

**Report**

of

**The Washington Advisory Group  
an LECG Company**

on

**External Review**

of

**Research  
at  
University of California, Davis**

May 27, 2010

**The Washington Advisory Group**  
*an LECG company*

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University consulting is a major field of activity for The Washington Advisory Group. A common thread in our university engagements is the improvement of an institution's national standing as a university that engages in both education and research so it can thereby contribute more to the cultural and economic growth of their community and the nation. Concomitant with this goal is improved ability to raise funds from federal and state agencies, philanthropic foundations, and industry.

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## **EXECUTIVE SUMMARY**

This report describes the review of research at University of California, Davis (UCD) by the Washington Advisory Group during a three day visit. The report includes our understanding of the organization, programs and activities, with detailed recommendations in many sections of the report.

In this summary we highlight overarching issues that the Chancellor and her colleagues should consider urgent and requiring their attention, as well as the advantages that will serve UCD well as it pursues the goal of increasing the size and prestige of its research enterprise.

### **ADVANTAGES**

- UCD has one of the broadest portfolios of the UC universities; one that it can leverage to enter into new areas of teaching, research and service.
- The Davis location is strategically advantageous: rural environment with a large campus area that can make new ventures possible and geographically close to Sacramento, the state capital and an urban environment.
- UCD enjoys prestige as a land-grant institution with facilities in agriculture, food, human and animal medicine, physical sciences, engineering and the humanities.
- UCD's base and its position in research, together with its pursuit of interdisciplinary opportunities will allow for further growth in research expenditures.
- Experienced faculty and administration, coupled with a new and dynamic executive, bode well for the future of the University.

### **ISSUES**

#### Organization

- Research Administration's Sponsored Programs group is almost universally charged with unilateral decision making, delays in processing time sensitive applications and responses, and not being team players. This situation has existed for years. While efforts have been made to address these complaints, the improvements have not been recognized by the users we encountered. We recommend that this group be moved to the newly formed Administration and Resource Management Group from the Vice Chancellor – Research organization.
- Technology transfer and business development in the Vice Chancellor for Research Innovation Access organization requires a broader view of its responsibility and new strategy, direction, and experienced staff. The Blue

Ribbon task force charged to address this area needs to finish its work and make bold, feasible recommendations.

- Organized Research Units (ORUs), centers, institutes, and service laboratories are increasingly important in the performance of academic research. The group of units at UCD has been established over a long period of time. It is important that these entities be reviewed with the purpose of either affirming the present system or making changes to it that regulate the establishment, life and disestablishment of such units and the ground rules under which they operate. Understanding the funding of the individual units, both short- and long-term, is an additional important matter.

Two research centers, namely the California Lighting and Technology Center and the Center for Transnational Health may be misplaced in the College of Letters and Science (CL&S) Division of Humanities, Arts and Culture and could be moved to COE and SOM, respectively.

- There are 34 departments in CL&S. The large number of departments needs to be reviewed with an eye towards reducing the number to below 15 in order to save overhead costs. We do not suggest reducing the programmatic activities of CL&S, but rather organizing these activities in a more efficient way. The graduate groups could help sustain the breadth and interdisciplinarity.

### Management

- UCD lacks an integrated university 5-year strategic plan including corresponding budget information. Such a plan needs to be created. While individual school/college plans exist, there is no such plan for the University as a whole and no clear indication what the priorities are for the institution.
- As a related matter to the point above, Garamendi funding of buildings on the UCD campus presents significant financial risks and will dramatically affect the ability of the campus to respond to strategic opportunities should there be a downturn in federal funding (or indirect cost rates reduced). Although this is a system-wide problem, UCD is particularly vulnerable because of the heavy reliance of the campus on state funding for research operations. Prudent financial planning taking these risks into account is necessary for the campus to reach its goals.
- With few exceptions, deans are not involved in the development task and are not active with potential sponsors and alumni. A dean can be the most important spokesperson for the university in any given field. This task needs to be explicitly stated in the individual's evaluation and the result judged in the performance review.

- We experienced difficulties in reconciling financial data (e.g., research expenditures) that we received from UCD. Differences seem to exist between the central organizations, deans and administrative organizations that are each responsible for this information. One wonders: What are the numbers that are at the Chancellor's disposal? A single central point needs to be established that verifies and is the sole distributor of financial information, especially for official documents, strategic planning, and for distribution to outside organizations, like NSF, *U.S. News* and ASEE.
- Student/faculty ratios are high in many areas and require some long range solutions that alleviate the most burdensome situations. Piecemeal solutions are not the answer.
- Space, space services, and maintenance are problems everywhere. We are not aware that a campus master plan addressing these issues exists and is available to responsible management. This should have high priority.
- Attention and early corrective measures are needed to address and ameliorate the impact of aging faculty cohorts in CA&ES and Mechanical and Aerospace Engineering.

### Programs

- Energy, and the closely related area of environmental research, are and will continue to be hot-buttons of science policy and federal funding. UCD has a number of programs in this area of research but does not seem to be a player on the national scene. Organizing this effort and making it visible is of great importance to the overall reputation of the institution.
- Chemistry, a key discipline for many of the interdisciplinary programs, needs a major and timely infusion to remedy the excessive teaching workload.
- IT (cyberinfrastructure) is and will increasingly be a necessary enabling tool for any organization. UCD needs to commit to and implement a plan that puts it on par with its peer institutions in networking, transmission, and capabilities for all its faculty, students and administrators. Cyberinfrastructure is fragmented and insufficient in many areas, yet outstanding in others, like the statewide TeleHealth system. This essential function must be integrated with strategic research resources and space planning, as well as academic/educational needs.
- For UCD, which has high priority activities in veterinary and human medicine, there is a critical need for access to level 3 and 4 containment facilities. If the issues this raises with the local community cannot be overcome, this might mean geographic separation of these activities from the campus.

- The campus seems to have missed the opportunity to expand programs in human genetics, genomics and other 'omics at a time of explosive growth in funding in these fields. This problem must be rectified swiftly and will require a major commitment of resources. Additional coordinated hires and integrated teaching programs with CBS should be established.

#### UCD National Visibility

- Unlike UCB, UCLA, or UCSD, UCD is not a household word. This needs to be rectified with a well planned and well executed "PR and Visibility Campaign." The time is now, when many problems are on the table and a resetting of values and activities is taking place.
- There is a need for UCD to have a Washington representative to interface with funding agencies and federal research organizations and to keep the campus apprised of new opportunities and developments.

## **INTRODUCTION**

### **1.1 Purpose of Review**

The Washington Advisory Group (WAG), an LECG company, was engaged by the University of California, Davis (UCD) to assist the organization in the identification of strategies to focus and significantly grow its research enterprise.

With \$643 million in total research expenditures in 2008, The University of California, Davis ranked 10<sup>th</sup> in the nation among all public universities.<sup>1</sup> However, in an increasingly competitive research funding environment, compounded by falling state support for higher education in general, every institution must be proactive in refining and optimizing its research enterprise. In recognition of these budget realities, UCD has launched an effort to ensure that the University not only maintains its competitive position, but builds upon it to reach an even higher level of prominence as a leading research institution.

The Washington Advisory Group was tasked to perform an independent review of UCD's comparative strengths in research and research-related education. This review is designed to supplement and complement that of its Blue Ribbon Committee on Research which is tasked with conducting extensive outreach and consultation with the academic community regarding opportunities for strengthening and expanding the UCD research enterprise and recommending strategies to reach this goal.

This report documents The Washington Advisory Group's findings, conclusions and recommendations regarding UCD's research capabilities and infrastructure, and the opportunities and challenges in growing its research enterprise in relation to its competitors and the national research agenda.

### **1.2 Approach and Charge to the Review Team**

The Washington Advisory Group conducted a 3-day review visit to the UCD campus over the period March 30 through April 2, 2010. Prior to arriving on the campus, the team members reviewed documents and data regarding organization, strategic plans, students, faculty, revenues and expenditures, technology transfer, endowment, research funding and productivity, and national rankings.

During the campus visit, The Washington Advisory Group review team met with representatives from engineering, geo- and physical sciences, life and medical sciences, social sciences, agriculture, veterinary science, computer and computational sciences, and the humanities for discussions covering a description and status of their areas; strategic

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<sup>1</sup> Table 32 in National Science Foundation, Division of Science Resources Statistics. 2010. *Academic Research and Development Expenditures: Fiscal Year 2008*. NSF 10-311. Arlington, VA. Available at <http://www.nsf.gov/statistics/nsf10311/>.

plans; accomplishments, issues, and a 5-year outlook re: resources required (people, funding, infrastructure/labs, space, etc.); and any other relevant topics.

The charge to the review team is presented in Appendix 1; the meeting schedule and list of participants are provided in Appendix 2.

### **1.3 The Washington Advisory Group Review Team**

The team that was assembled for the UCD assessment consisted of Washington Advisory Group Directors Erich Bloch and Frank Press, Affiliate Gilbert Omenn, and Associates Harris Lewin and Larry Smarr. The review team was led by Erich Bloch, former Director of the National Science Foundation and recipient of the National Medal of Technology. Frank Press is former President of the National Academy of Sciences and former Presidential Science Advisor. Gilbert S. Omenn is professor of medicine, genetics, and public health, director of the Center for Computational Medicine and Bioinformatics at the University of Michigan, and former CEO of the University of Michigan Health System. Harris Lewin is Gutsell Endowed Professor of Immunogenetics, and Professor in the Center for Advanced Study, and serves as the founding director of W.M. Keck Center for Comparative and Functional Genomics and founding director of the Institute for Genomic Biology at the University of Illinois at Urbana-Champaign. Larry Smarr is the Harry E. Gruber Professor in Computer Science and Engineering at UCSD and serves as the founding director of the California Institute for Telecommunications and Information Technology. He was also founding director of the National Center for Supercomputing Applications at the University of Illinois-Urbana/Champaign.

Biographical information on review team members is found in Appendix 3.

## **2. UNIVERSITY OF CALIFORNIA, DAVIS**

### **2.1 History and Status**

The University of California Davis' mission, structure, environment, and culture are deeply influenced by its history, maybe more so than is the case in other universities we have reviewed. The University of California was chartered as the California Land-Grant College in 1868. The Davis campus was established in 1905 as the university farm school of the UC system in concert with UC Berkeley. Initial structures of what today is the UCD College of Agriculture and Environmental Science (CA&ES) opened for students in 1908, and in 1959 Davis was established as a general UC campus. Successive development of other university units, such as the School of Veterinary Medicine (SVM) in 1946, the College of Letters and Science (CL&S) in 1951, the College of Engineering (COE) in 1962, the Medical School (SOM) in 1965, and the Muir Institute of Environmental Sciences in 1998 demonstrate the growth and the broadening of UCD's mission.

Today, UCD is a comprehensive research university that ranges from the already mentioned areas of activity to colleges and institutions in humanities, computer science, social sciences, extensive biological sciences, law and other disciplines. Our observations, comments and recommendations keep in mind the broad and expansive missions and expectations of UCD.

## **2.2 General Observations**

UCD is an important member of the UC system. Its presence in the Sacramento Valley makes UCD a vital contributor to the well-being of that region and of the state as a whole.

Its accomplishments in the life sciences, physical sciences, engineering, the humanities and social sciences make UCD increasingly attractive to students, researchers and faculty, which facilitates its involvement in new fields at the forefront of academic knowledge.

We recognize that UCD has accomplished much, but we would be remiss if we did not mention serious underlying issues with broad implications that must be addressed in order to strengthen the University and sustain its progress as a major research enterprise.

The review team had the opportunity to meet and talk with over a hundred UCD senior administrators, faculty and graduate students. For one of us it was a second visit; the first visit entailed less structured and shorter conversations with a similar cross section of the Davis population to provide background and insights for planning the second more extensive and focused team visit. On both visits participants raised a number of pervasive and underlying issues they identified as inhibiting factors in the Davis organizational environment.

We want to lay out these issues out first, as objectively as possible, because many of our observations and recommendations will need to deal with these realities.

1. **Culture:** Over many decades Davis has developed a culture that permeates its institutions and people, one that can best be described as risk-averse, modest and insular. It is said by many – old-timers and newcomers alike – that the walls between organizations, departments and schools are low and it is relatively easy for researchers and students to get together and agree on new directions or undertakings. Collegiality is the “approved” behavior, not internal or external competitiveness. The positive aspects of collegiality can also have negative consequences when events and behaviors are tolerated that in other similar institutions would cause friction and result in remedies. The prime example we heard about is tolerating decision-making delays that at times may have dire consequences.

- Another significant aspect of Davis' culture springs from its origin as a creation of Berkeley's initiative into agriculture. Even though that was an event of 100 years ago, it still casts a shadow on the institution. Berkeley is the measuring stick and that is not always useful as it leads to false goals and unhelpful comparisons. UCSB and possibly UCSD may be more reasonable comparison institutions.
2. Administration and Bureaucracy: The review team heard many observations and complaints about the research administrative groups and their activities. These concerned not only groups in the administrative organizations but also groups in some of the technical areas. The complaints included overstaffing, ineffective personnel, and playing "lawyer games" to be sure that no risks threaten the organization. Foremost, but not exclusively, mentioned is the sponsored research group in the Vice Chancellor of Research (VCR) area with charges of being "overbearing," "dictatorial" and prone to almost missing filing dates for proposals, thus jeopardizing the opportunity to participate in important competitions.
  3. Industry Relations: With the prominent exception of the viticulture and agriculture domains, relationships with industry on research or joint programs were frowned upon by former administrations as counter to what a university is all about. As a consequence, collaborative programs with industry are new to Davis and are in response to government agency requirements or suggestions.
  4. Visibility: UCD and its accomplishments are not as well known as they deserve to be, in large part because of some of the cultural traits discussed above. An exception is its world-famous viticulture program. Also, the participation of UCD leaders and researchers in the national science policy arena is not as cultivated as it is at other UC institutions. This situation does not help the institution in its dealings at the federal level in Washington, D.C. and results in UCD and its people gaining less recognition than they deserve.
  5. Strategic Plan and Budget: An institution as complex and broad as Davis requires a 5- or 10-year strategy, plan and budget. No such interlinking documents exist today. The draft Mission Statement (now being revised) does not serve this purpose. It is a collection of generalities, but does not get into the difficult decision making that a strategic plan exercise requires in weighing priorities and alternatives. In contrast, we found school and college level strategic plans to be meaningful and well documented.
  6. Organization: Some of the complaints about the dysfunctional and bloated administrative units are, in part at least, the result of the organizational configuration itself. This applies to the Office of Research and some other parts of the university. In this report we discuss and recommend certain new organizational arrangements to address some of the inadequacies of the present.

### **2.3 Office of the Provost**

Our conversation with the Provost and his colleagues was primarily about the budget, budget cuts and the personnel process for faculty.

