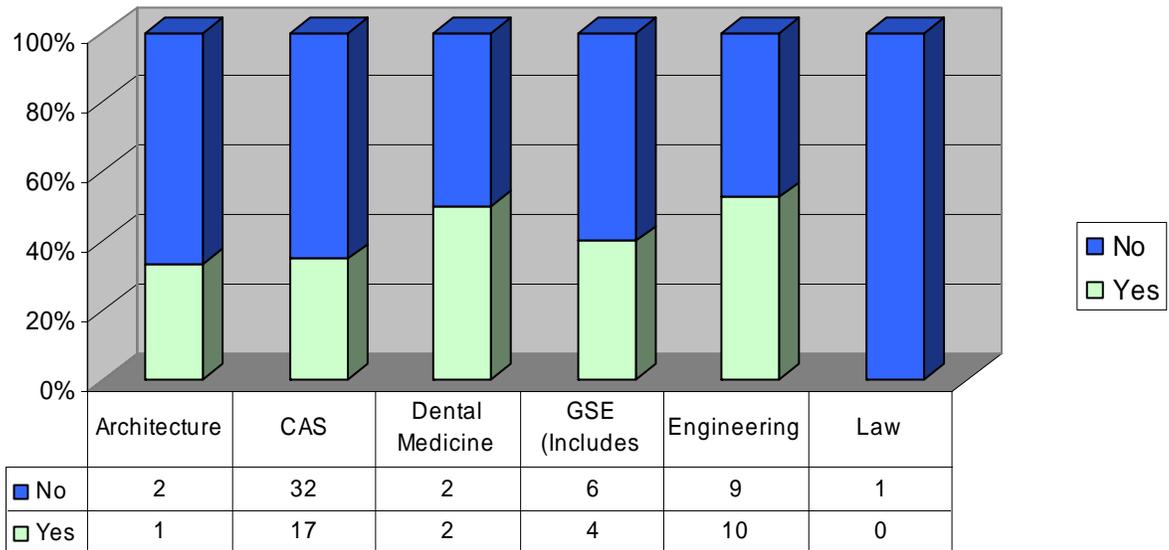
Have You Used the Electronic Approval Form?

Comments about the form included the following:

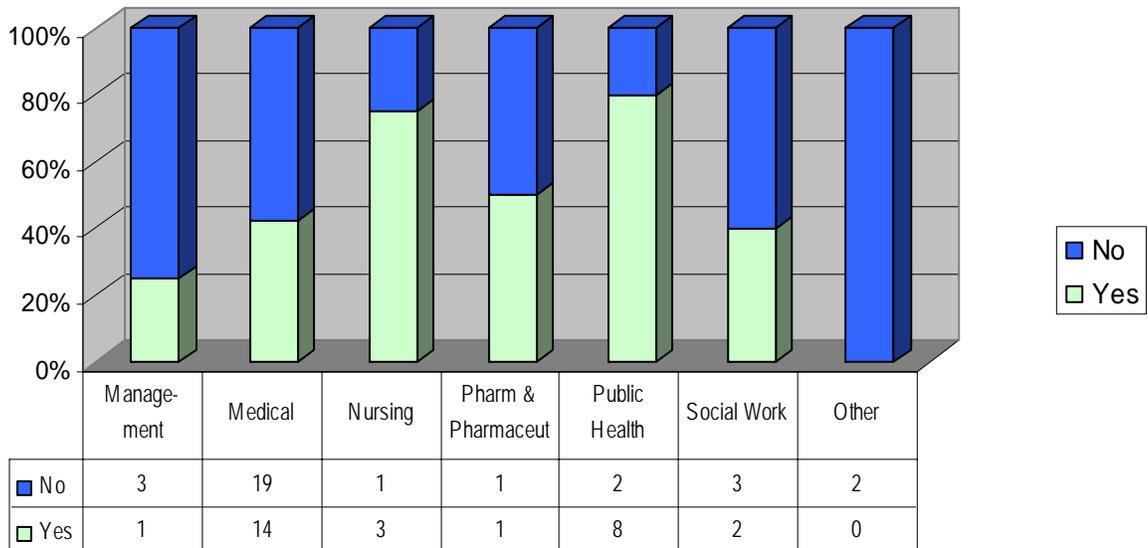
- o Awesome
- o Will use it for my next proposal
- o Very good facility
- o It could use some improvements
- o Still buggy- need better “yellow light” explanation
- o My grant manager does this
- o Did not know it existed
- o I find this form difficult to use- no ability to modify information on it
- o Tried once, it was a disaster
- o It is very cumbersome to use
- o It is not very user-centered and required emailing to troubleshoot issues several times

