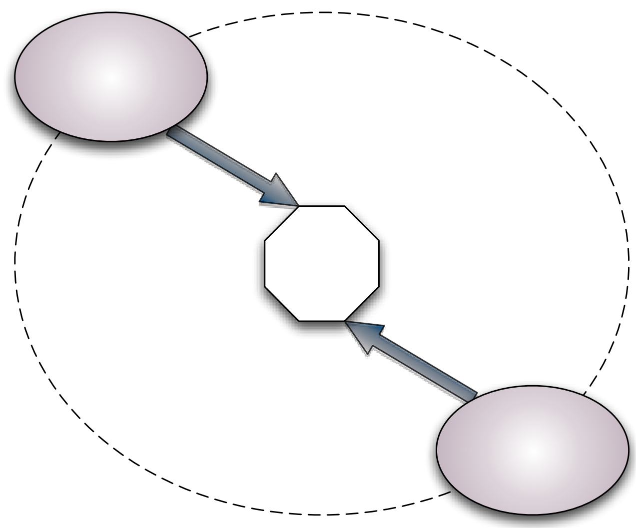
Scientific Computing at HMC: Interview Report



November 2009

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1. Introduction

This report describes the results of a series of interviews with faculty and staff members at Harvey Mudd College. The interviews had two main goals: to assess the scientific computing needs of faculty and to discover the current uses of scientific computing resources by faculty.

The interviews were conducted between March 27, 2009 and July 22, 2009, with a total of 25 faculty and 3 staff members across the seven academic departments at HMC. The interviewees were chosen from those who said they had been involved in using scientific computing in their teaching, research, and professional support as well as from those who were recommended for the interviews by each department chair. The names of the participants can be found in Appendix A.

Each interview lasted about 30 minutes. Interviewees were asked a series of questions regarding usages of scientific computing resources and support wishes for the new scientific computing specialist at the CIS department. The basic interview questions can be found in Appendix B.

The first outcome of the interviews was a job description of the new hire, Scientific Computing Specialist, at CIS. The CIS department has posted the job description on HigherEdJobs.com, SoCalHerc.org and the HMC web site. The complete job description can be found in Appendix C.

In summarizing the interviews, we outline two main subjects: scientific computing support wishes and scientific computing resource usages. The information about support wishes was used to write the job description for the Scientific Computing Specialist position. Using the up-to-date resource usage information, we developed a schematic view to visually map users and tools/systems on a 2-dimensional space. Details of the two themes follow.

2. Scientific Computing Support Wishes

25 faculty interviewees had mentioned a wide variety of support wishes that might be useful and helpful in conducting their scholarly activities using scientific computing resources. To find common expectations, we listed all quality-wise remarks and grouped them by common themes. We found that the support wishes could be grouped into three themes: consultation, pedagogy, and tech support. We report them here as three roles of the scientific computing specialist: a scientific computing consultant role, an associative teaching and research staff role, and a technical support personnel role.

2.1 Three roles of Scientific Computing Specialist

A scientific computing consultant role

Faculty members at HMC wish to have a person or a team who can:

- Make suggestions on finding right (or alternative) resources
- Show right (or alternative) methods on solving problems by being knowledgeable about the latest advances and available resources of scientific computing on campus as well as outside campus.

An associative teaching and research staff role

Faculty members at HMC wish to have a person or a team who can:

- Teach basic usages of Matlab, R, (scientific use of) Excel, Gaussian, LabVIEW, SolidWorks, Python, LaTeX and Gnuplot to faculty and students
- Write, update and test tutorials of such scientific computing tools
- Be a resource that the faculty members can recommend to students who need help on using and learning such scientific computing tools by offering seminars, crash courses, online/offline tutorial sessions, and one-on-one support.

A technical support personnel role

Faculty members at HMC wish to have a person or a team who can:

- Take care of scientific computing software licensing, new version updates and teaching/research lab computer maintenance
- Support programming such as C/C++, Java, and Python (Note: this role may overlap with the pedagogical role above.).

3. Scientific Computing Resource Usages

An important aspect of the faculty interviews was to discover the current usage of scientific computing resources at HMC so that it may be used to facilitate CIS' client-centered service strategies correctly and effectively. Gathering scientific computing usage statistics, we have discovered several interesting aspects:

- 56% of scientific computing users use Matlab.
- Mathematica is preferred over other similar tools such as Mathcad and Maple.
- There is a surprisingly high demand for parallel processing and High Performance Computing for a variety of different tasks.