The budget will be in a state of flux for sometime because of the economic situation of the state.

The academic personnel process presented by Barbara Horwitz is the classical process that universities employ. We did not encounter any concerns about the subject in our conversations.

As mentioned above, UCD lacks an integrated, 5-year strategic plan and budget that addresses priorities and goals for the University. The Provost's Office needs to be in charge of generating and administering such a plan.

### **2.4 Office of Research**

The Office of Research is a large organization, with the Vice Chancellor for Research (VCR) as its responsible executive. Its staff numbers 1,090<sup>2</sup> and projected annual expenditures for 2009-2010 are \$108 million.<sup>3</sup> There are 23 ORUs, organized research projects (ORPs), special research projects (SRPs), and central facilities that report into this organization, in addition to the Innovation Access organization and others.

The prime mission of the VCR is to advance research at Davis, be its spokesperson in matters of research at the state and national level, ensure that policies are in place that will enhance research and creativity, and promote a culture of both innovation and compliance.

We mention the organizational composition of the Office of Research because it seems to us that the massive nature of responsibility in terms of people, dollars and technical organizations and units may be too much for anybody to manage well. Within this organization, the Sponsored Programs unit elicited by far the most complaints regarding non-performance. Since there is a search underway for a VCR, we strongly recommend that, before a candidate is selected – or as part of the process – serious consideration be given to the following issues and alternatives:

- Is the Office of Research primarily a policy organization or an operating organization?

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<sup>2</sup> "Office of Research Organizational Chart," (April 8, 2010) received from the Office of Research.

<sup>3</sup> Information provided by the Office of Research on May 27, 2010. The \$108 million includes funds from all sources.

- Is there a need for the 23 ORUs, ORPs, SRPs, and central facilities now reporting to the VCR – many for a long time – to continue to do so rather than reporting into a well chosen School or College or Division?
- Can one individual do justice to the policy work she or he is responsible for and at the same time be the responsible line manager of a large, complex, and critically important technical enterprise?

We suggest that UCD give consideration to the following organizational changes for the Office of Research:

- Move each of the research organizations (central facilities, ORUs, ORPs, SPRs, etc.) to an operating unit with which it naturally relates. There might very well be a reason for a few of these units to stay in the Office of Research (start-ups, large interdisciplinary research units, remoteness from campus, experimental, pending more insight and clarification), but the day-to-day operation of the majority of them could be placed in one of the operating units.
- Move the Sponsored Programs organization to the Administrative and Resource Management (ARM) organization. The increasing volume of proposal submissions and increasing complexities of the submission process are commensurately increasing the associated administrative workload. ARM is a better place from which to discharge these responsibilities. At the same time, this would reduce the workload in the Office of Research.
- These changes to the Office of Research would allow the VCR to focus on what is most important, namely serving as the chief officer and spokesperson for research, inside the campus as well as outside.

For budget rankings of schools and departments, there is no value in holding and counting federal grant support in the OVCR. The lead units should get the credit; moreover, the academic units can provide much stronger leadership, with OVCR providing periodic oversight and review.

A related but separate subject is the UCD Washington, D.C. office. We did not have a briefing on this matter. Naturally, it would relate closely to the obligations of the VCR. The ramifications of such an office are broad and far reaching. We do not have sufficient information to have a well-developed viewpoint on this matter.

## **2.5 Office of Administrative and Resource Management**

As part of our campus visit we met with Vice Chancellor John Meyer and his colleagues. We were impressed with the management of this newly combined Administrative and Resource Management (ARM) unit, their understanding of the tasks that they are

confronted with, and their awareness and sensitivity to the external environment, especially the community and the state.

A view expressed many times during our 3-day conversation with faculty and research management was that “Administration” is overstaffed, not responsive and not concerned about the effort and work they cause for the academic units. In follow-up, we compared the administrative costs at UCD with those of the other campuses in the UC system and found that the proportion of UCD’s budget used for “Institutional Support” expenditures is very close to the UC average.<sup>4</sup> While this is an interesting fact and suggests that overstaffing may not be an issue, it does not speak to the efficiency of “Administration” on an absolute scale or what could be achieved with proper planning and management.

The recent reorganization which combined two administrative units into this new organization presents a golden opportunity to address the issue of efficiency. The review team proposes that the question of organization be addressed first, singling out units that can be combined or eliminating tasks and units that are superfluous. Input from ARM users/customers should be considered in the effort to streamline this vital and far-flung organization. In refining the ARM organization, management might also consider using the services of a consulting firm, particularly one that has done work for other UC universities and is familiar with the requirements the UC system places on campus organizations.

In the preceding section of this report we proposed that UCD consider moving the Sponsored Programs organization (SPO) to ARM to give relief to the OVCR and provide more appropriate management of the SPO function.

In our campus discussions space, space rearrangement, and services were other issues that were repeatedly mentioned. Another area requiring study and improved procedures concerns the lack of consistency in numerical data across different organizations within UCD.

## **2.6 Positioning of UCD**

### *Overview*

- (1) Where does UCD stand in the research university community of the United States today?
- (2) What can it reasonably aspire to within 5 to 10 years?
- (3) Does it know how to get there?
- (4) Does it have the resources to do so?

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<sup>4</sup> Analysis of institutional support expenditures by campus, 2006-07 through 2008-09 provided by Kelly Ratcliff on April 15, 2010.

Quick answers, based on the Academic Ranking of World Universities (ARWU) 2009 ranking of U.S. universities<sup>5</sup>:

- (1) Currently, UCD ranks 36<sup>th</sup> among U.S. universities. UCD is in the middle of the group ranked 30 to 40 that includes Vanderbilt, Penn State, UCI, Pittsburgh, Rutgers, University of Florida, Carnegie Mellon, and Ohio State.
- (2) UCD could aim to rise to 20<sup>th</sup> -30<sup>th</sup> in the US. That group now includes the University of Minnesota, Washington University in St. Louis, Northwestern, Duke, New York University, Rockefeller University, University of Colorado at Boulder, UCSB, University of Maryland at College Park, UT Austin, and UNC Chapel Hill. We call these aspirational peers (which of course are themselves taking actions to grow and trying to move up) the “Next Rank Group.”
- (3) Yes – From our discussions with faculty and administrators the review team believes that UCD does know what it has to do to achieve this higher ranking.
- (4) UCD (excluding possibly the Medical School) does not at present appear to have the resources from endowment, growing appropriations from California, federal grants, or other sources to do so. However, it can undertake initiatives to address this situation.

#### *Initial Conditions*

There are a number of attributes that are relevant to positioning UCD:

- A culture of collaboration is unusually pervasive on the campus, facilitating mentoring of young faculty, and cooperative, creative, joint research ventures, which could lead to more interdisciplinary proposals for large grants.
- UCD faculty project an image of problem solving, well suited for such California (and national) challenges as agriculture, environment, and transportation. One consequence is that substantial non-federal state and private research funds could be available to the university, which could be leveraged.
- The general impression that UCD’s founding legacy in agriculture is still a dominant feature that distinguishes UCD from the other comprehensive research universities.
- Percent of tenure/tenure track faculty with research funding between \$0-99K<sup>6</sup> (includes research inactive faculty):

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<sup>5</sup> Because of its use of criteria for research productivity rather than peer assessment alone, the review team is using here the Academic Ranking of World Universities (ARWU) 2009 ranking of U.S. universities at <http://www.arwu.org/Country2009Main.jsp?param=United%20States>. ARWU uses six objective indicators to rank world universities, including the number of alumni and staff winning Nobel Prizes and Fields Medals, number of highly cited researchers selected by Thomson Scientific, number of articles published in journals of *Nature* and *Science*, number of articles indexed in Science Citation Index - Expanded and Social Sciences Citation Index, and per capita performance with respect to the size of an institution. The ranking is updated on an annual basis.

<sup>6</sup> Table 4i (revised) provided by UCD to the review team on May 18, 2011.

- CA&ES	62%
- CBS	46%
- COE	60%
- L&S Math and Physical Sciences	67%
- SOM	50%
- SVM	72%

These percentages could signal significant lack of parity in research productivity with UCD's aspirational peers and should be looked into. One or several of the following possibilities may be at play here:

- These data may include a large fraction of faculty who have always been research unproductive.
  - Many faculty who were research productive at one time are no longer competitive for large grants, but they still may be renowned, and good teachers.
  - Theoreticians are low cost and tend to lower average research expenditures.
  - This may be indicative of a large fraction of young faculty who have not yet received their first grant. (The average age for a first NIH R0-1 grant is 43<sup>7</sup>).
- The SOM has met or exceeded elements of its 2004 strategic plan, with rapid growth of facilities and total extramural research funding (\$194M in 2009<sup>8</sup>) and a goal to contribute \$300M to the Chancellor's 2015 target of annual \$1 billion in R&D funding. Yet the ranking of UCD's SOM as a research medical school as assessed by *U.S. News*<sup>9</sup> is 47, significantly below that of its aspirational peers with medical schools (i.e., the "Next Rank" Group of schools with ARWU rankings from 20-30 in the overview section above), and ranks 42<sup>nd</sup> among the 108 medical schools in NIH funding for 2009.<sup>10</sup>
  - In the Physical Sciences and Mathematics the percentage of aspirational peers that score higher in ranking than UCD is as follows:

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<sup>7</sup> NIH data cited in *A Broken Pipeline? Flat Funding at NIH Puts a Generation of Science at Risk*, A Follow up Statement by a Group of Concerned Universities and Research Institutions (March 2008), page 4 at <http://www.brokenpipeline.org/brokenpipeline.pdf>

<sup>8</sup> *UCD Health System Research Enterprise*, Report to Washington Advisory Group (April 1, 2010) "School of Medicine Research Funding Aspiration" slide, page 14.

<sup>9</sup> *U.S. News & World Report America's Best Graduate Schools* (2011 edition). *U.S. News* research Medical School rankings are based on quality (peer) assessment, NIH research funding in total and per faculty member, student selectivity, and student/faculty ratios.

<sup>10</sup> Data on NIH awards released April 2, 2010 and available through the University of Michigan's M-Stat system to review team member Gilbert Omenn, M.D. The raw data from which the M-Stat reports were compiled are available at <http://report.nih.gov/>.

Math and Chemistry 70%

Physics 40%

Statistics 30%

Geology 10%

- UCD has 20 members who have been elected to the National Academy of Sciences. This is much smaller than the membership at UCB, UCLA, UCSD, and UCSB. However UCD membership numbers fall in a group that includes such respected universities as Michigan, Duke, Johns Hopkins, and Northwestern. Only 20% of UCD's NAS members are physical scientists; the larger fraction is drawn from the life sciences.<sup>11</sup> SOM has no primary faculty who are members of NAS or IOM.
- As will be discussed later, the Dean of Social Sciences has identified a group of respectable universities as peers (University of Illinois at Urbana-Champaign, University of Wisconsin - Madison, University of Washington, University of Texas - Austin, Ohio State University, University of Minnesota, and University of Virginia) and the *U.S. News* (2011 edition) rankings of UCD's graduate programs in Economics, History, Political Science, Sociology, and Psychology, place them within this group, albeit at the lower end.
- The College of Engineering stands out as having created a number of interdisciplinary departments, such as biological and agricultural engineering and biomedical engineering as well as combined classical disciplines such as chemical engineering and materials science, and civil and environmental engineering. This approach should stimulate COE pursuing research areas at the interfaces of disciplines, leading to new insights and distinguish UCD's COE from its peers.
- CA&ES is distinguished by its long history, tremendous success in securing external research funding across a broad portfolio, outstanding faculty, and strong leadership. UCD's ranking as #3 in the U.S. in life sciences research expenditures (excluding medical sciences) is based on the performance of CA&ES,<sup>12</sup> and underscores the importance of this College to UCD's standing.
- The SVM is likewise a highly ranked (#2 in the *U.S. News* rankings issued in 2011) program distinguished by its entrepreneurial faculty, excellent research, and focus on interdisciplinary studies as evidenced by the number and breadth of its centers and institutions.
- The relatively new CBS has quickly attained some national recognition and its Evolution and Ecology program is outstanding.

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<sup>11</sup> All data on NAS membership in this section of the report are based on an analysis of member information on the National Academy of Sciences' website accessed on May 19, 2010 available at <http://www.nasonline.org/site/Dir?sid=1011&view=basic&pg=srch>

<sup>12</sup> 2008 research expenditure data from the *NSF Survey of R&D at Expenditures at Universities and Colleges* available through WebCASPAR at [webcaspar.nsf.gov](http://webcaspar.nsf.gov).

### *Positioning Actions to Be Considered in Strategic Planning*

- Given that UCD is a comprehensive research university, the imbalance in national standing between the Biological Sciences (as distinct from the medical fields) on one hand and the Physical Sciences and Engineering fields on the other, is stark and separates UCD from its aspirational universities. If UCD aspires to reach the overall rankings of the 20th-30th “Next Rank Group,” it will need to create synergies and balance between the biological, life and medical sciences and the physical, computational, engineering, and social sciences fields. An alternative would be for UCD to climb higher by building on its strengths rather than its weaknesses, for the same investment. The review team agrees with Irwin Feller, an economist at Pennsylvania State University who studies rankings and expresses concern with this model, saying “for all its efforts to improve its rankings, a university may not improve conditions for itself or its community by pumping money into marquee programs that drain money from other departments leaving steeples of excellence surrounded by tenements of mediocrity.”<sup>13</sup>
- Also striking is the comparatively low ranking of the SOM relative to those of the “Next Rank” Group of universities with medical schools. SOM is doing well in building its extramural research programs and aims to continue on this path. Increasing competitive research awards from NIH is essential not just for fund raising but also for rankings and image.
- Considering its ranking of 32,<sup>14</sup> COE’s cohort of only two NAE members among full-time active faculty is low and requires considerable improvement. The lack of meaningful connection with industry could account for this low membership.
- Two of UCD’s outstanding programs, CA&ES and SVM, must address the issue of inadequate facilities if they are to maintain their leadership status. Aging faculty present another challenge to CA&ES, and the SVM could benefit from increased synergies with the SOM.
- Reorganization alternatives for the CBS might better leverage its resources and talent in achieving UCD’s strategic goals and merit careful consideration.

### *Opportunities Unique to UCD*

- Quality biological sciences research performance, as found in CBS, CA&ES, and SVM, positions UCD to become a significant player on the national biological sciences scene. Biological science has been called the “science of the 21<sup>st</sup> century,” just as the physical sciences dominated the 20<sup>th</sup> century. Some 80% of

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<sup>13</sup> M. Arnone, “The Wannabes,” *The Chronicle of Higher Education* ( January 3, 2003). Also see Feller, I., *Strategic Options to Enhance the Research Competitiveness of EPSCoR Universities*, at <http://www.aaas.org/spp/rcp/epscor/Feller.html>.