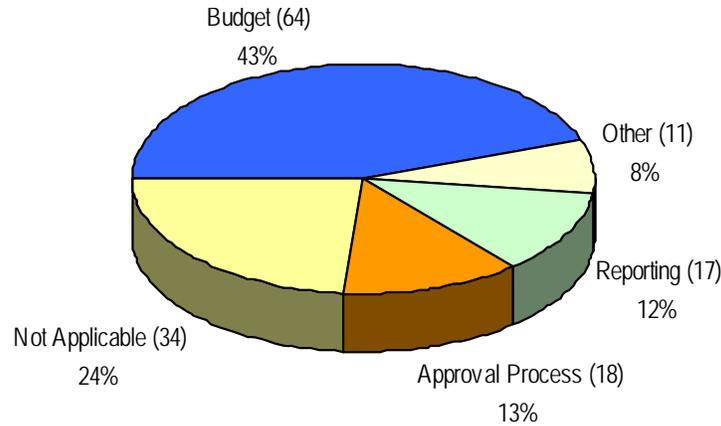
Use of the electronic approval form across decanal areas follows:

Have You Used the Electronic Approval form?



Have You Used the Electronic Approval Form?



Q14: What do you find to be the most difficult part of the grant management process?

Comments about the “most difficult part of the grant management process” included the following:

- o Getting funded
- o We need money to support the process in the department, not centrally; i.e., more administrative help is needed in the trenches
- o Sponsored Programs should take the administrative burden from the PI; too much left to PI
- o Post-award management
- o Post award tracking of budget/expenditures
- o I do not find any of it difficult, just time consuming, if by approval process you include crossing all the t’s, this is the most nebulous
- o Paperwork for travel and acquisitions
- o Accurate, real time info not available
- o Financial reports from Grants & Contracts are not comprehensible
- o Financial reports from foundation aren’t especially useful
- o The budget accounting is very poor, particularly at the end of a grant. Why can’t this be improved: it was better 10 years ago
- o Overall budget management at the local level of the project is completely inadequate at UB, compared to other top public research universities in the US
- o My grants manager handles most of it
- o The approval process isn’t hard; it’s just the least easy thing on the list
- o Help with the application and approval is needed
- o NYSTAR is horrible: even Russia is easier
- o Research and having any vision that is in sync with the national agenda
- o Supplies, summer support, student support, etc. We need clerical assistance for managing our grants
- o Need fund-based accounting snapshot available across all accounts (UBF, RF, State)

9. Additional Comments about Research Computing Needs

Q16: Please enter any additional comments you would like to add about your research computing needs.