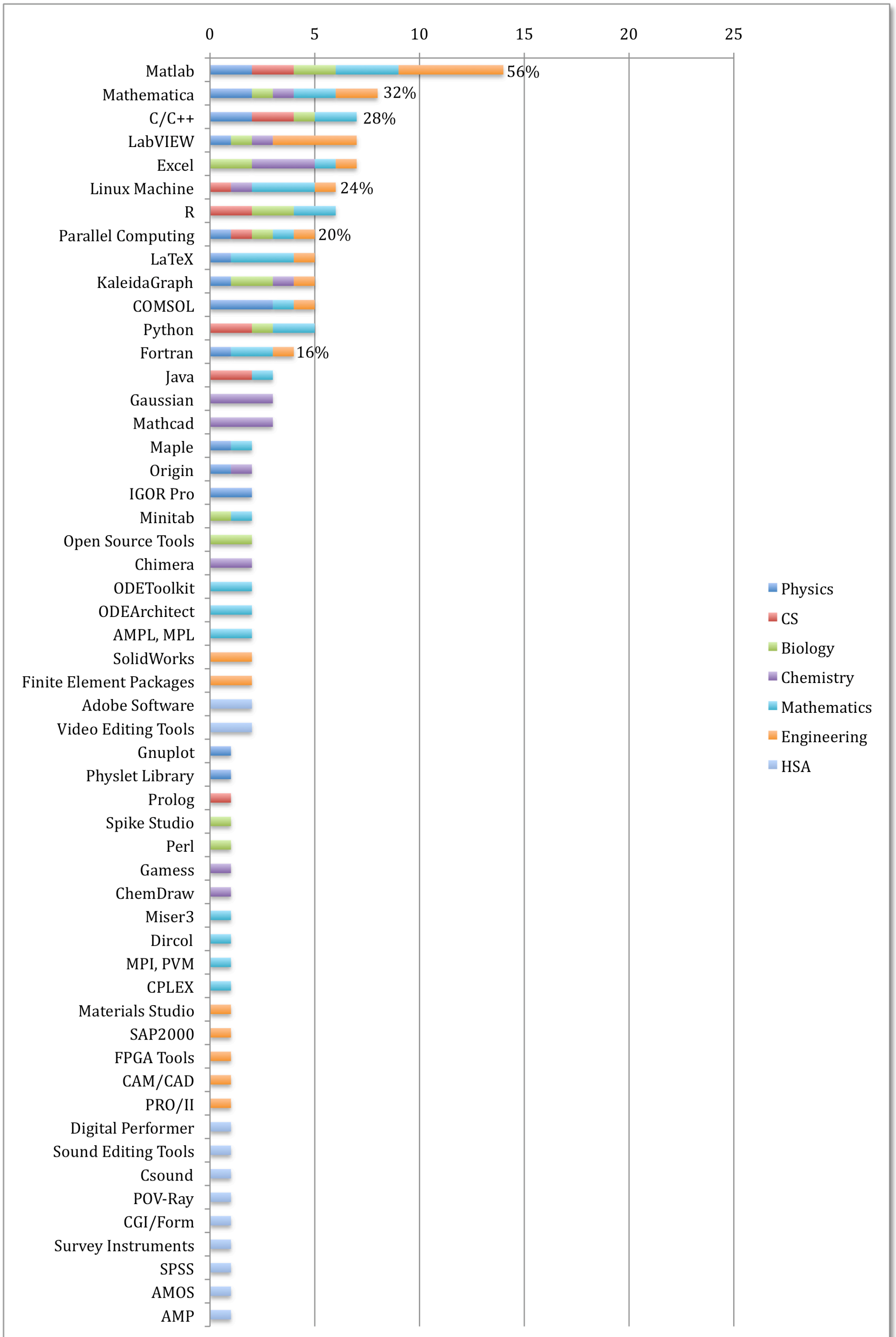
- 24% of the interviewees express their intention to learn or use R for statistical computing mainly because it is a free and powerful alternative to expensive commercial statistical applications such as SPSS and SAS.
- There is a growing interest and demand for open source tools such as R, LaTeX and discipline specific libraries.
- Many faculty members have used programming languages such as C/C++, Java, Fortran, and Python for their courses and research projects, and have needed practical support to some extent.