<sup>14</sup> *U.S. News & World Report America’s Best Graduate Schools* (2011 edition)

- UCD members in the National Academy of Sciences (NAS) are biologists and life scientists.<sup>15</sup>
- Given UCD’s current strengths and interests and where the world is going over the next few years, large growth opportunities may exist to the comparative advantage of UCD. For funding we have in mind the growing budgets of federal research agencies targeted for the relevant fields:
    1. Environmental sciences and climate change
    2. Alternative and renewable energy systems
    3. Global food system, food crop cultivation under extreme environmental conditions, food safety
    4. Epidemiology and emerging diseases, in animals and humans
    5. Human and animal population health, personal genomics
    6. Transportation, particularly next generation vehicles

*Positioning UCD As It Is Today and Making It More Visible Nationally*

UCD’s rich contributions now and in the past are in the agricultural and environmental fields. Its existing strengths in the biological and life sciences and its current mature involvements in the “issues of the day,” as described above, should have earned it a more prominent national position in higher education and research than it now enjoys. Universities use different methods for outreach: advertising, websites and web links; faculty serving on important national committees; publicizing important faculty papers and awards; announcing accomplishments of alumni; etc. Effective outreach efforts take every opportunity to describe what their university is uniquely doing for their community and for the country. Branding, and appropriate communications and public relations now and in the future, should receive more attention from UCD’s leadership and faculty.

*How Does UCD Develop the Resources to Compete in the “Next Rank Group” (20<sup>th</sup> - 30<sup>th</sup>)?*

California, which over the years made the necessary investments to grow the UC system of universities to be the best in the nation – better than New York and Texas – is no longer a reliable source of support. How long this will last is uncertain. Under these circumstances, what are possible options for UCD to obtain the resources needed to improve its position as a nationally recognized research university? UCD’s small endowment is an impediment. This is reflected in the relatively small number of endowed chairs and the limited ability of the Chancellor to use endowment income for special opportunities that may arise.

*Recommendations for Enhancing the Environment for More Competitive R&D at UCD*

1. Examine the performance of the UCD development staff – for numbers, experience, and end results. High priority must be given to designing inventive

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<sup>15</sup> Membership information on the National Academy of Sciences’ website, op.cit.

- programs appropriate for UCD's alumni, regional philanthropists, industrial affiliates, and national foundations interested in the six research opportunities listed above, for which UCD has distinctive strength. Some universities have been successful in attracting Endowed Chairs as a tool to compete for star level faculty.
2. At a time of new priorities for funding agencies, UCD needs to follow closely funding opportunities as they arise almost on a daily basis. Monitoring [www.grants.gov](http://www.grants.gov) is an effective way to accomplish this.
  3. Explore opportunities for creative use of the large campus area or adjacent areas to campus for appropriate commercial development, as Stanford has done, and as is proceeding on the Sacramento Campus.
  4. Establish programs attractive to students and compete better with other UC universities to increase enrollment and student quality. Hopefully undergraduate enrollment increases will lead to more FTEs from the UC System.
  5. Other universities have raised enough funds from a relatively small tuition increase to create up to 300 new faculty positions. The review team appreciates that UCD is not a free agent in raising tuition and incomes are impaired currently, but it should explain to legislators, students, parents, and the general public that the value of a UCD degree will increase with such investments.

### **3. REVIEW OF SELECTED COLLEGES AND SCHOOLS**

#### **3.1 College of Letters and Science**

##### *Overview*

The College of Letters and Science (CL&S) is the largest on the campus with more than 11,000 students, 500 faculty, and over 50 departments and programs.<sup>16</sup> As is the case with most of the top universities which fall under the rubric of "liberal arts and science," UCD's image as seen by the higher education community will be influenced by the excellence of research, scholarship, and teaching, the quality of students, the performance of graduates, and the significance of programs encompassed by CL&S. The college is composed of three divisions: Mathematical and Physical Sciences, Social Sciences, and Humanities, Arts, and Cultural Studies. The College was established only 59 years ago, some 50 years after UCD itself was founded.

The review team understands the weakness and uncertainty involved with the rankings of universities and departments. Nevertheless, while awaiting the next assessment of graduate departments by the National Academy of Sciences, we will refer to the rankings in the 2011 edition of *U.S. News & World Report America's Best Graduate Schools*,

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<sup>16</sup> UCD, CL&S website at <http://www.ls.ucdavis.edu/about/>

realizing that at the level of individual disciplines they are based solely on peer assessment and not all disciplines are re-ranked every year. The image UCD projects to the Deans, Chairs and Graduate Study Directors surveyed by *U.S. News* is a major determinant of the standing of the university and the referral of good students to UCD. It is arguably the case, therefore, that a ranking by *U.S. News* signifies how intellectually strong a department is in the view of its peer academic community.

*Division of Mathematical and Physical Sciences (MPS)*

This Division encompasses Physics, Chemistry, Mathematics, Geology, and Statistics. Its enrollment consists of 1,521 undergraduate and 498 graduate students (2008-09).<sup>17</sup> It believes that it has a foundation of strength and the potential to rise in national recognition, were it not for “Legacy Budgeting that perpetuates under-investment in the Mathematical and Physical Sciences.”<sup>18</sup> To the extent that this underinvestment is true for this Division (and perhaps the College), it represents an imbalance unique to UCD that places it at a disadvantage compared to its peer research universities. The Division also suffers from the high costs of setting up faculty in the Physical Sciences. The primary source of discretionary funds is savings from unfilled FTEs. These funds are particularly hard to accumulate under current circumstances in California. It is surprising that the budgeted student/faculty ratio is the same as that of Social Sciences, somewhat higher than Humanities, Biological Sciences, and Agricultural and Environmental Sciences. It is striking that the ratio is twice as large as Engineering.<sup>19</sup> Chemistry and Mathematics carry a very high load of service course teaching, negatively affecting research time and productivity.

The department rankings below are from *U.S. News & World Report America’s Best Graduate Schools* (2011 edition).

Physics: Faculty size of 46 FTE<sup>20</sup> in our opinion generally matches that of universities with approximately the same ranking. The fields covered by the department span currently important sectors identified by the National Academy of Sciences: high energy, condensed matter, cosmology, and nuclear. It is a good sign of currency that there are emerging programs in biological physics, computational physics, and complex systems.

Physics ranks 26<sup>th</sup> (improved from 29<sup>th</sup>)<sup>21</sup> and falls in a peer group that includes Rice, Northwestern, Duke, and Ohio State. Within the UC System this places it equal to UCI, below UCB, UCSB (which ranks 10<sup>th</sup>), UCLA, and UCSD, and above UCSC and UCR.

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<sup>17</sup> Enrollment data are from Tables 2a (undergraduate) and 3a (graduate) provided by UCD to the review team in advance of the campus visit.

<sup>18</sup> Handout given to review team during campus visit meeting with MPS representatives.

<sup>19</sup> *Mathematical & Physical Sciences Academic Plan for 2009-2014*, Submitted by Winston Ko, Dean (August 2008 Revised May 2009) page 5.

<sup>20</sup> Except as otherwise noted, MPS faculty FTE data by department are from an untitled table distributed to review team during campus visit and are presumably for 2008-2009 academic year.

<sup>21</sup> References to previous rankings for Chemistry, Geology, Mathematics and Physics are the 2008 rankings as cited in *Mathematical & Physical Sciences Academic Plan for 2009-2014*, op. cit., page2.

Another indicator of research productivity is the annual research expenditures per FTE faculty member. For this department the figure is about \$200K<sup>22</sup> a figure that seems at the low side to the review team.

Chemistry: For a chemistry department of 37 faculty, the active research fields show reasonable breadth and currency: nanotechnology, pharmacology, laser spectroscopy, magnetic resonance, and environmental chemistry. The plans to expand chemical biology, strengthen synthesis and grow the field of energy research make good sense.

The department ranks 38<sup>th</sup> nationally (down from 34<sup>th</sup>) in a group that includes the Universities of Arizona, Indiana, and Utah. Within the UC system this places it below UCB, UCLA, UCSD, UCI, UCSF, and UCSB (33<sup>rd</sup>) and above UCR and UCSC. The annual research expenditure per professor in Chemistry is \$300K, a figure acceptable in our opinion for the ranking group within which it falls.

Chemistry is at risk because of a very high teaching burden (S/F ratio 42.6).<sup>23</sup> As a result, failures in recruitment and retention of the best people are occurring. This has led to a reduction in federal grant support over the past two years after steady growth over the previous decade. The potential for joint research efforts with other departments on campus and in the Medical School is excellent, particularly in the materials, biological and medical fields.

Geology: This department with 23 faculty wisely chose three fields to emphasize: crustal and mantle evolution, paleoclimatology (ancient environments and the history of life), and environmental geology and natural resources. These are frontier fields with growing student interest, and growing federal support. It succeeded in recruiting two individuals who are members of the National Academy of Sciences (one of whom is also a member of the Royal Society), as well as other research proven faculty. As a result, the department can claim world renown. It ranks 17<sup>th</sup> (up from 21<sup>st</sup>), now equal to UCLA and UCSD and better than UCSB. Recruiting high quality faculty and frontier fields shows results.

Enrollment in the field is cyclical and in recent years has experienced declining student interest nationally. The S/F ratio at UCD is 13.7, at the top of the national range and exceeds the range in California by nearly 50%.<sup>24</sup> The department is creative in its plans to increase enrollments by taking advantage of the growing national interest in oil and gas exploration, oceanography, water, and natural hazards.

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<sup>22</sup> Research expenditures per faculty FTE for Chemistry and Physics were calculated based on 2008-2009 faculty FTE (untitled table) and 2008-2009 research expenditure information (“MPS Research Expenditures and Indirect Costs”) distributed to the review team during the campus visit.

<sup>23</sup> S/F ratio data is from untitled table referenced in footnote 20.

<sup>24</sup> S/F ratio data for UCD and comparison with national and California ranges is from “Summary of Geology Department Academic Plan for 2009-2014” (June 2008; revised August 2008) pages 3 ff in *Mathematical & Physical Sciences Academic Plan for 2009-2014*, op. cit.

Mathematics: Both Mathematics and Applied Mathematics are covered by this department with faculty size of 41.<sup>25</sup> The Department believes it is a contender “for a spot among the top ten in the nation.”<sup>26</sup> However its peers disagree. The Department’s *U.S. News* ranking is 36 in a group that includes CUNY, Carnegie Mellon, and University of Illinois-Chicago. It ranks above UCSB and UCI, and below UCSD, UCB, and UCLA. In order to handle its large teaching load of students who require math for another major, the Department uses several types of instructors. However, ladder rank faculty do teach at all levels. The Department covers all the classical fields of Mathematics, but also mathematical biology, mathematical physics, and scientific computing.

Extramural funding of research has increased impressively almost fivefold over the past decade drawing support from six different federal agencies.<sup>27</sup>

Statistics: This Department believes it is among the top ten departments in the nation.<sup>28</sup> But according to *U.S. News*, its peers give it a ranking of 31, below UCB but equal to UCLA and better than UCSB. Almost every scientist, engineer, and social scientist needs more than a working knowledge of statistics. It is therefore significant that the Department is planning a transformation to build strength in four interdisciplinary fields: biomedical imaging, computational biology, the analysis of dynamic and complex systems, and the theory and applications of statistical finance. It also plans to increase its involvement with several centers and with groups in the Medical School, and even with work in the environmental, atmospheric and cosmological sciences. The dedication of its resources to building interdisciplinary cooperation in these frontier fields is laudatory.

Discussion: The review team believes that the performance of the Division of MPS will be a major determinant in how the higher education community views the College and hence UCD. The departments of the Division have the know-how and ambition to rise in national ranking, but not the resources. Unfortunately, a case can be made that the Division has been historically underfunded and held back – that it may have been viewed as a service Department to other units rather than one that both teaches and engages deeply in research, as is typical for a top research university.

### *Division of Social Sciences*

In terms of enrollments and faculty size, this is the largest division in the College. Some 6,000 undergraduate students and 500 graduate students are enrolled, and the faculty size

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<sup>25</sup> Faculty size data is from untitled table referenced in footnote 20.

<sup>26</sup> “2009-2014 Academic Plan, Department of Mathematics Summary” (unpaginated) in *Mathematical & Physical Sciences Academic Plan for 2009-2014*, op. cit.

<sup>27</sup> Ibid.

<sup>28</sup> “Statistics Planning Document Summary” (unpaginated) in *Mathematical & Physical Sciences Academic Plan for 2009-2014*, op. cit.

consists of 250 Senate Faculty members.<sup>29</sup> The Division encompasses 10 Departments, one Campus Center, one ORU and several Programs and Research Centers.

The social sciences are defined inconsistently among American research universities. For example, Psychology is a major department in this UCD Division, yet it falls under the Life Sciences at UCLA. By choice Social Science at UCD is moving in directions distinct from many, if not most, of its peers. The Dean of this division is a renowned cognitive neuroscientist, and the founding Director of the Center for Mind and Brain, which has many links across the campus including biological sciences, medical science, electrical engineering, computer science, and psychology. “The programs are heavily quantitative .... Psychology does not support a clinical program, instead focusing on experimental psychology...a large investment in neuroscience via ...leadership in campus centers.”<sup>30</sup> This organizational structure, unique to UCD, opens many opportunities for breakthrough research. Also some nine graduate degrees that fall under departments at other universities are offered by graduate groups at UCD. All of this is blazing a new trail and inter-university comparisons are not easy.

To get an overall impression of the Division, in the following we comment on a selection of individual departments based on information provided by the Dean. We note that the level of extramural support has little relationship to the intellectual quality and importance of a department since many fields within social sciences suffer from a dearth of federal agencies that can make grants in their fields. This is where a lack of significant endowment at UCD particularly hurts and should be a target for philanthropy.

Psychology: Majority funding is from NIH and extramural support to Psychology accounts for about 85% of the Division’s extramural research funding.<sup>31</sup> Its *U.S. News* ranking<sup>32</sup> is 23, in a group that includes University of Chicago, Duke, UVA, Indiana University and Johns Hopkins. It ranks above UCI and UCSB and just below UCSD and Cornell. UCB ranks #1.

History: Ranking is 28 in a group that includes Emory, MIT, and Washington University. It ranks below UCB and UCLA and above UCSD, UCI and UCB.

Sociology: Ranks 31<sup>st</sup> in a group with UCSD, Vanderbilt, and the University of Massachusetts, but below UCB, UCLA, UCSB and UCI. In the specialty “Sex and Gender”, it ranks in the top 10.

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<sup>29</sup> Division of Social Sciences, College of Letters and Science handout given to review team during campus meeting on April 2, 2010 (unpaginated).