| ADDITIONAL COMMENTS | |
|-------------------------------------|--|
| CCR and High Performance Computing | <ul style="list-style-type: none"> ○ Some codes don't run well on a cluster (see previous comment about "Lennon"). CCR staff support has been essential to port code to other platforms, maintain codes etc. ○ Since my overhead dollars probably go towards supporting the computational infrastructure of this university, it is not clear to me with these surveys whether there needs to be a central computing resource given the fast desktops PCs and clusters that are now available at low cost. It is not clear to me if a significant fraction of the university uses the CCR facility actively given that PCs are so much faster than they were in 1997-98 when CCR was established. I do not have the dollar figures, trends or statistics in front of me to make an objective evaluation, but would hope that someone would look into this. ○ I miss CCR on North campus. |
| CPU/Compute Cycle Needs | <ul style="list-style-type: none"> ○ I see two problems: <ul style="list-style-type: none"> ○ Since most of the scientific computing software is written for single CPU, I wish my dept or node had available up-to-date workstations with fast 64bit processors, e.g., 3.6GHz Xeon. The current ones are 500MHz Pentium III or less. ○ A new cluster in the Math Dept or College or SENS Node. The current "brainiac" is very outdated.. |
| Database Creation and Support | <ul style="list-style-type: none"> ○ Not sure where to put this, but we have a great need for a database that can be used across Windows and Mac machines and that can be administered by our staff. |
| Research Support Awareness | <ul style="list-style-type: none"> ○ I probably need an update on what's available and how to use it. ○ It's not readily apparent how to find out what's available from the University. |
| Research Data Storage Needs | <ul style="list-style-type: none"> ○ I would like a centralized data backup system. I talked about this with Corky way back, but the cost was extremely high. |
| Research Administrative Needs | <ul style="list-style-type: none"> ○ A grant document editing / sharing tool would help faculty pursuing interdisciplinary proposals. This same tool can then be used for research papers with multiple authors (including students). It helps to ensure that people are editing the same version. |
| Programming and Staff Support Needs | <ul style="list-style-type: none"> ○ My needs are small and could be easily met by minor additions to current staffing ○ Need better Mac support ○ We need a statistical support center...help with analysis ○ Developing software or programs for artistic reasons ○ Software assistance is the most important Also better junk mail filters ○ I would like to know who can help me in dealing with ODBC between Lotus Notes and SPSS. |

ADDITIONAL COMMENTS

Perceptions of IT, Support Organizations, University Leadership

- Having our own IT staff makes a great difference. They are excellent and offer the support I need for my research.
- Access to medical school computing center staff is excellent
- This response, and interest in the topic, are consequent upon a long-standing interest in the availability of adequate computing resources in support of research throughout UB
- CCR, HSUSG, and SENS have been extremely helpful and have responded with time, machinery, and staff help with problems.
- IT requires greater organization and clear follow-up
- The University needs to provide infrastructure for research. Instead, I am forced to protect myself.
- We need leadership with a vision that is in sync with the national agenda when it comes to research computing, computational science and engineering, simulation and modeling, HPC and its outreach internal and external to the University, and topics that are on top of NSF's list, including cyberinfrastructure and grid computing. Areas such as Informatics are also critical. ...
- Money in the bank that the university is not allowing me to spend. NSF is less than thrilled when I have to have discussions with them about the lack of support from UB despite the letters of support to the contrary - they are trying to work with me to figure out how to resolve the situation without having to send nearly \$1M back to NSF
- My school is not connected to these services, we pay our IT unit for all services through our department or grant budgets, UB provides no IT support
- It's too bureaucratic. I need computing power not questionnaires

10. Recommendations and Action Steps

The findings support the need to provide a portfolio of enterprise services that all researchers can access, including data storage, management, and analysis solutions; the provision of centrally negotiated volume software licensing discounts for needed software; tools for collaborative work, and programming and other technical support services. Researchers also need to have desktop computers with routine 3-4 year refresh cycles and, in the case of high-end technology users, access to high-performance computing resources and advanced networking infrastructure. Continued investments in the CCR and in networking initiatives need to continue to be a University priority. Investments in these areas will enable UB researchers to participate in national “big team science” projects and the multi-institutional projects that comprise the national research agenda and funding priorities.

Improvements can also be made to better meet the research administration needs of our faculty by providing tools and resources for grant proposal development as well as award management tools. Many researchers repeatedly specified their need for lab space in spite of the fact that we were asking them about research computing needs. As we add faculty in our strategic strengths areas with UB2020 faculty hires, the need for research computing resources, tools, and services will increase.