In the following sections, we summarize the usage information in two ways: a traditional bar chart/table and a novel schematic representation. In section 3.1, we show the number of users for each tool in a bar chart and a table format. Note that there are 25 faculty interviewees as the maximum horizontal label on the chart indicates.

To help see the whole picture of scientific computing resource usages at HMC, we developed a schematic in which scientific computing tools and users are mapped. The scientific computing space described in detail in Section 3.2 and current scientific computing space is available at http://www3.hmc.edu/scspace.

3.1 Usage Chart and Table

- Chart



- Table:

  The table below shows the number of users of each scientific tool or system by department along with the percentage of usages for each tool: e.g., by looking at the % column of Matlab row, we find that sixty percent of the interviewees said that they had used Matlab for their teaching and research.

	Physics	**CS**	**Biology**	**Chem**	**Math**	**Engr**	**HSA**	**Total**	**%**
Number of Participants	*4*	*3*	*3*	*4*	*3*	*5*	*3*	*25*	*100%*

Tool/System	**Physics**	**CS**	**Biology**	**Chem**	**Math**	**Engr**	**HSA**	**Total**	**%**
Matlab	2	2	2	0	3	5	0	14	56%
Mathematica	2	0	1	1	2	2	0	8	32%
C/C++	2	2	1	0	2	0	0	7	28%
LabVIEW	1	0	1	1	0	4	0	7	28%
Excel	0	0	2	3	1	1	0	7	28%
Linux Machine	0	1	0	1	3	1	0	6	24%
R	0	2	2	0	2	0	0	6	24%
Parallel Computing	1	1	1	0	1	1	0	5	20%
LaTeX	1	0	0	0	3	1	0	5	20%
KaleidaGraph	1	0	2	1	0	1	0	5	20%
COMSOL	3	0	0	0	1	1	0	5	20%
Python	0	2	1	0	2	0	0	5	20%
Fortran	1	0	0	0	2	1	0	4	16%
Java	0	2	0	0	1	0	0	3	12%
Gaussian	0	0	0	3	0	0	0	3	12%
Mathcad	0	0	0	3	0	0	0	3	12%
Maple	1	0	0	0	1	0	0	2	8%
Origin	1	0	0	1	0	0	0	2	8%
IGOR Pro	2	0	0	0	0	0	0	2	8%
Minitab	0	0	1	0	1	0	0	2	8%
Open Source Tools	0	0	2	0	0	0	0	2	8%
Chimera	0	0	0	2	0	0	0	2	8%
ODEToolkit	0	0	0	0	2	0	0	2	8%
ODEArchitect	0	0	0	0	2	0	0	2	8%
AMPL, MPL	0	0	0	0	2	0	0	2	8%
SolidWorks	0	0	0	0	0	2	0	2	8%
Finite Element Packages	0	0	0	0	0	2	0	2	8%
Adobe Software	0	0	0	0	0	0	2	2	8%
Video Editing Tools	0	0	0	0	0	0	2	2	8%
Gnuplot	1	0	0	0	0	0	0	1	4%
Physlet Library	1	0	0	0	0	0	0	1	4%
Prolog	0	1	0	0	0	0	0	1	4%
Spike Studio	0	0	1	0	0	0	0	1	4%

Perl	0	0	1	0	0	0	0	1	4%
Gamess	0	0	0	1	0	0	0	1	4%
ChemDraw	0	0	0	1	0	0	0	1	4%
Miser3	0	0	0	0	1	0	0	1	4%
Dircol	0	0	0	0	1	0	0	1	4%
MPI, PVM	0	0	0	0	1	0	0	1	4%
CPLEX	0	0	0	0	1	0	0	1	4%
Materials Studio	0	0	0	0	0	1	0	1	4%
SAP2000	0	0	0	0	0	1	0	1	4%
FPGA Tools	0	0	0	0	0	1	0	1	4%
CAM/CAD	0	0	0	0	0	1	0	1	4%
PRO/II	0	0	0	0	0	1	0	1	4%
Digital Performer	0	0	0	0	0	0	1	1	4%
Sound Editing Tools	0	0	0	0	0	0	1	1	4%
Csound	0	0	0	0	0	0	1	1	4%
POV-Ray	0	0	0	0	0	0	1	1	4%
CGI/Form	0	0	0	0	0	0	1	1	4%
Survey Instruments	0	0	0	0	0	0	1	1	4%
SPSS	0	0	0	0	0	0	1	1	4%
AMOS	0	0	0	0	0	0	1	1	4%
AMP	0	0	0	0	0	0	1	1	4%

3.2 Scientific Computing Space: A Schematic View

In this section, we describe key aspects of the scientific computing space developed by the Educational Technology and Media Services group in the CIS department to help visualize the usage information of scientific computing resources at Harvey Mudd College.