<sup>30</sup> Division of Social Sciences supplemental information provided by the Dean to review team member Frank Press in document dated April 14, 2010, page 1.

<sup>31</sup> Division of Social Sciences, College of Letters and Science handout, op.cit..

<sup>32</sup> All rankings referenced in this section are from *U.S. News & World Report America’s Best Graduate Schools* (2011 edition).

Political Science: Ranks 24, much better than UCI and UCSB, just below Illinois and UT Austin.

Economics: Ranks 34<sup>th</sup> in a group including University of Iowa, UNC Chapel Hill, University of Washington, and Vanderbilt. UCD's program ranks well below UCB, UCLA, and UCSD and well above the other universities in the UC system.

Aspirational Group Comparison: Another way to assess the standing of Social Science is from materials submitted by the Dean<sup>33</sup> in which UCD's *U.S. News* rankings are compared to a peer group: University of Illinois at Urbana-Champaign, University of Wisconsin, University of Washington, UT-Austin, Ohio State, University of Minnesota, and University of Virginia. Aspirational peers named were University of Michigan, UNC Chapel Hill and UCSD. In the 35 possible combinations of peer university and field, UCD was outranked some 29 times. Nevertheless, most of the UCD social science departments named by the Dean are ranked between 20<sup>th</sup> and 30<sup>th</sup>.

Discussion: The Division of Social Sciences is unorthodox in several ways: Its growing strength in the cognitive neurosciences; the success and distinctiveness of the Center for Mind and Brain; a strong portfolio of empirical case studies in its Science and Technology Studies Program; its Center for Innovation Studies; and its multiple linkages across the campus. The well known adage that "pioneers are the ones with arrows in their backs" may be appropriate here, meaning it will be watched by competitors, funding agencies and foundations to see if social science is being redefined creatively by UCD, or if its organizational structure at UCD is injudicious. The review team would guess that in the short term it is the latter and in the long term the former.

The unique qualities of the Division, particularly its innovative explorations, its improving rankings, the strain between the teaching load and research productivity (6,000 undergraduate majors!), lend weight to the Dean's view that investment in the social sciences dollar for dollar provides more impact...<sup>34</sup>

#### *Division of Humanities, Arts, and Cultural Studies*

The Division has three groups of departments: 1) Arts; 2) Ethnic Studies; 3) Languages and Literature, with a total of 19 departments of which only seven currently have PhD programs: Departmental PhD programs are offered in English, French, Music, Comparative Literature, German, Native American Studies, and Spanish. It has a faculty of 220.<sup>35</sup> Graduate Group PhDs in Cultural Studies, Performance Studies, and Religion (proposal pending) are also offered.<sup>36</sup> The English Department is ranked 26 by *U.S.*

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<sup>33</sup> Division of Social Sciences supplemental information, op. cit., page 1.

<sup>34</sup> Ibid., page 3.

<sup>35</sup> *Research Priorities*, Division of Humanities, Arts and Cultural Studies handout dated March 2010 given to review team members during campus meeting, page 2.

<sup>36</sup> Owens, Jessie Ann. "The HArCS Research Agenda: A response to questions posed by Frank Press for the Washington Advisory Group," April 21, 2010, response to question 1.

*News & World Report America's Best Graduate Schools* (2011 edition) in a group that includes Emory University and Ohio State, below UCB, UCLA, and UCI and just above UCSB. The Master of Fine Arts Degree is ranked 21<sup>st</sup> by *U.S. News*, better than UCB, Michigan, Stanford, and several other major universities.

In collaboration with other groups on the campus two PhD degrees are offered using the graduate group model: Performance studies and Cultural Studies. Other graduate group programs are being considered.

Several research centers are associated with the Division: California Lighting and Technology Center, Center for Transnational Health, Native American Language Center, Language Learning Center, Consortium for Women and Research, Second Language Acquisition Institute, and UC Language Consortium. The review team did not perceive the rationale for the location of some of these centers in the Division. Centers have received support from NIH, NSF, industry, and the state. Core strengths are in Early Modern Studies and Digital Humanities. The Division also operates three museums, a gallery and fine arts collection.

Importantly, over the past decade the Division has emerged from a service unit to a Research I Humanities Division, quite appropriate for a nationally visible research university. While the humanities PhD programs are not as comprehensive as that of many other universities, the Division may well be competitive with UCSD and UCSB, as it claims.<sup>37</sup> Its academic portfolio is certainly rich and broad enough to enable UCD to qualify as a “liberal arts and science” research university, one that deepens the education for students in the other UCD colleges, offers a more comprehensive curriculum to undergraduate majors, and contributes to the university’s national image through graduate education and research. Its faculty is still a relatively young one, 62% hired since 2000.<sup>38</sup> The Division has progressed and improved steadily over these years, following a unique style of its own. Unfortunately, along with other humanities divisions in the UC system, it has suffered disproportionately in California’s fiscal crisis.

*Summary: College of Letters and Science*

For UCD to rise in ranking from 36 in the U.S. (ARWU<sup>39</sup> criteria) to the level of 20<sup>th</sup> to 30<sup>th</sup>—“Next Ranked” institutions like Michigan, UNC Chapel Hill, Duke, or Minnesota, science and social sciences will have to be resourced to improve. The know-how and motivation to improve exist. Unfortunately, the support has historically not been available to do so.

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<sup>37</sup> *Ibid.*, response to question 4.

<sup>38</sup> *Research Priorities* handout, *op.cit.*, page 2.

<sup>39</sup> Academic Ranking of World Universities (ARWU) 2009 at <http://www.arwu.org>.

### 3.2 College of Engineering<sup>40</sup>

#### Overview

UCD College of Engineering was formally established in 1962. It consists of eight departments, 2,602 undergraduates, 883 graduate students, 272 tenure/tenure track faculty, and 15 engineering degree programs. Its research expenditures are \$86 million/year, or 13% of total research<sup>41</sup> of the university. The research expenditure per faculty is an impressive \$456K per FTE.

The *U.S. News* ranking for the College of Engineering based on a weighted average of 10 factors is 32 out of a total of 192 institutions ranked. UCD is ranked overall among NC State, University of Florida, Duke, Rice and RPI. Of the UC universities, UCD in Engineering ranks ahead of UCI, UCR and UCSC and behind UCB, UCSD, UCLA, and UCSB in that order.

The College has succeeded in fostering interdisciplinarity in creating new departments, establishing centers and research units, and broadening its offerings in undergraduate and graduate education. The departments of Biological and Agricultural Engineering, and Biomedical Engineering are examples of interdisciplinary departments, and the approximately 20 centers address problem areas that clearly do not fall into the sphere of a single discipline. UCD also combines classical engineering disciplines into single departments, such as Civil and Environmental Engineering or Mechanical and Aeronautical Engineering to address issues that require the knowledge and approach of multiple disciplines.

As in the rest of the University, the absence of meaningful connection to and with industry is a deficiency that requires the management's focus and action. While there is some indication of an increasing connection with industry, the College has a long way to go in achieving a satisfactory relationship. One should think of an industry day (as it is done in other universities) to exhibit the results of the College in its many research areas. The invitees should be national and international enterprises, not just local industry.

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<sup>40</sup> Unless otherwise noted data sources for information in this section are as follows:

College and program rankings: *U.S. News & World Report America's Best Graduate Schools* (2011 edition)

Research expenditures and research per faculty FTE: Table 4 Research Expenditures for Departments by Federal, State and Private Sources FY 2008-09 (10/9/09) in UCD College of Engineering, *College Statistics, Volume 1* distributed to review team members during the campus visit.

Enrollment: 2008-2009 data from Tables 2a (undergraduate) and 3a (graduate) provided by UCD to the review team in advance of the campus visit.

Number of faculty: College – 2008-2009 data from Table 4a provided by UCD to the review team in advance of the campus visit. Department – same source, except as cited otherwise below.

Degree programs: 2008-2009 data from Table 2d provided by UCD to the review team in advance of the campus visit.

<sup>41</sup> Based on reported COE research expenditures of \$86,312,419 as a percentage of total research expenditures of \$642,519,000 for UCD reported to NSF for 2008-2009.

A comment on the sources of engineering's research expenditures is also needed. With funding from the state being close to 25% and the uncertainty of this funding's continuance, the College needs to turn more to federal funding, especially from NIH, NSF, DOE, DHS, DOD, and the intelligence agencies. Many of the existing UCD programs and plans for new ones are attractive to these particular agencies.

External recognition through membership in the NAE is not commensurate with other UC universities or with the accomplishments of the College. There are presently two COE faculty with full-time active status at UCD (not including the Chancellor) who are NAE members. This contrasts markedly with the other UC universities that have comparable status in engineering (Santa Barbara has 26, UCLA 15, San Diego 20, and UCI 8 members).<sup>42</sup> This comparison may not reflect the relative quality of researchers so much as UCD potential candidates being relatively unknown and a lack of an active candidate identification and promotion program by UCD management.

Additional insights can be gained from the rankings of the departments, where available. The following department discussions will include these comparisons.

### *Departments*

The eight departments that make up COE are well chosen. They are key engineering disciplines that can be fruitfully linked with science and medical areas to pursue new engineering advances. Creating these interdisciplinary departments benefits engineering and the science disciplines it embraces. The combinations of biology and agriculture with engineering, and biomedicine with engineering, are examples. There are further advantages when the combination is expected to result in new research findings that otherwise might not easily be discovered. Mechanical and aerospace, and chemical and materials science, are examples. COE deserves credit for taking advantage of these opportunities.

**Biological and Agricultural Engineering:** The mission of the department is "...the production and management of biological materials and processes, particularly under ...the constraints of the western U.S."<sup>43</sup> Its research and interests go beyond this rather general and broad statement. The department has programmatic activities in agricultural systems engineering, biological, food, and natural resources engineering.

Its engagement in bio-energy should be a major attractor for funds and lead to accomplishments. We must observe that energy research seems to be worked on in a number of areas within the campus. A more organized and central focal point for this work should be considered.

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<sup>42</sup> National Academy of Engineering, *Directory of Members and Foreign Associates 2009*.

<sup>43</sup> "Biological & Agricultural Engineering Department Strategic Plan for 2009-2014," (April 25, 2008) UCD College of Engineering, *Academic Plans* distributed to review team members during the campus visit. (unpaginated)

The research expenditures of the department for 2008 are in the order of \$5 million; with 16 FTE faculty, research expenditure per faculty member is \$317K/FTE. This program is ranked by *U.S. News* at 5 among the 28 programs assessed, an outstanding performance for its size and resources. The question that management needs to ask itself is: what could additional resources yield? It should be noted that one of the goals or needs of the department is modernization of its research facilities.

Biomedical Engineering: The mission statement, among other goals, focuses on "...advancement of technologies and computational techniques that meet medical and societal challenges."<sup>44</sup> Its programmatic activities are computational bioengineering, including bioinformatics and systems biology, and biological network research. Biomedical imaging with emphasis on molecular imaging and cellular and molecular systems analysis and synthesis are other areas of interest. This is a broad research agenda, considering that in August 2008 its faculty numbered 19 (although the total research staffing consisted of 115 people).<sup>45</sup> Its research expenditures per year are \$12million or \$664k/FTE and its *U.S. News* ranking as a department is 23. The chair brought several grants to UCD and has put this department on an ascending path.

This program is much sought after by undergraduates with 256 students enrolled for the 2008-2009 academic year. This is a significant workload for the department and, in light of the present financial situation of UC in general, needs to be carefully monitored for the future.

Another issue seems to be ABET accreditation. Since ABET is not going to go away, it certainly is a goal that should be pursued.

Chemical Engineering and Materials Science: In addition to their research activities, the faculty is heavily involved with teaching requirements caused by an increasing interest in the subject matter of the Department. Undergraduate enrollment is 369 and graduate enrollment is 91. There are 31 faculty equating to 25 FTE.<sup>46</sup> The difference between these two numbers is explainable by the faculty dividing its time with other assignments, like services or positions in other areas of engineering or the broader Davis activities.

The *U.S. News* ranking for the department is split between the two disciplines, with chemical ranked 30 and materials science 26.

Civil and Environmental Engineering: Combining civil and environmental engineering in a single department is an important move that should give it a base that will be productive in a research and educational sense. The Department should take advantage

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<sup>44</sup> "Academic Plan, Department of Biomedical Engineering," (August 13, 2008) UCD College of Engineering, *Academic Plans* distributed to review team members during the campus visit. Page 3.

<sup>45</sup> *Ibid.*, page 5.

<sup>46</sup> "Academic Plan, Department of Biomedical Engineering," *op.cit.* page 3.

<sup>46</sup> "Academic Plan, Department of Chemical Engineering & Materials Science," (April 10, 2008) UCD College of Engineering, *Academic Plans*, *op. cit.*, page 2.

of this fact and assure that it is active in some of the national level deliberations that continually are being created.

The enrollment in the Department's courses of 582 undergraduates and 170 graduate students is the highest in the COE, with 30.87 FTE faculty. Its research expenditures are \$23 million. A large proportion of the department's research expenditures come from the state, over \$12 million in 2008/9; given the current fiscal situation in California, this could be a major issue. Similarly, research expenditures from private sources of \$6 million could be a major vulnerability. Federal expenditures are only \$5 million. The *U.S. News* rankings applicable to the Department are 16 for civil engineering and 14 for environmental.

Computer Science: The Department focuses on research in three areas: computer security, graphics and visualization, and networks. These are areas of importance and of demand, especially computer security. Additional areas being considered are software systems and computational biology. Funding by DHS and DOD are targets of opportunities.

The Department's undergraduate enrollment is 240 and there are 150 graduate students. As in other universities, undergraduate enrollment in computer science has fallen off as a consequence of the dot.com bubble. There are 32 faculty<sup>47</sup> with 28 FTEs. Research expenditures are \$9.4 million, corresponding to \$337K/FTE.

Electrical and Computer Engineering: Although the COE is ranked at 32 by *U.S News*, this Department's ranking is 38, the lowest ranking of the eight departments in the College. The importance of this Department should not be underrated. Not only does it have high enrollment (464 undergraduate and 154 graduate students), but it also functions as the base for much research in engineering, and in other areas as well. Therefore, the Department's standing and reputation in relation to its peers, especially within the UC system, is a matter for concern.

The Department's research expenditures are \$8 million with 27 faculty FTE or \$299K/FTE, the second lowest in COE.

Nanoscale devices and energy scavenging circuits are identified by the Department as playing major roles in the future. These developments as applied to circuits, computers and information systems could indeed yield circuits and devices with improved characteristics. A further focus suggested is bio-electronics. It is not clear from the information provided if there is an understanding of what problems are important to address and if the capabilities exist to pursue this general area.