Major Findings:

- Response yield & quality of comments indicate high faculty interest in research computing.

- 65% of respondents indicated current research computing services meet or exceed their needs, however 75% of faculty respondents whose high-end technology needs “push the envelope” reported that current services do not meet their needs.
- Software licensing (volume discount negotiations by central IT with vendors) to help lower the cost of research computing software is needed.
 - Adobe Acrobat Professional is needed by all PIs on campus in order to comply with funding agency requirements.
- Many faculty use their workstations for compute cycles, raising concerns about aging or outdated faculty workstations.
- The CCR is relied on for many high-end compute needs.
- Department/school/research group compute systems are aging.
- Current data storage needs for research computing are being met, but there are concerns regarding future growth and data backup, with approx 30% of respondents indicating that their storage needs will grow to 500GB-100TB in the next 2 years.
- Collaboration tools are needed to allow connectivity and facilitate interactions with researchers at other institutions.
- Many faculty would like to see improvements to local networks around campus to improve connection speed to various compute systems, such as local clusters or to the CCR.
- There is significant demand for technical support in several key areas, with statistical support, scientific programming/modeling, interface development, database support, and visualization being dominant.
- A majority of faculty (77%) are satisfied with the funding opportunities as listed on the sponsored projects web site.
- Budget management at the local level is a problem for many faculty.
- Additional communication about existing research computing services and resources available to faculty is needed.
- Assistance from contract writers/editors for grant proposal development would improve success in acquiring external funding.

Specific recommendations based on these findings include the following:

Recommendation 1: Identify and prioritize IT projects that will enable UB faculty to compete for large, multi-discipline and multi-institutional research grants more effectively.

- Develop processes to regularly collect multidisciplinary research IT needs
- Charge the newly created Enterprise Research Computing Services group with the responsibility for collecting enterprise research IT needs and coordinating the development of services and deployment of resources to meet those needs
- Conduct focus group sessions to probe research computing needs further
- Communicate to faculty more effectively about existing services

Recommendation 2: Software Needs

- Negotiate volume software discounts for commonly needed research software packages.
- Software candidates to consider for volume licensing negotiations:
 - Matlab (negotiations underway)
 - Adobe Acrobat Professional

Recommendation 3: CPU/Compute Cycle Needs

- Continue to make investments in CCR hardware to increase available compute cycles a University priority
- Support the policy proposed by the UB2020 Workstation Standardization Initiative to refresh old, out-dated machines on a cyclic basis to help address desktop research computing
- Plan for increased compute cycle needs: As UB2020 hires come on board, it is likely that there will be an increased need for HPC resources
- Develop cost effective compute clusters that allow applications to migrate easily from small school based compute systems to larger CCR clusters. Whenever possible, insure that the

computing environments of the small clusters are identical to that of the larger compute clusters in CCR, thereby providing a seamless transition for faculty researchers.

Recommendation 4: Research Data Storage Needs

- Provide an institutional data/storage repository to foster research activities of under-served segments of UB community, as well as researchers with high-end technology needs whose storage needs are increasing rapidly.
- Develop a data modeling/database support service for research data.
- Data archiving and backup needs: Provide data backup services and off-site storage for faculty desiring such services.

Recommendation 5: Networking Needs

- Continue to make investments in wired and wireless network infrastructure to increase speed and reliability (mUB, UBNet).
- Continue to make connectivity to advanced national research networks a UB priority.

Recommendation 6: Programming and Staff Support Needs

- Create a UB Statistical Support and Services Center.
- Provide additional programming and staff support for researchers with high-end technology needs.