In the following subsections, you will learn about:

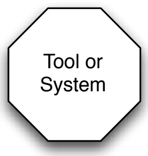
- Entities of scientific computing space
- Purpose of the schematic diagram
- How to read and use the space
- How to use the scientific computing space website

3.2.1 Entities of the Scientific Computing Space

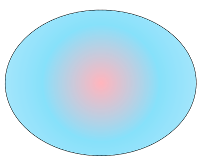
"Make everything as simple as possible, but not simpler." – Albert Einstein

The schematic is composed of four entities: user object, tool/system object, common space and its boundary.

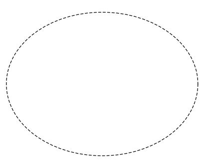
User object (oval): The object representing a faculty or a staff member who uses/wishes to use certain scientific computing tools and systems. The user object may be thought of a body with a force that pulls a tool/system object closer to itself. An arrow from a user object to a tool/system object represents a user-tool or a user-system usage relationship.



Tool/system object (octagon): The object representing a scientific computing tool or system. The more connections a tool/system object gets, the closer to the center it is placed in the space.



Common space (gradient oval): The space where tools and systems that have two or more connections (or usages) reside. When there are two users connecting a tool/system object, the tool/system object enters into the common space. Otherwise it stays outside the common space to the corresponding user.



Orbit (dashed oval): The outer boundary of the common space. User objects are placed on the orbit.

3.2.2 Why the space?

The scientific computing space was devised to visually show common usages of scientific computing tools and systems at the college. By mapping users and their tools on a relational diagram, we found that it would convey a lot of interesting user-centric information. As the space intuitively visualizes the usages of scientific computing tools, you may easily find answers to various questions such as:

- Who uses what?
- Which tool or system is more preferred than others?
- What is a departmental tendency/preference on using certain types of tools?
- What is a personal preference on using certain types of tools?
- What are the scientific computing tools in use by which department?
- Who would most likely be a regular customer?
- And many more

3.2.4 How to read and use the space

On the orbit, you will find users (a.k.a. clients). They are essentially the faculty members who participated in the scientific computing interview. The faculty members are clustered by their department.

Inside the common space, you will find scientific computing tools and systems that have two or more arrows – an arrow directed from a user to a tool/system object shows that the user has been using the tool/system or planned to use (or to learn) the tool/system in near future.

Outside the common space, you will find less common tools and systems that were mentioned by only one user. This doesn't necessarily mean that there is only one user using the tools in the college or that they are less important. But if we consider probability, they would most likely be less popular tools than the ones closer to the center of the space.

Tools or systems that receive more arrows from users are moved closer to the center of the space. Hence, by examining the objects near the center, you will find popular software tools or systems for scientific computing users of the college. A dashed oval near the center of the space indicates a so-called hot region, hence reddish.

3.2.5 The scientific computing space website

URL: http://www3.hmc.edu/scspace

For interactive use of the space, we developed a website containing all tool-user highlighted pages and departmental usage spaces. In this section, we give examples of the web pages and describe how to utilize them.

By clicking on a tool/system object, you highlight its users who have attached their arrows to the tool/system object. This is the best way to focus on a particular tool and system in the tangled and complicated-looking space. An example for Matlab is shown below in Figure 1.

By clicking on a department name, you open another diagram showing the departmental usage of scientific computing tools and systems. In the department-specific scientific computing space, you may perceive the tendency (or the preference) of using and choosing certain types of scientific computing tools and systems for each department. Mathematics department space is shown below as an example in Figure 2.

By clicking on a user name, the departmental usage diagram will pop up to show the user's usage of scientific computing tools and systems.

By looking into the arrows on the entirety of the space, you may be able to see who and which department would likely be a regular customer of the scientific computing services and vice versa, for example, HSA department vs. mathematics department.