Mechanical and Aerospace Engineering: This Department is in a difficult position because of the unusually high number of potential retirees in the next few years. About

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<sup>47</sup> "Department of Computer Science Academic Plan 2009-2014" (undated) UCD College of Engineering, *Academic Plans*, op. cit., page 7.

1/3 of the faculty are over 60 years old and many have served for a long period of time in their respective positions, as long as 30 to 40 years. It is also a department that has a high teaching load in areas that are not necessarily on the hot list for support of funding agencies. The transition for this Department for the next 5 to 10 years requires some special consideration to allow hiring that overlaps retirement and a TA policy that addresses the teaching load dynamics the Department faces.

The Department's research expenditures are \$8 million and \$255K/FTE, the lowest in COE. Its *U.S. News* ranking is 33 for the mechanical engineering discipline and 24 for aerospace. Eight emphasis areas comprise energy, environment, vehicles, acoustics, aerospace, biomechanical engineering, mechatronics, and industrial design. The Department claims that "UCD is poised to be the energy university in California."<sup>48</sup> We have not seen a convincing plan that this is in the cards. With the Department's work in energy, transportation, and the environment, it would be possible to aspire to this position; but it takes leadership, a visible organization and a convincing strategy to achieve this position.

Applied Science: This Department fills a "niche" role between science and engineering. It has been able in that role to focus on interdisciplinary areas like bio-photonics and apparently is a bridge to Livermore Laboratory and perhaps other institutions. The department has research expenditures of \$9.2 million or \$617K/FTE, third highest in COE and an indication that this Department is a significant player in the research arena.

### 3.3 School of Medicine (SOM) and Health System (HS)

The Washington Advisory Group review team met with Claire Pomeroy M.D., Vice Chancellor for Human Health and Dean of the School of Medicine; Fred Meyers M.D., oncologist and former chair of Internal Medicine, now Executive Associate Dean, SOM, and Associate Director of the Clinical and Translational Science Center for Education; Tom Nesbitt, M.D., MPH, director of the California TeleHealth Network and Associate Vice-Chancellor for Strategic Alliances; and Heather Young, RN, PhD, MPH, Dean of the Betty Irene Moore School of Nursing. We were provided excellent narrative and financial documents.

#### *Strengths*

1. A Fully Realized Strategic Plan. In 2003-2004, led by former Dean Joseph Silva and newly-arrived Executive Associate Dean Claire Pomeroy M.D., the School of Medicine prepared an impressive Strategic Plan. Key features were: values of equity, justice, and diversity; mission of discovering and sharing knowledge to advance health; creation of the UCD Health System with a single leader and a single financial statement embracing educational, research, clinical, and community engagement; and specific metrics for each element of the mission.

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<sup>48</sup> "Mechanical and Aeronautical Engineering Strategic Plan Winter 2008," (March 21, 2008) UCD College of Engineering, *Academic Plans*, op. cit. page 9.

Under Dr. Pomeroy's leadership, the UCD Health System and SOM have made remarkable progress on the stated objectives, including the consolidation of the SOM education programs of all four years at the 142-acre Sacramento site, considerable development of the hospital and the network of clinics, generation of 4 to 7 percent annual surpluses from clinical operations through FY09, and a dramatic increase in research funding. Integration of the clinical, research, and educational programs with appropriate synergies, and use of funds for capital and other Health System investments and for program and facility development and faculty recruitment in the SOM have been outstanding.

An example of strategic investment and leadership was the early commitment to institution-wide electronic medical records, making the institution essentially paperless now for an investment of \$80-90M, with research support included in the IT mission. This capability and the Clinical Research Investigator Services Program (CRISP) positioned UCD to compete successfully for one of the first 12 Clinical and Translational Science Center awards in 2005, a top-priority program of the NIH, intended to be expanded to 60 institutions. This success gave UCD heightened visibility among academic medical centers and at NIH. They have teamed with UCSD and the vendor EPIC to lead in health information technology among the five UC medical campuses. They have used Collexis and the i2B2 "hive" of Harvard Medical School to identify and link researchers throughout the SOM, which is helpful in mobilizing faculty to submit research grant proposals, including larger proposals. The plan identified neuroscience, cancer, infectious disease, and vascular disease as primary research areas for emphasis. Specific goals for information technology have been established for 2010.<sup>49</sup>

Another example of preparedness paying off was the planning for a School of Nursing, including formation of the Nursing Science and Leadership Graduate Group of 27 interdisciplinary faculty. Through Dean Pomeroy's service on the board for the California Institute for Regenerative Medicine (CIRM, the \$3B California Stem Cell Initiative), UCD was able to learn early about the interest and compete successfully for the \$100M naming gift from the Gordon and Betty Irene Moore Foundation to create the Betty Irene Moore School of Nursing, truly a transformative event for UCD.

Many years of development of TeleHealth and the Center for Health and Technology paid off as UCD won the lead role for the UC and for the State of California on delivering TeleHealth services through a peer2peer broadband network to 860 sites with Federal Communications Commission funding of \$22M and matching funds of \$8M from a donor and two California-based foundations.<sup>50</sup>

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<sup>49</sup> See *2010 State of the Health System* distributed to review team members when they met with representatives from the SOM and HS on April 1, 2010.

<sup>50</sup> Ibid re: number of Telehealth sites; funding information provided in presentation by Tom Nesbitt.

In February 2010, the new 5-year strategic planning process for the Health System was launched, with an external consulting firm assisting.

2. Outstanding Leadership. Dr. Pomeroy is an articulate, organized, engaged leader who exudes confidence and demonstrates focus on goals and metrics. She utilizes a dashboard with data for the past two years, the current year, and the near-term goal for four key metrics: mortality rate for hospitalized patients, number of endowed chairs and professorships, total externally-funded research expenditures, and number of publications about educational innovations in the journal *Academic Medicine*. Dr. Pomeroy has built a strong team, including the individuals we met (above), the Medical Center and Faculty Practice Plan leaders, the CFO, and the CIO. She has invested funds and multiple FTEs in the appointment of three new chairs in the basic sciences. UCD secured a major facilities grant from the California Institute for Regenerative Medicine (CIRM) that helped attract Dr. Jan Nolte from Washington University as Director of the UCD Stem Cell Institute.
3. Budget Success. The Medical Center has grown its clinical operations and physical facilities impressively. For the year ending 30 June 2009, the Medical Center had operating revenue of \$1,077M, net operating income of \$58M, and net gain after transfers of \$39M to the SOM of \$45M.<sup>51</sup>
4. Research. The SOM total extramural research funding grew from \$55M in 2000 to \$161M in 2008 and \$194M in 2009,<sup>52</sup> exceeding the 2004 Strategic Plan goal of \$150M by 2010. Of the 2009 total, \$95M was from NIH; R01 grants accounted for \$12M in 1999 and \$50M in 2009.<sup>53</sup> In data released by NIH in April 2010,<sup>54</sup> UCD SOM is listed as having reached \$111M in NIH awards and ranking #42 among 108 medical schools. Dr. Pomeroy has set a goal of \$300M in total extramural funding as part of the Chancellor's goal of \$1,000M for all of UCD.

The SOM has secured seven 5-year grants of \$15M to \$25M from NIH (5), NSF, and CIRM: the Clinical and Translational Science Center (CTSC), the NeuroTherapeutics Research Institute, the Center for Regenerative Medicine, the Center for Biophotonics Science and Technology, Study of Intensive Treatment for Toddlers with Autism, the Northern California Children's Study, and the Clinical Cancer Center core grant.<sup>55</sup> The pending proposals for expansion of the NIH-designated UCD Cancer Center into a Comprehensive Cancer Center and renewal of the CTSC will be important benchmarks, for which UCD is well-positioned. There is

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<sup>51</sup> UCD Health System Financial Results handout provided to review team members when they met with SOM and HS representatives on April 1, 2010, page 4.

<sup>52</sup> UCD Health System Research Enterprise, Report to Washington Advisory Group (April 1, 2010) "Growth in School of Medicine Research Funding" chart on page 7.

<sup>53</sup> Ibid., page 11.

<sup>54</sup> Data on and analyses of NIH awards cited in this section 3.3 was available through the University of Michigan's M-Stat system to review team member Gilbert Omenn, M.D. The raw data from which the M-Stat reports were compiled are available at <http://report.nih.gov/>.

<sup>55</sup> UCD Health System Research Enterprise, op. cit., page 8.

also an ARRA C06 proposal for facility renovations for the CTSC and Stem Cell programs pending.

The School of Nursing is off to a good start with a \$300K grant from the Robert Wood Johnson Foundation and a \$600K grant as a supplement to the CTSC.<sup>56</sup> Its first class of graduate students will enter in Fall 2010.

### *Opportunities*

1. Growth of Facilities/Research Space in Sacramento. The campus plan for UC Sacramento is bold, with multiple expansions and new buildings, including a “march down Stockton Avenue” with four new building sites for research and for private sector/UCD partnerships. The SOM intends to address an estimated 200,000 ft<sup>2</sup> shortage of space at present. The Health System is prepared to continue investing in the academic and research programs, so long as the Health System can sustain an annual surplus from clinical operations, supplemented by industrial and philanthropic funding. The goal for 2010 from fund-raising is \$66M, the sum of \$21M for the current baseline, \$35M for Cancer Center expansion, and \$10M for the new Pediatric Intensive Care Unit.<sup>57</sup> The consolidation of the entire four-year educational experience of medical students in Sacramento reinforces the synergies across the SOM and Health System missions.
2. Interdisciplinary Collaborations across UCD and with other UC Campuses and National Labs. Dean Pomeroy gave very clear responses on this point, referring to “research neighborhoods.” Veterinary Medicine is a major partner in Global Health/One Medicine and in the Cancer Center. UCD ranks #1 nationally in Veterinary Sciences support from NIH, with \$28.6M in awards to the CVM and \$6.8M to the SOM for a total of \$35.4M in 2009. Biomedical Engineering is a potent player in Imaging, and there have been contributions from Geology to imaging and modeling. The CA&ES is strong in the area of quality of life of young people in the Central Valley and the Center for Regional Change, including social determinants of health status. The COE has faculty partners for SOM in Health IT. And the graduate group structure enhances many faculty interactions.

In contrast, collaboration with CL&S is weak. On March 30, there was a Chancellor’s Retreat to stimulate connections with the physical and computational sciences, as recommended in the 2009 National Research Council report on *A New Biology for the 21<sup>st</sup> Century*,<sup>58</sup> emphasizing integration of life sciences and physical sciences, with applications to societal needs for energy fuels, food, water, and health. Dr. Pomeroy would like to encourage, as would we, MPS and Biological Sciences hires who could leverage strengths in the SOM. Chemistry might be particularly well-suited to build on capabilities for research on structural biology of proteins.

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<sup>56</sup> Ibid., page 12.

<sup>57</sup> 2010 State of the Health System, op. cit.

<sup>58</sup> National Research Council, *A New Biology for the 21<sup>st</sup> Century* (The National Academies Press, 2009).

Increasing UCD strength in genomics with applications to human biology and clinical medicine would be welcomed.

There are some connections with Lawrence Livermore and Lawrence Berkeley National Laboratories and with other UC campuses, like UCSD for information technology and Merced for rural health.

3. Initiation of the Program and Eventually a School for Population and Public Health. Given the regional/Central Valley dominant role of the UCD Health System and the importance to health of embedding medical institutions in an effective population-based framework, the early stages of the UCD process in this domain are laudable. The example of the School of Nursing highlights the potential for a transformative philanthropic gift for Population and Public Health. In contrast, the opposition to a new school of public health at UCD from within the UC system by the schools of public health at Berkeley and UCLA is indefensible, given the size of the California population and the capabilities at UCD/UC Sacramento.

This academic unit will be integrated, most likely, with the Global Health program led by Ellen Gold and the One Medicine Program led by the School of Veterinary Medicine. Dr. Pomeroy stated that she looks forward to announcing a high-profile appointment as director of the Population and Public Health Program.

The Health System will ensure efficiencies and integration across the Health Schools of Medicine, Nursing, and Public Health, based on shared core values and on established decisions to have single registrar, library, information sciences unit, and basic science departments, including the basic public health sciences of epidemiology and biostatistics.

### *Weaknesses*

1. Accounting for Federal and Total Funding to Office of the Vice Chancellor for Research (OVCR) Research Units. For budget rankings of schools and departments, there is no value in holding and counting federal grant support in the OVCR. The lead units should get the credit; moreover, the academic units can provide much stronger leadership, with OVCR providing periodic oversight and review.
2. Industrially-funded Research. The level of industrially-funded research in the SOM is quite modest at \$14.7M, but has doubled in the past year as the SOM invested in contract research staff, after becoming frustrated with the campus operation.<sup>59</sup> This amount of funding has very high administrative burden, since it represents 246 agreements. Of course, UCD has a long history of productive research with and for industry in the viticulture and agriculture domains, symbolized now by the new Mondavi Institute Building.

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<sup>59</sup> Information provided by Dean Pomeroy in her presentation to the review team, April 1, 2010.

3. Databases for Basic, Clinical, and Population-based Research. The Collexis research inventory should be university-wide (even UC system-wide). The unwillingness of the UCD campus to participate should be remedied. The advanced position of UCD HS and SOM in health IT may bring substantial new research funding and higher reimbursement for clinical care under the recently enacted federal health care reforms.
4. Partners for Collaborations (see Opportunities, above). Strengthening the capabilities of CL&S and the inclination of CBS to participate in collaborative biomedical research could help overcome perceived weaknesses. The CBS Academic Plan highlights ties with SOM in the Genomics Building and in the Center for Neuroscience.
5. The Critical Role of Internal Medicine. In the vast majority of research-intensive medical schools, the department of internal medicine, with its many large divisions and intellectual bent, leads the way in individual and collaborative research and grantsmanship. The table below shows how UCD's Department of Internal Medicine NIH awards compare with those of other institutions.

<b>Department of Internal Medicine NIH Awards</b>		
<b>Institution</b>	<b>NIH Funding</b>	<b>Rank</b>
UCSF	\$170M	2
UCLA	\$100M	12
UCSD	\$ 95M	13
UCD	\$ 25M	42
UCI	\$ 11M	67
Utah	\$ 36M	36
Oregon	\$ 35M	37
Georgetown	\$ 33M	38
Rochester	\$ 31M	39
Wake Forest	\$ 31M	39
UT-San Antonio	\$30M	41
UCD	\$25M	42
University of Arizona	\$19M	51
University of Florida	\$15M	60

The table below shows how Internal Medicine's NIH award total compares with that of other departments, especially major clinical departments in UCD.