Recommendation 7: Research Administrative Needs

- Collaboration Tools
 - Provide collaborative writing/document/office tools to researchers developing multi-site grant applications (e.g., by site licensing Groove software).
 - Develop PI profile tools based on Cornell's VIVO (<http://vivo.cornell.edu/>).
 - Implement a wiki to help researchers share information regarding strategic strength areas.
 - Provide faculty training for these tools.
- Continue to implement Coeus as a proposal development tool, streamlining the budget process and flagging potential proposal errors before submission. Consider developing a local grants.gov mirror, training site, or helpful materials as University of California-San Francisco and University of Washington have done.
- Provide contract grant editing services for grant proposal developers.

Recommendation 8: Address Other Research (Non-Computing) Needs

- Researchers repeatedly mentioned their need for lab space.

Elias Eldayrie

Tom Furlani

Matt Jones

Steve Gallo

Tom Wendt

Matt Stock

Sandy Peters

Bibliography

Blustain, H., Braman, S., Katz, R.N. Salaway, G., 2006, [*IT Engagement in Research: A Baseline Study*](#), *ECAR Research Study*, EDUCAUSE.

Blustain, H., 2005, [*The Engagement of Information Technology and Research*](#), *ECAR Presentation*, EDUCAUSE.

Braman, S., 2006, [*What Do Researchers Need? Higher Education IT from the Researcher's Perspective*](#), *ECAR Issue 1*, EDUCAUSE.

Daigle, S. L., Voss, B.D., 2006, [*IT and the Changing Face of Research in Higher Education*](#), *ECAR Research Bulletin*, EDUCAUSE.

Murray, P. J., 2007, [*IT Support for Research Grant Activity in Higher Education: Pursuing Integrated Electronic Research Life-Cycle Systems*](#), *ECAR Research Bulletin*, (ID: ERB0712), EDUCAUSE.

National Science Board, [*Enhancing Support of Transformative Research at the National Science Foundation*](#), May 7, 2007.

NSF 07-28, [*Cyberinfrastructure Vision for 21st Century Discovery*](#), March, 2007.

Appendix A: Survey Instrument

2007 Research Computing Survey

This survey will help identify faculty research computing needs, including needs for software programs, compute cycles, storage and data management, networking, and programming. Focus group sessions will also be held to identify research computing needs. These needs will be communicated to the University administration with recommendations on how best to meet them.

We hope that you will choose to complete the survey. Your responses will be confidential and any contact or identifying information you provide will be removed from the response database. The survey will take only 5 minutes to complete.

Please feel free to skip or mark as "N/A" (not-applicable) any questions that are not relevant or applicable to your research needs.

The survey was developed by the following units: the Center for Computational Research (Tom Furlani, Steve Gallo, Matt Jones), the Office of the Vice President for Research (Tom Wendt), and the CIO Office (Elias Eldayrie, Matt Stock, Sandy Peters).

1) Software Needs:

Please specify the names of any software packages you need for your research that are not currently available to you because of cost or other reasons. Please enter "N/A" if this question is not relevant to your research needs.

2) Software Needs

What are the major software packages you are using for your research (e.g., matlab, sas, gene annotation software, other analysis software)? Please do not include the personal productivity and communication software you use, such as word processing and spreadsheet tools, email clients, etc. Please enter N/A if this question is not relevant to your research needs.

3) Compute/CPU Needs

How are your research computing needs for "compute cycles" currently being met? (Select all that apply.)

- Desktop system (Local personal computer, workstation)
- Faculty/Research Group Cluster
- Department-owned Cluster
- School or "IT Node" Cluster (e.g., Medical School or SENS cluster)
- Center for Computational Research (CCR) Cluster
- Grid Computing
- National Systems (e.g., National Lab, Supercomputing Center, Research Center)
- Not applicable
- Other (please specify)

If you selected other please specify:

Additional comments:

4) Compute/CPU Needs

If your research needs for "compute/CPU cycles" are not being met, please specify the unmet needs. Please enter "N/A" if this question is not relevant to your research needs.