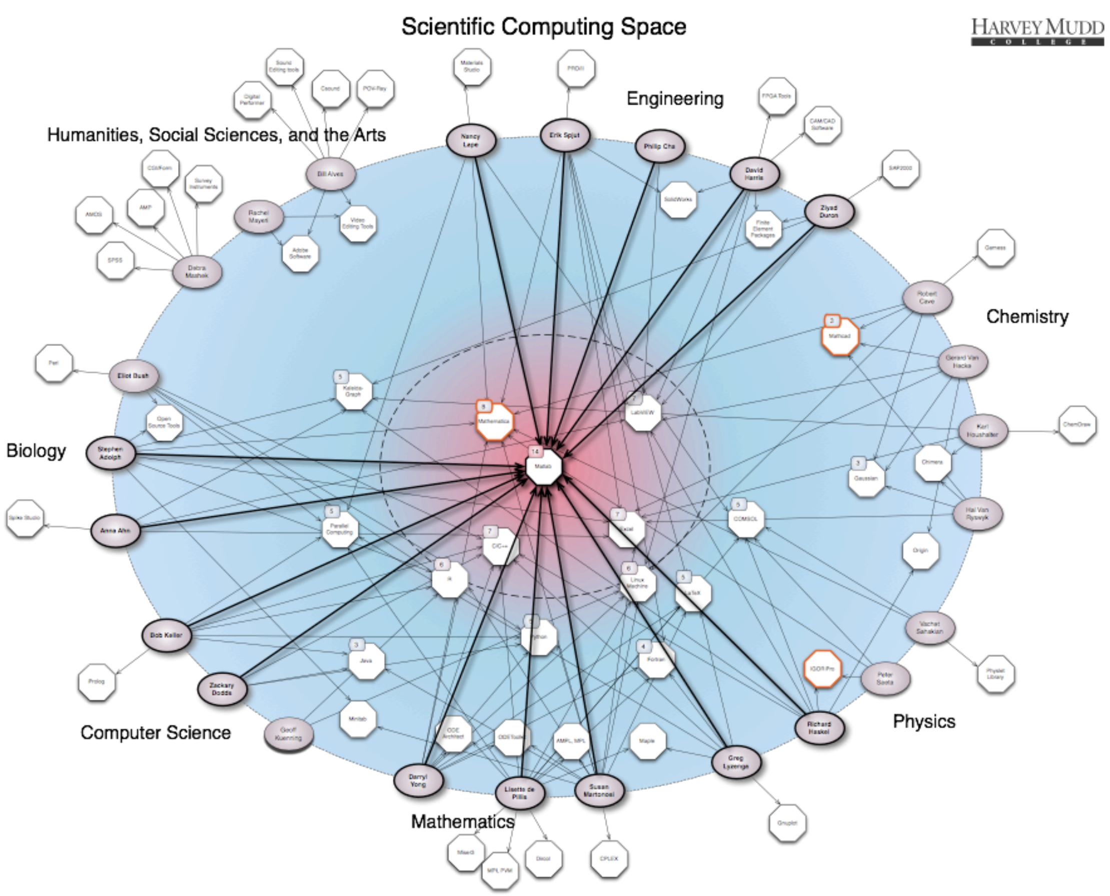


Figure 1: An example of the tool-user highlighted space – Matlab Space

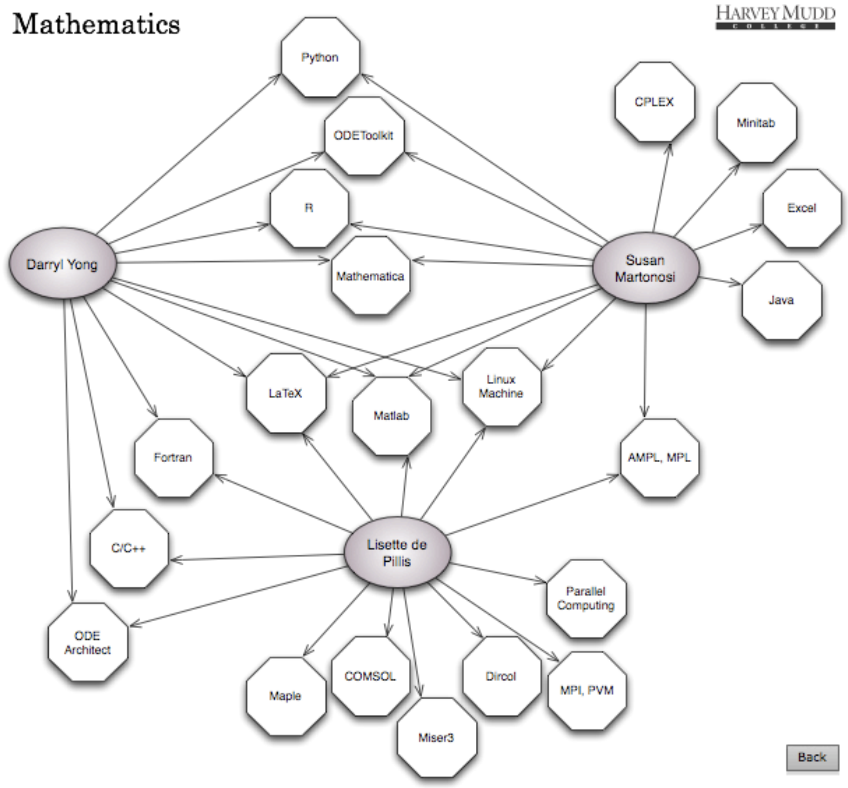


Figure 2: An example of the departmental space – Mathematics Department

4. Conclusion

Interviewing individual faculty members was a valuable tool for assessing faculty needs and desires. We believe that the information we've gathered will be an essential guide in our strategic plans for supporting teaching and research using scientific computing resources at Harvey Mudd College. We would like to thank everyone who helped in gathering this valuable information.

Appendix A

Interview Participants

We thank 28 faculty and staff members for voluntarily giving up their valuable time to participate in the interview:

- Stephen Adolph (Biology)
- Eliot Bush (Biology)
- Anna Ahn (Biology)
- Hal Van Ryswyk (Chemistry)
- Gerald Van Hecke (Chemistry)
- Karl Haushalter (Chemistry)
- Robert Cave (Chemistry)
- Geoff Kuenning (Computer Science)
- Bob Keller (Computer Science)
- Zachary Dodds (Computer Science)
- Tim Buchheim (Computer Science – System Administrator)
- Nancy Lape (Engineering)
- David Harris (Engineering)
- Philip Cha (Engineering)
- Ziyad (Zee) Duron (Engineering)
- Erik Spjut (Engineering)
- Rachel Mayeri (Humanities, Social Sciences, and the Arts)
- Bill Alves (Humanities, Social Sciences, and the Arts)
- Debra Mashek (Humanities, Social Sciences, and the Arts)
- Lisette de Pillis (Mathematics)
- Darryl Yong (Mathematics)
- Susan Martonosi (Mathematics)
- Claire Connelly (Mathematics – System Administrator)
- Richard Haskell (Physics)
- Greg Lyzenga (Physics)
- Peter Saeta (Physics)
- Vatche Sahakian (Physics)
- Annie Atiyeh (Physics – Lab and Stockroom Manager)

Appendix B

CIS Scientific Computing Interview Questions

Regarding yourself (2 questions):
1. What is your research field? (your research interest)