UCD SOM Clinical Departments NIH Awards		
UCD Department	NIH Funding	Rank
Internal Medicine	\$25.0M	42
Urology	\$5.5M	3
Psychiatry	\$14.9M	21
Neurology	\$4.7M	27
Surgery	\$1.8M	45
Pathology	\$3.9M	56

Significant, even dramatic growth is needed if UCD is to move into the ranks of the top 20-30 institutions.

6. National Awards for Faculty. Dr. Pomeroy has stated in her annual self-assessments her efforts to focus on nominating faculty for important recognition in their fields and for national recognition as they progress. At present UCD has 18 members of the NAS, four members of the Institute of Medicine,<sup>60</sup> and one Howard Hughes Medical Institute young investigator, none of whom holds a primary appointment in the SOM. Stepping stones to the IOM, especially in Internal Medicine, Pediatrics, Neurology, and Pathology, are elections to the American Society for Clinical Investigation (ASCI) and the Association of American Physicians (AAP). A search of the ASCI directory showed six UCD faculty, elected during the period 1970 through 1991, compared with 50 at UCLA, 64 at UCSD, 88 at UCSF, and 63 at Michigan. None of the five active ASCI members has become a member of the AAP.

Early stage faculty development grants are a critical investment in young people. UCD has just renewed the Building Interdisciplinary Research Careers in Women's Health (BIRCWH) grant and has a K-30 mentored clinical research training program grant. Individuals can compete for K99-00 post-doctoral transition to faculty awards and K08, K09, and other career development awards. Institutional recognition is related, of course. For example, the Health System was named one of the Top 45 hospitals for safety and efficiency by the Leapfrog Group (of employers).<sup>61</sup> In *U.S. News* 2011 edition rankings, UCD SOM moved up to 20 (from a ranking of 35 in the previous year's edition) for primary care but remained virtually static at 47<sup>th</sup> in research (ranked 48<sup>th</sup> in the previous edition). There is a substantial lag in reputational components of these rankings.

### *Threats*

1. Budgets. The State of California economy and state budget have been under pressure recently, which translated into a budget cut of \$113M for UCD in FY09-10, including

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<sup>60</sup> NAS and IOM membership data from respective on-line membership directories accessed May 19, 2010 at <http://www.nasonline.org/site/Dir?sid=1011&view=basic&pg=srch> and <http://www.iom.edu/Global/Directory.aspx>.

<sup>61</sup> 2010 *State of the Health System*, op.cit.

an \$8.1M cut to the Health System.<sup>62</sup> In addition, the rapid increase in uncompensated care of patients, rising from \$102M in FY08 to \$165M in FY09,<sup>63</sup> has reduced the favorable financial statement of the Health System from \$47M for 12 months in FY09 to \$17M so far for 8 months of FY10.<sup>64</sup> The SOM shows a net loss of \$11.2M for 8 months through 2/28/10, compared with a net gain of \$1.8M for FY09,<sup>65</sup> probably reflecting the state cuts plus a lower rate of transfers from the Medical Center.

2. Lots of Competitors. We applaud bold goals and credible strategies. There is little doubt that the UCD SOM will continue its impressive upward path in research funding. However, nearly every research-intensive institution shares these goals; most also have built or are expanding facilities for research. The competition is fierce, as reflected in the fact that UCD SOM faculty submitted \$229M of research proposals for Stimulus Funding grants, with a return, so far, of \$18M.<sup>66</sup>

As noted above, UCD has special assets like its well-developed TeleHealth Center and Rural Health-PRIME program, its access to CIRM funding for facilities growth and research in regenerative medicine, and its UCD collaborators for interdisciplinary research, especially the Primate Research Center, SVM (Mouse Biology Program, Comparative Cancer Center, etc.) and CA&ES (Human Nutrition, Human Ecology). The aspiration to move up among the five UC campuses with medical schools will be particularly challenging as overall NIH awards for 2009 were \$526M for UCSF (#4 nationally), \$452M for UCLA (#9), and \$412M for UCSD (#11), then UCD at \$219M (#29), and UCI at \$141M (#51).

### *Recommendations*

1. Strategic Plan. Continue to build upon the excellent strategic plan, capital plan, metrics, and dashboard utilized by the SOM and UCDHS to create synergies across educational, research, and clinical service missions and to try to move up in national rankings.

The 2004 plan has been pursued quite successfully, and a fresh effort was launched in February 2010.

2. Information Technology. Build on the IT strategic plan, the Center for Health and Technology, the state-wide TeleHealth Network, and the opportunities for a leading role of UCD in UC information technology and informatics domains with federal, state, and philanthropic funding. Establish and utilize databases for basic, clinical, and population-based research. Persuade the rest of the UCD campus to utilize a

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<sup>62</sup> Ibid.

<sup>63</sup> Ibid.

<sup>64</sup> *UCD Health System Financial Results*, op. cit., page 4.

<sup>65</sup> Ibid.

<sup>66</sup> *UCD Health System Research Enterprise*, op. cit., page 7.

common database (presumably Collexis, already deployed in the SOM) to facilitate finding collaborators for interdisciplinary research proposals and to expedite production of major proposals.

3. Leveraged Faculty Recruitments. Continue with high-profile recruitments of faculty in clinical, as well as basic science, fields, individuals who bring national reputations and substantial research funding with them. Especially strengthen Internal Medicine, which should be the flagship of the clinical departments.
4. Enhance Current Large Grant Programs. Focus on successful renewal of the Clinical and Translational Science Center and renewal of the NCI Cancer Center with expansion to comprehensive status. Continue to build ties between SOM and SVM and CA&ES in comparative cancer research.
5. Catch up in Human Genome Sciences. Recruit in the SOM, jointly with the Genome Center and CBS if possible, a strong leader in human genomics research and expand related core laboratories. A cluster hire across several schools and colleges would be desirable.
6. Expand Nursing and Public Health. Expand the academic health center with further development of the Betty Irene Moore School of Nursing and of the Population and Public Health Program into a full-blown School of Public Health.
7. Enhance Research Support Services with clear targets of increased federal and total R&D funding. Assist the Chancellor and Provost in laying out a clear plan for reaching the \$1 billion per year threshold in R&D funding, including specific goals for SOM, UCDHS, and interdisciplinary developments and programs in which the SOM participates. A critical element is much improved Research Support Services.

### 3.4 College of Agricultural and Environmental Sciences

#### *History and Overview*

The College of Agriculture and Environmental Sciences (CA&ES) is the foundational academic unit at UCD, representing more than 100 years of distinguished service to the people of California, the nation and the world. Its mission is "...to provide research-based solutions to problems of our state, nation and globe and to reach out to our stakeholders in the tradition of land grant universities." In its current configuration, CA&ES has 350 FTE faculty in 17 departments organized into three Divisions: Agricultural Sciences, Environmental Sciences and Human Sciences. CA&ES faculty participate in 13 college-based and numerous campus-wide centers and institutes that address stakeholder needs across California.<sup>67</sup> In 2008-09 CA&ES had 5,106 (21.9% of

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<sup>67</sup> Background and demographic information from handout prepared for and distributed to the review team by Neal Van Alfen, April 1, 2010, page 3.

UCD's total) undergraduate students enrolled, and a substantial but declining number of graduate students; 845 or 13.5% of the UCD total.<sup>68</sup> In FY08-09, CA&ES had contract and grant expenditures of \$77.9M of which \$40.2M was from federal sources.<sup>69</sup>

The review team heard a presentation by Dean Neal Van Alfen, which was followed by a question and answer period with CA&ES Associate Deans and selected faculty members. A 2008 strategic plan for the college was available on line for review.

### *Strengths*

1. Outstanding Faculty and Rankings. By all available measures<sup>70</sup> CA&ES is among the elite agriculture and environmental sciences colleges in the world. It enjoys an international reputation for excellence in entomology, crop and animal sciences, food science, nutritional sciences, plant pathology, viticulture and enology, and environmental toxicology. The college has five members of the U.S. National Academy of Sciences, the second highest concentration on campus and among the highest concentration at any peer college of its kind, and three members of the Institute of Medicine (highest number on campus).<sup>71</sup>
2. Competitive Externally Funded Programs, Strong IP Portfolio and Large Endowment. UCD ranks #1 in competitively awarded grants that support agricultural R & D, #1 in funding under the NSF Plant Genomics Program (1998-2009) and #1 in funding from the U.S.-Israel Binational Agricultural Research Development Fund. Average funding per faculty member in FY08-09 was ~\$240,000, an excellent indicator of grantsmanship and quality. The number of peer reviewed papers is the highest for comparable institutions with programs/colleges of Agricultural Sciences, Food Science and Nutrition, and Ecology/Environmental Studies.<sup>72</sup> The College leads the university in the amount of royalties generated from intellectual property (\$7.2 million/\$9.8 million total)<sup>73</sup> and in annual giving (\$39.2 million).<sup>74</sup> Among all campus units, CA&ES has the second largest book value of its endowment (\$82.3 million).<sup>75</sup>

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<sup>68</sup> Tables 2a (undergraduate) and 3a (graduate) provided by UCD prior to review team visit.

<sup>69</sup> Handout by Neal Van Alfen, op.cit. page 11.

<sup>70</sup> Rankings consulted were *The Chronicle of Higher Education*, Scholarly Productivity Index 2007 at <http://chronicle.com/stats/productivity/page.php?year=2007&institution=544&byinst=Go>, and rankings from PhDs.org at [www.phds.org](http://www.phds.org).

<sup>71</sup> Data on UCD memberships from Table 4d provided by UCD prior to review team visit; data on NAS memberships at peer institutions from analysis of membership data by home institution on the NAS website [www.nas.edu](http://www.nas.edu).

<sup>72</sup> Unless otherwise noted, background information on funding and rankings in this paragraph are from handout prepared for and distributed to the review team by Neal Van Alfen, op.cit.

<sup>73</sup> Handout by Neal Van Alfen, page 12.

<sup>74</sup> Table 7b provided by UCD prior to review team visit.

<sup>75</sup> Table 7a provided by UCD prior to review team visit.

3. Strong Leadership and Stakeholder Support. Under Dean Neal Van Alfen, CA&ES has benefited from stable, competent leadership for the past 11 years, outstanding faculty and extensive engagement with alumni and stakeholders around the state. Its organizational structure has enabled it to respond quickly to emerging opportunities in renewable energy research as evidenced by the laudatory \$25 million research agreement with Chevron, which involves many CA&ES faculty. CA&ES is uniquely positioned to lead the world in solving important problems facing humanity, such as agricultural sustainability, global food security, renewable energy and environmental integrity. These research areas were all identified in the College's strategic plan, and significant progress has been made in faculty hires and the establishment of new centers and institutes to meet the plan's goals. However, considerably greater emphasis should be placed in cross-college programs in bioenergy and other renewable energy sources.

#### *Weaknesses*

1. Aging Infrastructure. As the oldest academic unit on the UCD campus, the college faces a particularly acute problem in providing large segments of its faculty with high quality laboratory space. At least six buildings housing research programs were built before 1960. Many of these buildings do not have high speed internet services, although the campus backbone is accessible. These aging facilities will inhibit the natural growth of the college and will severely impact faculty recruiting in the future.
2. Inadequate Facilities for Animal Research. The university's facilities for livestock and poultry are outdated or have been phased out. These deficiencies may affect competitiveness for funding in the areas of animal functional genomics and animals as biomedical research models. The relative deficiencies in mammalian genomics at UCD may stem in part from the lack of modern facilities for animal research. This deficiency not only hurts CA&ES, but also efforts to raise the rankings of SOM, which has very limited expertise in the field of human genetics and genomics. The College also seems particularly unprepared for the flood of data coming from genomics and environmental research. It is not evident that significant planning has been done to address needs in bioinformatics.
3. Faculty Age Gap. A very serious issue to CA&ES is its aging faculty. Approximately 50% of the faculty is over the age of 55<sup>76</sup> and it is anticipated that half the faculty will retire during the next 10 years. This extraordinary situation is of particular concern to junior faculty in the college, who cited the prospect of increased teaching loads as senior faculty retire. In an increasingly competitive environment for top researchers, these factors may affect recruiting and retention over the long term. It is thus critically important that CA&ES have a well articulated plan for faculty hiring. This plan must include areas of strategic importance both to the college and the campus at-large.

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<sup>76</sup> Table 4f provided by UCD prior to review team visit.

4. Declining Numbers of Graduate Students. Another area of concern is the declining number of graduate students supported in the college. There was little information available to the review team that addressed the cause of this decline. It was suggested that the high cost of funding out-of-state students is a major contributing factor, which seems plausible. Full out-of-state tuition must be recovered in all cases. Tuition payments may be quite difficult for research conducted on state and private dollars, which are a major source of funding for CA&ES faculty. CA&ES should focus on NSF, NIH and USDA pre-doctoral training opportunities to address this problem.
5. Obstacles Presented by Campus Research Administration. Significant concerns were raised by CA&ES faculty with respect to the research administration at the campus level and technology transfer. Finalizing research agreements with private companies has become increasingly difficult because of the risk-averse nature of the Office of Research and management of intellectual property. All aspects of research administration, from supporting grant submissions to executing materials transfer agreements to post-award grants administration were identified by CA&ES researchers as major obstacles. Elsewhere in this report we include recommendations regarding organizational changes to improve research administration.

### *Opportunities*

1. Expanded Federal Research Programs. The major opportunities for expanding the CA&ES research base are in the area of global climate change, renewable energy, and food security. The college's programs can be brought into better alignment with new competitive programs at DOE, USDA and NIH that address these issues. Specifically, CA&ES is poised for leadership in the new research priorities established by USDA-AFRI (Agriculture and Food Research Initiative). The new program, with \$262 million in competitive funding for mission oriented research in Food Safety, Child Obesity Prevention, Climate Change, Global Food Security, and Sustainable Bioenergy, must be a target for CA&ES researchers and their collaborators.
2. Leading Interdisciplinary Research. CA&ES faculty, with its broad range of expertise, also has the opportunity to participate in large-scale interdisciplinary research initiatives with faculty from CBS, SOM, COE and MPS. This is the most obvious mechanism for gaining campus-wide synergies that can result in funding of high value targets sponsored by NIH, NSF, DOE and other federal funding agencies. The "value added" for CA&ES faculty should be strongly promoted and supported by the College. Such targets would include the College's stated research priorities: Bio-based Materials, Complex Microbial Ecosystems, and Environmental and Human Health. The microbiome of humans and animals is suddenly amenable to study with high throughput sequencing techniques; microorganisms in the gastro-intestinal tract and on other surfaces surely influence nutrition, metabolism, and effects of medications.

3. Increasing Stakeholder-Driven Programs. The College has had enormous success in obtaining support from philanthropic, industry and commodity groups, such as the Mondavi family. The strength of agriculture, environment, energy and human development interests in California continually presents challenges to the College's research faculty. CA&ES has tremendous resources for mission-oriented research aimed at solving the problems of the people of California. The College must ensure that it retains the resources that enable it to respond quickly and effectively to stakeholder needs.