5) Data Storage and Access Needs

What are your greatest data access and storage needs? (Please select as many as apply)

- Storage capacity, more storage for research data
- Data management software
- Transferring experimental data to storage facility
- Transferring data from storage to desktop or cluster
- Access to national repositories
- Data archiving/Backup
- Data/format compatibility
- Meeting data privacy/security requirements
- Not applicable
- Other (please specify)

If you selected other please specify:

Additional comments:

6) Data Storage

Are your current research needs for data storage being met?

- Yes
- No
- Not applicable

Additional comments:

7) Data Storage Needs

What do you anticipate your research data storage requirements will be for the next 2 years? (Please select one option)

- 1-500 Gigabytes
- 500 Gigabytes - 2 Terabytes
- 2-100 Terabytes
- More than 100 Terabytes
- Not applicable
- Other (please specify)

If you selected other please specify:

Additional comments:

8) Networking Needs

What are your greatest networking needs for your research? Please enter "N/A" if this question is not relevant to your research needs.

9) Networking Needs: Collaborations

Does your current or near-term future (next 2 years) research require connectivity to any national laboratories or research centers?

- Yes
- No
- Not applicable

Additional comments:

10) Programming and Staff Support

What are your greatest programming and staff support needs for your research? Please select as many as apply.

- Interface development (GUI, Web-based)
- Database support (e.g., Schema design, management, tuning)
- Scientific programming/Modeling
- Visualization (Scientific, Medical, etc.)
- Statistical support (e.g., survey design, analysis)
- Software tailoring (e.g., porting code, scripting)
- Software parallelization
- IT system administration
- Grid Computing
- Not applicable
- Other (please specify)

If you selected other please specify:

Additional comments:

11) Research Administration Needs

Are the existing funding opportunities, located on the Sponsored Projects Services web site (<http://www.research.buffalo.edu/sps/>), adequate? If not, please explain why in the Additional comments text box.

- Yes
- No

Additional comments:

12) Research Administration Needs

Please specify any specialized software (aside from word processing software) tools you use to develop your grant applications. If there are tools that could be purchased or developed that would assist you in the grant application development process, please specify those as well. Similarly, are there software tools that could be purchased or developed that would assist you in managing your proposals and awards?

13) Research Administrative Needs

Have you used the new Electronic (online) Approval Form (<https://www.research.buffalo.edu/account/eps/submission/index.cfm>) on the Sponsored Projects Services web site?

- Yes
- No

Additional comments:

14) Research Administrative Needs

What do you find to be the most difficult part of the grant management process?

- Budget
- Approval process
- Reporting
- Not applicable
- Other (please specify)

If you selected other please specify:

Additional comments:

15) In general, the research computing services (CPU cycles, storage, networking, and software engineering/programming) provided by the University:

- Do not meet my needs
- Meet my needs
- Exceed my needs
- Not applicable

Additional comments:

16) Please enter any additional comments you would like to add about your research computing needs.

17) Please enter the name of your department.

18) Please select your School or College from the list below. If your affiliation is not with a School or College, but rather with a Center or other group, please specify the name of the Center or group in the "Other" text box.

- Architecture and Planning
- Arts & Sciences
- Dental Medicine
- Graduate School of Education and Library & Information Studies
- Engineering & Applied Sciences
- Law
- Management
- Medical & Biomedical Sciences
- Nursing
- Pharmacy & Pharmaceutical Sciences
- Public Health & Health Professions
- Social Work
- Other (please specify)

If you selected other please specify:

19) Type of response: Are you responding as: (Select one)

- An Individual
- For a Group
- For a Center
- For a Department
- For a College or School
- Other (please specify)

If you selected other please specify:

20) Would you be willing to participate in a focus group to discuss faculty research computing needs? Focus group sessions will be scheduled for 1-2 hours at times convenient to participants this spring and summer.