2. What do you teach? (your teaching interest)

Regarding your teaching (5 questions):
1. What kind of educational technology do you regularly use for your teaching?
2. What kinds of scientific computing resources do you regularly use for your classes?
3. If someone could help out with your class on the scientific computing resources, what would you ask the person (in and out of classes)?
4. If the specialist supports your students out of your class, which level and what kind of expertise would you expect?
5. What may be the most helpful support that the specialist could provide to your students?

Regarding your research (5 questions):
1. What kinds of scientific computing resources do you regularly use for your research?
2. If you were in need of any support for the scientific computing resources in the past, what were they?
3. If someone could help you on the scientific computing resources, what sort of support would you ask the person?
4. What is (has been) the most demanding aspect on using scientific computing resources for your research?
5. What seems to be the most useful role of the scientific computing specialist for your research?

General (3 questions):
1. What may be the most helpful role of the scientific computing specialist for your department?
2. Does your department provide any kind of support for scientific computing resources? If so, what is the level (and kind) of support?
3. Please add any comments to be addressed in addition to the answers you have given so far.

Appendix C

Job Description of Scientific Computing Specialist

What to include with your application: In addition to a Harvey Mudd College employment application available at www.hmc.edu/employment, please submit a resume and a cover letter describing your qualifications. All required documents must be submitted with your application in order to be considered for this position.