### *Threats*

1. Declining State Budget. The heavy dependence of CA&ES on state dollars to fund research and outreach activities is a clear and present danger to the college and the campus as a whole. In FY09, \$23.7 million or 18% of its total research awards (\$127 million) from all sources was in the form of state funding.<sup>77</sup> It is unclear how the College will respond if state funding to UCD is reduced further. In the short term, there are plans to eliminate the departments of Textiles and Clothing, Landscape Architecture, and Nematology. These moves should yield some short term gains. However, further reductions will likely affect faculty numbers, which could have catastrophic consequences given the vulnerabilities related to an aged faculty. This "perfect storm" may cause faculty flight and undermine attempts to build strategic depth to address emerging scientific opportunities.
2. Challenges from other Strong Land-Grant Universities. CA&ES faces significant challenges to its scientific preeminence in a number of areas, particularly from large Midwest land-grant universities and from several Eastern schools, such as Cornell University and University of Maryland. Many of these schools have programs that are of equal or greater strength in nutritional sciences, plant and animal genomics, and in biofuels research. These threats can only be met by strategic hiring that is in step with major campus-wide initiatives. Coordination of hiring with other colleges to address strategic needs should be strongly encouraged as should active participation in the Chancellor's faculty hiring initiatives.

### *Recommendations*

1. Develop a coordinated faculty hiring initiative with other campus units to address problems of strategic depth in emerging interdisciplinary research areas, such as bioenergy and global change biology. The hires should be at junior level as well as a select number of high quality mid-career scientists in order to fill the current age gap in the CA&ES faculty.

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<sup>77</sup> Table 5c provided by UCD prior to review team visit.

2. Align internal research programs more strongly with emerging USDA-AFRI programs, especially global climate change.
3. Build greater strategic depth in vertebrate (specifically mammalian) genomics and bioinformatics with the School of Veterinary Medicine and the School of Medicine.
4. Develop a strategic plan for updating animal facilities.
5. Coordinate efforts for interdisciplinary pre-doctoral training grants to restore strength in graduate student numbers.
6. Develop appropriate infrastructure to support writing and administration of federal and private grants and contracts.
7. Create an internal plan for future IT and informatics needs.
8. Drive development efforts toward increasing named professorships, start-up funds and graduate student assistantships.

### **3.5 College of Biological Sciences**

#### *History and Overview*

The College of Biological Sciences (CBS) grew out of CA&ES and CL&S in 2005. In just 5 years, the CBS has achieved national recognition as a leader in biology education and research. Its 125 tenure/tenure-track faculty members are housed in five academic departments that span the breadth of modern biological sciences, from molecular and cell biology to organismal biology. Three major interdisciplinary centers are supported by CBS: the Genome Center, the Center for Neuroscience, and the Center for Population Biology. Collectively, there are more than 5,000 undergraduate majors, ~450 graduate students and 10 Graduate Groups that fall under the auspices of the CBS faculty. Funding for research comes primarily from state (\$36 million) and federal (\$52 million) sources.<sup>78</sup>

Dean Ken Burtis made a summary presentation to the review team. The 2009-2014 CBS Strategic Plan was obtained from the CBS website.<sup>79</sup> The review team commends CBS for the comprehensive and forward looking plan it has developed for the College. The College has set the goal of increasing the average annual per capita extramurally funded research expenditures by 50% over the next five years.

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<sup>78</sup> Background information in this paragraph is from the handout prepared for and distributed to the review team by Kenneth C. Burtis, April 2, 2010 (unpaginated).

<sup>79</sup> Available at [http://biosci.ucdavis.edu/about/academic\\_plans.html](http://biosci.ucdavis.edu/about/academic_plans.html).

### Strengths

1. Quality of Faculty and Rankings. The College was launched with a distinguished history in several disciplines in the biological sciences. The 2011 edition of the *U.S. News* rankings place the graduate program at UCD as #20 in the nation, with an average peer assessment score of 4.1, only 0.1 point behind five outstanding universities ranked at #15 (UCSD, University of Wisconsin/Madison, Columbia University, University of Washington, and Rockefeller University). UC San Francisco was tied for #7, with a score of 4.5, and UCB at #2, at 4.8. In 2006, UCD had the top ranked program in Evolution and Ecology in the nation, and in the 2011 edition was ranked 3<sup>rd</sup> after UCB and Harvard. The College boasts 11 NAS members (4 active) and 2 National Medal of Science winners.<sup>80</sup> In 2009, Neil Hunter was named as its first HHMI Early Career Scientist and two faculty members received the Presidential Early Career Award for Scientists/Engineers. Annual per capita research funding is ~\$400,000.<sup>81</sup> Aggressive recruiting from 2003-2008 brought 37 new faculty members to CBS. Although federally funded sponsored research leveled off in 2008-2009, that funding had increased 23% since 2004-2005.<sup>82</sup> UCD ranks #1 in the nation in the number of doctoral degrees and bachelor degrees granted in the biological sciences.<sup>83</sup>
2. The Genome Center and Other Interdisciplinary Centers. The Genome Center is housed in a new facility that was built with Garamendi funding in 2004. The Center has a director with an excellent scientific reputation, Richard Michelmore, who reports to the Dean of CBS and to the Provost. According to several faculty members the review team interviewed, housing the Genome Center primarily in CBS may have resulted in a scientific emphasis that does not appropriately give weight to human genomics and genetics. There is an impression in SOM that human genetics is not well supported by the center. However, most faculty and administrators the review team met with felt that the Genome Center has been a resounding success. Although the review team did not have a chance to visit the Genome Center or view relevant financial information relating to the center, it did meet with Professor Jonathan Eisen, a recent recruit to UCD (joint appointment between CBS and SOM). As evidenced by Eisen's move to UCD, the Genome Center has been important in recruiting star power to the campus. The extensive core facilities of the institute have been instrumental in catalyzing genome science and bioinformatics across the entire campus. The center is very technology focused, supporting an array of services, including high throughput DNA sequencing, gene expression profiling, bioinformatics, proteomics and metabolomics. The Genome Center Building provides a terrific interdisciplinary gathering of investigators. There was no hard evidence presented to the review team that the campus investment has yielded any

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<sup>80</sup> Handout by Kenneth C. Burtis, op. cit.

<sup>81</sup> Per comments made by Dean Burtis in presentation to review team on April 2, 2010.

<sup>82</sup> Table 5b provided by UCD to review team prior to campus visit.

<sup>83</sup> Handout by Kenneth C. Burtis, op. cit.

new large center grants, but, over time, this can be expected if the center morphs its technology focus to one that is more focused on genome biology.

3. World Class Program in Evolution and Ecology (E&E). UCD became the academic home of Theodosius Dobzhansky after he retired from Columbia University in 1971 and where he penned the famous essay "Nothing in Biology Makes Sense Except in the Light of Evolution."<sup>84</sup> Since that time, genetics, ecology and evolution have thrived at UCD, making it one of the world's intellectual and research powerhouses in these areas. In 2010, *U.S News & World Report* (2011 edition) ranked the doctoral program in Evolutionary Biology as #3 in the nation and it has consistently been ranked among the top four programs in the nation. Professor Eisen is a coauthor of a popular new textbook in the field of evolution, a significant indicator of UCD's durable leadership in this discipline. Because of the new and powerful tools of genomics, evolution is fast becoming foundational for all of biology. CBS has recognized its comparative advantage and rightly plans to further enhance its academic and research programs in this area. E&E and CBS could assist the SOM to emphasize evolution in medical teaching, as recommended by an NAS Symposium and reports from the Howard Hughes Medical Institute and the American Association of Medical Colleges.<sup>85</sup>

#### *Weaknesses*

1. A Stand-alone College of Biological Sciences May Not be Optimal for the Future. Although the College has achieved high recognition as part of its hard fought independence, the separation is not natural and there is considerable overlap in research goals and programs with CA&ES and other units. Although this problem is not unique to UCD among the land-grant universities, in times of budgetary constraint, such overlaps need to be scrutinized, and the administrative costs associated with a stand-alone CBS carefully weighed against the financial and strategic gains that could be realized by an alternative configuration. One example is the department of Plant Biology, which overlaps considerably with Plant Sciences in CA&ES. Both units have relatively large numbers of faculty, with basic science concentrated in CBS and applied science more prevalent in CA&ES. These and other CBS units could exist under one structure, with associated gains in undergraduate and graduate programs and lower administrative overhead. It may be beneficial to merge these departments under one of the administrative units.

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<sup>84</sup> Dobzhansky, Christian, "Nothing in Biology Makes Sense Except in the Light of Evolution," *American Biology Teacher*, vol. 35 (March 1973), pages 125-129.

<sup>85</sup> Nesse RM, Bergstrom CT, Ellison PT, Flier JS, Gluckman P, Govindaraju DR, Niethammer D, Omenn GS, Perlman RL, Schwartz MD, Thomas MG, Stearns SC, Valle D. Evolution in health and medicine Sackler colloquium: Making evolutionary biology a basic science for medicine. *Proc Natl Acad Sci USA*. 2010 Jan 26;107 Suppl 1:1800-7. Epub 2009 Nov 16, and AAMC-HHMI Scientific Foundation for Future Physicians Committee (2009) *Scientific Foundations for Future Physicians* (American Association of Medical Colleges and Howard Hughes Medical Institute, Washington, DC).

2. Separation from the Physical Sciences Weakens Both Units. The separation of CBS from the physical sciences is an inherent weakness of the current organization. This separation is part of the historical legacy of the separation of CBS from CA&ES and L&S. As UCD drives to increase research funding, one of the main avenues to achieve this goal is through large grants for interdisciplinary research. Proposals for large institute and center grants are more competitive if research infrastructure and programs are administratively integrated. As major advances in the biological and biomedical sciences will demand the skills of chemists, physicists, mathematicians, statisticians, computer scientists, and bioinformatic professionals, interdisciplinary research at UCD would benefit if greater synergies were stimulated between faculty in the physical and biological sciences.
3. Insufficient Space for Interdisciplinary Research. Although the CBS Academic Plan did not indicate space to be a problem, the College (and campus as a whole) seems to lack sufficient space for large interdisciplinary research activities. While the Genome Center provides a healthy addition, without sufficient space in the “open lab” format it will be difficult for CBS faculty to compete for large center grants from NSF and NIH, particularly those that will require integration with the physical sciences. The goal of increasing annual research funding by 50% in 5 years with little or no faculty growth will be a difficult problem if new opportunistic space is not made available to support interdisciplinary research. Such space would facilitate interdisciplinary interactions within CBS and across units, without penalizing individual investigator driven programs.
4. Few Incentives for Expanding Research Activities. The academic departments in CBS have very few incentives for increasing research activities, particularly those involving other units. The faculty in CBS have relatively heavy teaching loads and receive little or no reward for taking on new research activities, either in the form of salary (which might come from incentives for putting appropriate percent faculty effort on grants and, in certain cases, from a joint appointment with SOM) or indirect cost recovery (ICR). The current ICR policy of the UC system is a major problem for units like CBS, which has high infrastructure costs and requirements for faculty start-ups (see Section 4.5).
5. Low Annual Giving by Alumni and Friends. The College has not done well with its development efforts. In 2008-2009, giving dropped to its lowest level historically and is last among the Colleges at UCD.<sup>86</sup> Faculty complained about lack of investment in development.

### *Opportunities*

1. Core Strengths Enable Leadership in Interdisciplinary Research. As we move into the new “century of biology,” UCD, with its obvious strength as a life sciences

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<sup>86</sup> Table 7b provided by UCD to review team prior to visit.

research university, is in an ideal position to lead in both discovery and translational research, particularly in medicine, agriculture, energy and the environment (domains highlighted in the 2010 NRC Report on 21<sup>st</sup> Century Biology<sup>87</sup>). A strong CBS is absolutely essential to this effort. In its Academic Plan, CBS has identified Evolutionary and Comparative Genomics, and Biological Networks/Systems Biology/Integrative Biology as targeted research thrusts. Indeed, these could be campus priorities as well as College priorities (with COE, SVM, CA&ES, and SOM). In both general areas there is already considerable strength, which should create the right conditions for building programs.

2. Responsibility for Building Programs in Human Genetics and Genomics. One of the deficiencies at UCD noted by the review team is in human genetics and genomics. With the major genomics programs now in place in CBS and CA&ES, it should be possible to concentrate on joint programs and recruiting in human genetics with SOM. The synergies with comparative genomics (and proteomics and metabolomics) programs in agriculture and microbial genomics across campus will be enormous and should lead to new funding opportunities. The College is in an excellent position to help drive such an initiative, and should push for joint hires with SOM to strengthen this critically important area of research.

### *Threats*

1. Reliance on the State for Research Funding. State funding has accounted for about 41% of research expenditures in CBS over the last three years.<sup>88</sup> This heavy reliance on state funds, which might be jeopardized by California's financial woes, if persistent, may be limiting UCD's rankings in the biological sciences.
2. Pay Differential with the School of Medicine. The salary differential between SOM and CBS basic science faculty was noted by the review committee. This differential exists in comprehensive research universities everywhere. It could be perceived as a threat to the well being of the College in recruiting top faculty to CBS if CBS has to compete with medical schools in California and across the country. Although potentially advantageous to the individual when allowed and appropriate, joint appointments with the SOM could create two subgroups of faculty and might lead to morale problems within the CBS. This is a very sensitive subject and needs to be addressed carefully by the University.
3. Start-up Costs for New Faculty Hires. In its Academic Plan, CBS indicated that each new faculty hire will cost \$750K on average for experimentalists. It was estimated that "\$4M per year just to maintain the *status quo*" would be needed.<sup>89</sup> It is unclear

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<sup>87</sup> National Research Council, op. cit.

<sup>88</sup> "CBS by the Numbers – Research Increases Past Decade" in handout by Kenneth C. Burtis, op.cit. (unpaginated) – percents calculated for 2006-07 through 2008-09 are from data in this table.

<sup>89</sup> *Academic Plan for 2009-2014: Sustaining Excellence in the Biological Sciences*, College of Biological Sciences (undated). page 5.

how this need will be met given current budgetary constraints. Failure to secure sufficient funding for start-up packages might seriously affect the future ranking of CBS, and the goal of increasing its research expenditures.