- Yes
- No

Additional comments:

21) Responder Name: Completion of this field is necessary only if you would like to participate in the research computing focus groups or would like someone to contact you about your research computing needs.

Thank you for your time. Your responses will help us build our research computing infrastructure to meet faculty needs. Please click submit to complete the survey.

Appendix B: Complete Q1 and Q2 Software Responses

Q1: Please specify the names of any software packages you need for your research that are not currently available to you because of cost or other reasons.

Q2: What are the major software packages you are using for your research? Please do not include the personal productivity and communication software you use.

| Q1 & Q2 Software Needs & Software In Use | | |
|--|--------------------|-------------------------------|
| Software | Software Needs: Q1 | Software Currently in Use: Q2 |
| 3D*Studio*Max | 0 | 1 |
| ABAQUS | 1 | 2 |
| Accelrys*Insight | 1 | 1 |
| Acrobat*Professional | 1 | 0 |
| activeStat | 0 | 1 |
| ADAMS | 1 | 1 |
| Adobe Acrobat Writer | 1 | 0 |
| Adobe*Illustrator | 1 | 2 |
| Adobe*Professional | 0 | 1 |
| AMBER | 0 | 3 |
| AMOS | 2 | 1 |
| Ansoft HFSS | 1 | 0 |
| ansys | 0 | 3 |
| ArcGIS | 0 | 2 |
| ArcView | 0 | 1 |
| Arena | 0 | 1 |
| Artemis ACT | 0 | 1 |
| Atlas*TI | 4 | 3 |
| AUTOCAD | 1 | 3 |
| BBEdit | 1 | 0 |
| Bilog | 0 | 1 |
| Bio-rad | 0 | 1 |
| BLAST | 0 | 1 |
| c++ | 1 | 7 |
| Cadence VLSI Design | 0 | 1 |
| Canvas | 0 | 1 |
| CASL | 0 | 1 |
| Castep | 0 | 1 |
| Cellquest | 1 | 1 |
| Chaos Data Analyzer | 0 | 1 |
| CHARMM | 1 | 3 |
| Chemstation | 0 | 1 |
| Clustal X | 0 | 1 |
| Computer Speech Lab | 0 | 1 |
| Comsol | 5 | 1 |
| Condor | 0 | 1 |
| COOT | 0 | 1 |
| Corel*Draw | 1 | 1 |

| Q1 & Q2 Software Needs & Software In Use | | |
|--|--------------------|-------------------------------|
| Software | Software Needs: Q1 | Software Currently in Use: Q2 |
| Cspeech | 0 | 1 |
| Delta*Graphs | 0 | 1 |
| Delta3D | 0 | 1 |
| Direct | 1 | 1 |
| DNASTar | 1 | 0 |
| Dreamweaver | 1 | 0 |
| Endnote | 0 | 1 |
| Endnote | 0 | 1 |
| Epistat | 0 | 1 |
| eqs | 1 | 0 |
| EQS | 1 | 0 |
| Erdas*Imagine | 0 | 1 |
| Eviews | 0 | 1 |
| FEA Analysis | 1 | 1 |
| Femlab | 1 | 0 |
| FileMaker | 1 | 1 |
| FLTK | 0 | 2 |
| fortran | 2 | 9 |
| Gauss | 1 | 3 |
| Gaussian | 1 | 2 |
| Gaussview | 1 | 0 |
| Gene*Spring | 1 | 0 |
| GIS | 1 | 3 |
| Globus | 0 | 1 |
| Glomosim | 0 | 1 |
| HML | 1 | 0 |
| ICEM | 0 | 1 |
| IDL | 0 | 2 |
| Igor | 0 | 2 |
| Image*Quant | 0 | 1 |
| ImageJ | 0 | 2 |
| Insight | 2 | 1 |
| Instat | 1 | 0 |
| Isabelle | 0 | 1 |
| iWork | 1 | 0 |
| Java | 0 | 4 |
| JMP | 0 | 1 |
| Kaleidagraph | 0 | 1 |
| labview | 2 | 2 |
| Lasergene | 1 | 0 |
| Lecturnity | 1 | 0 |
| Ledit | 1 | 0 |
| Lisp | 0 | 1 |
| Lisrel | 2 | 1 |
| Lotus Notes | 1 | 1 |
| LS-DYNA | 1 | 1 |
| Mac*Vector | 1 | 1 |
| maple | 0 | 10 |