Information about the position: Salary is dependent upon qualifications with a minimum $5,000.00 per month. Usual working hours are Monday-Friday, 8:00 a.m.-5:00 p.m. Hours may vary due to the needs of the college or department. This is a full-time, 12-month, benefits-eligible, exempt position.

What the successful candidate will do: Reporting to the Director of Educational Technology and Media Services in the Computing and Information Services Department, this position will primarily work in close relationship with faculty, students and instructional staff at Harvey Mudd College, providing professional support in the use and integration of discipline-specific information technologies and tools with teaching and research, with particular attention to engineering, mathematical, statistical, modeling and graphing tools; and in the design, development, and implementation of course materials, learning modules, and course management software. The Scientific Computing Specialist is required to have broad knowledge of software used by the science disciplines, and interest in technology used in the Humanities, Social Sciences and the Arts; interest in higher education technology in general and a willingness to learn new applications and train others in their use.

Essential Functions:

- Collaborate with faculty to provide expert support for mathematical, statistical and graphing software used by faculty in the seven HMC academic departments.
- Proactively research and evaluate software tools and toolkits. Recommend new software and other tools to faculty.
- Train students, faculty and staff in the use of discipline specific software to ensure basic levels of literacy are achieved.
- Provide support for students in the use of mathematical, statistical and design software.
- Lead and contribute to the College's faculty development program, by offering workshops for faculty and consulting with faculty one-on-one. Write documentation in the form of tutorials, web pages, FAQs, etc.

- Consult with faculty on high performance computing needs. Assess needs and make recommendations to CIS management regarding high performance computing resources.
- Collaborate with faculty to produce instructional materials and make them widely available.
- Work with User Support team to install, test and maintain software on departmental lab and research systems.
- Collaborate with colleagues within the Claremont University Consortium to develop joint projects in support of instructional technology initiatives.
- As appropriate or necessary, supervise and evaluate the performance of assigned staff.
- Keep abreast of developments in higher education technology with an emphasis on scientific and engineering disciplines; report back to the HMC community about developments as appropriate.
- Participate in cross-functional teams that work on educational technology projects. Coordinate team work when assigned to the position of team leader.

What the ideal candidate will bring to this position and HMC:

Required Qualifications:

Master's degree in engineering, the natural sciences, humanities or social sciences and three years of professional experience in instructional technology, curriculum and instruction or other related fields.

Knowledge of:

- Detailed knowledge of mathematical and statistical packages, such as Matlab, Mathematica, Maple, SPSS, and R, as well as modeling and graphing software in order to train others in their use, trouble shoot issues and evaluate other applications within the genre.
- General knowledge of parallel processing in cluster environments as well as multi-core, multi-CPU systems in order to advise faculty.
- General knowledge of programming languages such as Java, Fortran, C, or C++ in order to assist faculty in the creation of instructional software.
- Detailed knowledge of the theory and exemplary practices for integrating technology into the instructional environment of a liberal arts college.
- General knowledge of operating systems including Apple OS X, Microsoft Windows and Linux. Ability to advise users on appropriate selection of operating systems to achieve identified goals.
- Application software including word processing, spreadsheets and database management, web authoring tools, multimedia software development tools, course management software, digital asset management software.

Ability to:

- Research, analyze and recommend new software and hardware.
- Communicate technical issues to users in a clear and effective manner.
- Communicate effectively both orally and in writing with a diverse population.
- Learn new software applications quickly.
- Interpret, apply and explain rules, regulations, policies and procedures.
- Establish and maintain cooperative and effective working relationships with others, using tact, patience and courtesy..
- Operate a computer and assigned office equipment.
- Analyze situations accurately and adopt an effective course of action.
- Meet schedules and time lines.
- Work with people in such a manner as to build high morale and group commitments to goals and objectives.
- Define realistic, specific goals and objectives and to prioritize them.
- Work with staff to provide high-quality customer services.
- Identify problems and work with staff to recommend and implement solutions.
- Work independently with little direction in a dynamic and goal-oriented work environment.
- Plan and organize work.
- Prepare comprehensive narrative and statistical reports.

Preferred qualifications:

- Ph.D. or terminal degree in the natural, applied or social sciences; work or teaching experience within a higher educational setting.