| Q1 & Q2 Software Needs & Software In Use | | |
|--|--------------------|-------------------------------|
| Software | Software Needs: Q1 | Software Currently in Use: Q2 |
| MathCad | 0 | 1 |
| mathematica | 1 | 8 |
| Matlab | 9 | 23 |
| Max QDA | 1 | 0 |
| Max/MSP | 0 | 1 |
| MediaLab | 0 | 1 |
| Microwave Office | 0 | 1 |
| MPI | 1 | 5 |
| Mplus | 3 | 2 |
| Multinet | 0 | 1 |
| MySQL | 0 | 3 |
| NAMD | 0 | 2 |
| NeuroLucida | 1 | 1 |
| NeuroQ | 0 | 1 |
| NeuroStst | 0 | 1 |
| Noldus Observer | 1 | 0 |
| NONMEM | 1 | 0 |
| Nud*ist | 1 | 1 |
| Nutritionist Pro | 0 | 1 |
| NVIVO | 0 | 1 |
| NWChem | 0 | 1 |
| Omnigraffle | 1 | 0 |
| OpenInventor | 0 | 1 |
| OPNET Network | 0 | 1 |
| oracle | 2 | 3 |
| Origin | 2 | 1 |
| Pclamp | 1 | 2 |
| Peak | 0 | 1 |
| PhotoShop | 4 | 4 |
| PMOD | 0 | 1 |
| postgresql | 0 | 1 |
| Prism | 0 | 1 |
| Prizm | 1 | 1 |
| ProEngineer | 0 | 2 |
| ProMechanica | 0 | 1 |
| Protools | 0 | 1 |
| PSPICE | 0 | 1 |
| PVM | 0 | 1 |
| QSR | 0 | 1 |
| Qualnet Opnet | 1 | 0 |
| Quantity One | 0 | 1 |
| Quark | 1 | 0 |
| Rasch Modeling | 1 | 0 |
| RNA Structure | 0 | 1 |
| SAS | 10 | 22 |
| SEM-AMOS | 1 | 0 |
| SGI Performer | 0 | 1 |
| Sigma*Plot | 4 | 4 |

| Q1 & Q2 Software Needs & Software In Use | | |
|--|--------------------|-------------------------------|
| Software | Software Needs: Q1 | Software Currently in Use: Q2 |
| sigma*stat | 1 | 2 |
| Simulink | 1 | 1 |

| | | |
|---------------|-----------|-----------|
| SNePS | 0 | 1 |
| solidworks | 2 | 2 |
| SPM | 0 | 1 |
| SPOT | 0 | 1 |
| SPSS | 12 | 38 |
| sql | 1 | 3 |
| Star-CD | 0 | 1 |
| Stata | 0 | 5 |
| STATA | 0 | 5 |
| Statistica | 2 | 2 |
| StatMost | 0 | 1 |
| Sudaan | 1 | 0 |
| Sybyl | 1 | 0 |
| systat | 1 | 0 |
| TecPlot | 1 | 1 |
| Turbomole | 1 | 1 |
| UCINET | 1 | 2 |
| Vectorworks | 0 | 1 |
| Visual Studio | 1 | 0 |
| Visual*Basic | 0 | 1 |
| VMD | 1 | 3 |
| vmware | 0 | 1 |
| VTK | 0 | 2 |
| WinNonLin | 1 | 1 |
| Winsteps | 0 | 2 |
| Zeiss | 0 | 1 |