### *Recommendations*

1. The College should consider planning a future reorganization that would strengthen and expand its programs in teaching and research. As major advances in the biological and biomedical sciences will demand scientists with quantitative skills, CBS could benefit greatly by joint programs with MPS. Enhancing the interdisciplinary role of graduate groups and investing in high-priority program project or center grant proposals would be good intermediate steps. An alternative to consider is combining CBS with CA&ES. While the committee understands that this recommendation may be difficult politically, nevertheless, it is in the best interests of UCD to explore alternatives to the current organization as part of its university-wide strategic planning.
2. The campus should support a cluster hire program in areas targeted in the CBS Academic Plan (Evolutionary and Comparative Genomics, and Biological Networks/Systems Biology/Integrative Biology) together with human genetics.
3. The campus should revitalize plans for expansion of interdisciplinary research space to support emerging strength in neuroscience and other opportunistic areas (bioenergy).
4. New incentives should be developed to encourage faculty to increase grant submissions, especially targeting NIH Program Project grants and large center awards. These large grants require a solid base of individual grants for the participating investigators, which UCD has. Such incentives might include direct return of a significant fraction of ICR to the sponsoring center or PIs, salary incentives and named chairs for successful individuals and teams.
5. The College should improve its development efforts. With the large number of undergraduate and graduate students that have benefitted from its programs not just since CBS' inception but for several decades in predecessor departments, CBS must launch an aggressive development campaign that will allow it to raise its stature and ranking.

## **3.6 School of Veterinary Medicine**

### *History and Overview*

The School of Veterinary Medicine (SVM) at UCD was established in 1948 and is the only veterinary school in the University of California system. Its programs represent the convergence of animal health, environmental health and human health, reaching all

sectors of the state and impacting the lives of nearly every citizen of California. The SVMs mission is "...to serve the people of California by providing educational, research, clinical service, and public service programs of the highest quality to advance the health and care of animals, the health of the environment, public health, and contribute to the economy."<sup>90</sup> The School has the 4<sup>th</sup> largest class of DVM graduates in the nation.<sup>91</sup> and is among the largest programs in veterinary clinical and diagnostic medicine. Its faculty develops and deploys innovative programs to teach modern veterinary medical arts. The School has 300 faculty<sup>92</sup> (including clinical faculty) in six academic departments that deliver the veterinary curriculum, conduct biomedical research and perform service to the state through the Veterinary Medicine Teaching Hospital (VMTH) and diagnostic labs. Faculty in SVM participate in 29 different research and service centers on and off campus.<sup>93</sup> SVM's annual research budget is \$63M.<sup>94</sup>

The review team met with Dean Bennie I. Osburn, who has been in the Dean's position since 1999. Presentations were also made by several directors or co-directors of prominent institutes and centers housed within SVM, including Mouse Biology, the Comparative Cancer Center, Wildlife Health, and Regenerative Medicine. The 2008 Academic Plan for SVM<sup>95</sup> was used as source of information by the review team in evaluating the research goals of the unit.

### *Strengths*

1. Outstanding Faculty and Rankings. *U.S. News & World Report America's Best Graduate Schools* (2011 edition) ranks the SVM as #2 in the nation, tied with the veterinary school at Colorado State University. It has consistently been among the leading centers of veterinary research and education in the nation. The school has excellent research programs in virology, genetics, hematology, oncology, disease diagnostics, theriogenology, wildlife and ecosystem health, and food safety. The School has two members of the Institute of Medicine and one member of the U.S. National Academy of Sciences.<sup>96</sup> UCD ranks #1 nationally in Veterinary Sciences support from NIH, with \$28.6M in awards to the CVM and \$6.8M to the SOM for a total of \$35.4M in 2009.<sup>97</sup> The School also enjoys strong support from private

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<sup>90</sup> UCD School of Veterinary Medicine, *Academic Plan 2008* (undated), page 6 at <http://www.vetmed.ucdavis.edu/executive/AcademicPlan.pdf>

<sup>91</sup> IPEDS Completions Survey 2008 data accessed from NSF's WebCASPAR at <https://webcaspar.nsf.gov/>.

<sup>92</sup> UCD SVM "Facts" at <http://www.vetmed.ucdavis.edu/about/facts.cfm>. The review team notes however that this figure is not dated and that elsewhere on the SVM website (<http://www.vetmed.ucdavis.edu/about/distinctions.cfm>) the annual SVM research budget is reported as \$76M.

<sup>93</sup> Compiled from materials provided by the Dean during the review visit.

<sup>94</sup> UCD SVM "Facts" op. cit.

<sup>95</sup> At <http://www.vetmed.ucdavis.edu/executive/AcademicPlan.pdf>.

<sup>96</sup> UCD SVM "Distinctions" at <http://www.vetmed.ucdavis.edu/about/distinctions.cfm>.

<sup>97</sup> Data on NIH awards released April 2, 2010 and available through the University of Michigan's M-Stat system to review team member Gilbert Omenn, M.D. The raw data from which the M-Stat reports were compiled are available at <http://report.nih.gov/>.

donors, with more than \$52 million book value in endowment assets (third on campus after SOM and CA&ES).<sup>98</sup>

2. Large Federally-funded Institutes and Centers. A prominent feature of SVM research is the number of unique centers and institutes that bridge multiple colleges and disciplines: the Wildlife Health Center, Center for Comparative Medicine, Comparative Cancer Center, the Western Institute for Food Safety and Security, and the Mouse Biology Program stand out as excellent. The research conducted at SVM is international in scope as well as locally relevant to the health and well being of animals, humans and the environment. These centers leverage faculty and infrastructure in other colleges and universities in a manner that only a handful of veterinary schools have attained. The faculty is highly entrepreneurial while maintaining a focus on the highest standards of veterinary medical education.

### *Weaknesses*

1. Declining Relative Strength in Infectious Diseases. Research on infectious diseases has been an area of distinction at UCD for many years. During the past two decades, containment facilities for animal research have become antiquated, resulting in lost opportunities for SVM faculty, particularly in the area of biodefense. There is a critical need for level 3 and better access to level 4 containment facilities for large animals. The lack of such facilities may have critical consequences on California agriculture and human health in the event of an attack with a zoonotic pathogen.
2. Missing Synergies with the School of Medicine. The physical separation of SVM basic sciences faculty from SOM basic sciences in the Health Sciences District has a negative impact on competitiveness, particularly with regard to One Medicine research programs. Much greater integration between SOM and SVM is possible and should be coordinated at the campus level.
3. Obstacles Presented by Campus Research Administration. Specific concerns were raised regarding the difficulties in obtaining approval from Sponsored Programs for company-sponsored drug trials. These must be addressed for SVM to achieve its full potential in translational and comparative medicine.
4. Declining State Support for Core Activities. Although the financial reports supplied to the review team by UCD do not provide a transparent accounting of how state funds are deployed for research, it appears that nearly 40% of SVM's research expenditures in FY08-09 came from state sources.<sup>99</sup> An overreliance on state funding for research activities could have adverse consequences given the current budget climate in California.

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<sup>98</sup> Table 7a provided by UCD to review team prior to visit.

<sup>99</sup> Table 5b provided to review team by UCD prior to campus visit.

With the eroding state budget, SVM is also down considerably on faculty numbers. The School is authorized for 157 faculty positions but expects to have just 100 faculty FTEs in the 2010-2011 budget, which will be a reduction from 112 positions in 2009-2010.<sup>100</sup> Several areas of historical strength and current opportunity will be weakened, such as microbiology, pharmacology and structural biology.

### *Opportunities*

1. Campus-wide Interdisciplinary Activities. SVM is in a position of great strength to lead and to participate in cross college interdisciplinary centers and institutes. The most significant opportunity is in One Medicine – the interface of animal and human medicine. Impact of such programs would be on a local, national and global scale. One Medicine builds on a long tradition of excellence in comparative medicine at UCD. New faculty lines should be allocated from campus to specifically support this initiative. Also to be considered is the restructuring of several related centers and institutes under the One Medicine umbrella. Currently, the Veterinary Genetics Laboratory (VGL) serves largely as a service facility and does not add much value to cross-campus initiatives.

Stem cell biology and regenerative medicine is another obvious target for SVM to expand its cross campus activities. The new program in equine regenerative medicine is an example where large state resources going into the Center for Regenerative Medicine (CIRM) can be leveraged. It would be logical to include horse and other animal models, such as pig, in the UCD effort, and to concentrate these efforts in the new facility that is being built in the Medical District. An integrated program should include the Veterinary Genetics Laboratory (VGL), which has been serving largely as a service organization, and expanded interaction with the programs in SOM.

A high priority strategic initiative for SVM should be in the area of Biosecurity and Emerging Infectious Diseases. Although there are many activities and existing strengths, programs should be better integrated and tied with programs in SOM. With California leading the nation in agricultural cash receipts, SVM has the important responsibility of protecting animal agriculture from external threats. It is thus imperative that long term strategic planning with state, federal and local officials is supported internally.

### *Threats*

1. Improved Infrastructure at Competing Institutions. The most significant threat to SVM is the crisis in state funding. Further erosion will likely damage the research mission more than the teaching mission of the college. Federal Laboratories, such as the National Animal Diseases Center (Ames, Iowa) and other land-grant universities such as Colorado State University and Kansas State University, have marshaled the

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<sup>100</sup> Information provided to the review team by the Dean during his presentation on April 2, 2010.

resources to build large level 3 and level 4 containment facilities for working on animal pathogens. This leaves California vulnerable, with the vast expertise at SVM underutilized and underfunded. Very large funding streams go to these centers, to which talented scientists usually follow. UCD stands to lose many of its most talented researchers in infectious diseases to these centers where the work can be done more cost and time effectively.

2. Competing One Medicine Programs. The University of Pennsylvania and other universities with medical and veterinary schools have emerging One Medicine programs. The University of Pennsylvania has a trademarked “Many Species. One Medicine.” DVM-PhD. program. Unless SVM moves swiftly to establish equivalent programs with SOM, it risks being losing its traditional position of preeminence in comparative medicine.

### *Recommendations*

1. A strategic plan for One Medicine should be developed with SOM. The plan should include stem cell biology, regenerative medicine and genomics/genetics.
2. Merge or better integrate VGL with the Genome Center. This would greatly strengthen both units, improve efficiency and enhance programs in mammalian genomics, which are critical to the success of the emerging initiatives in One Medicine.
3. Develop a strategic plan for Biosecurity and Emerging Pathogens that includes infrastructure, faculty hires, program support, disaster preparedness and outreach. The targets of the plan should be the state legislature and the Governor.
4. The school should strengthen efforts to increase its endowment. Given its size and impact, SVM should set a goal of doubling its endowment in 2-3 years.
5. Establish a high level committee including SOM faculty to deal with the problem of company-sponsored clinical trials (both human and animal).

## **3.7 Faculty and Students**

### *Faculty*

As mentioned a number of times in this report, the faculty at UCD have a culture of collaboration, which is well suited to their research strengths, which lie in cross-disciplinary problem-solving arenas, particularly related to biological and environmental problems.

Given that the number of new hires at UCD, as throughout the UC system, will be quite limited over the next 5-10 years, it might be difficult for UCD to improve its faculty

quality in the traditional basic research or engineering areas. Instead, UCD has a unique opportunity within the UC system, and indeed nationally, to engage some of its top faculty from the traditional areas to partner with the top tier departments and schools in creating cross-disciplinary teams focused on key challenges in research. The collegial culture at UCD, with low barriers to collaboration between departments, is a great strength for this strategic approach.

This same tactic can be used to bring more strength in physics, chemistry, mathematics, and statistics to fundamental research in SOM. The same can be said by drawing on faculty from the economics, psychology, sociology, and political science departments to engage on the rapid changes in medical policy, behavioral modification in the move to personalized medicine and wellness, and the needed reforms to take practical advantage of UCD's great strength in telemedicine. Such an emphasis on problem-solving is quite different from the traditional research university focus on basic research, but given the relative strengths of the UCD faculty noted above, it provides a path forward for increasing UCD's national rank with very restricted new hires.

UCD's standing in interdisciplinary research approaches is confirmed by a recent NSF analysis<sup>101</sup> which puts UCD in 11<sup>th</sup> place among institutions with doctoral recipients reporting two or more research fields as part of their dissertation work. Only three other UC institutions are among the top fifty institutions on this important measure, all them ranked below 40.

For this cross-disciplinary approach to produce increased federal, state, and non-profit grants, UCD must move expediently to remove the institutional barriers that so many of the faculty complained about: the Research Office must be reworked to provide nimble services for larger grant requests; space for the execution of multi-departmental grants needs to be made available; faculty rewards must recognize contributions to team work and not just single paper authorship; and bookkeeping methods must be developed that allow grants to be partially counted by all the departments and schools involved. While these reforms will take time, the sooner UCD can put them in place, the sooner the faculty will begin to take advantage of this novel approach to excellence.

#### Recommendation:

- Stress interdisciplinary approaches in key research areas and use interdisciplinary teams to staff programs.

#### *Students*

Undergraduate Students: Due to time constraints, the planned meeting with undergraduate students was cancelled so direct feedback on the undergraduate experience, particularly related to research, could not be evaluated. No metrics were

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<sup>101</sup> National Science Foundation, *Interdisciplinary Dissertation Research*, Arlington, VA, InfoBrief NSF 10-316 (March 2010), Table 3, page 4.

provided to assess the number, types and quality of undergraduate research programs at UCD. With more than 24,000 students (98% in the top 10% of their high school graduating class<sup>102</sup>), the campus has a large, diverse and talented population of undergraduate students to educate and draw upon for research activities. The potential for interdisciplinary and field experiences for undergraduates is probably among the best in California. Therefore, coordinated programs and scholarships for undergraduate research should be supported and encouraged.

Graduate Students: There are more than 6,000 graduate students<sup>103</sup> enrolled in 87 graduate programs across campus.<sup>104</sup>

Graduate students at UCD come from ethnically diverse backgrounds, with the largest fraction (45%) being Caucasian.<sup>105</sup> Trends in ethnic composition have been relatively stable over the past five years, with an increasing percentage of Chinese, Korean and East Indian students enrolled, consistent with national trends. International enrollments are at ~16%, with large proportions in COE (38%) and MPS (25%) and relatively low numbers in SOM (1.7%) and SVM (7.3).<sup>106</sup> Many programs graduate very small numbers of students each year, reflecting the number and diversity of the graduate degree programs at UCD. There appears to be a significant need to review and consolidate the number of graduate groups to lighten workload and overhead.

The review team met over lunch with a group of six female graduate students representing different disciplines and programs on campus. Several of them were elected representatives of graduate student organizations. All students the review team met were interested in academic careers. These students were uniformly positive about their experiences, although several concerns were raised.

The issue of “principal investigator vs. mentor” was of particular concern. While all felt their advisors are good PIs, many expressed that mentoring capabilities or interest in mentoring was inadequate. The affected students felt that their PIs were simply too busy and could only afford the time to go over data. These students were concerned about discussing career options and accessing networks that would lead to good positions after graduation. The university should recognize these troubling comments and consider expanding mentorship training programs for faculty to address these concerns.

One student who worked at the Primate Center was concerned about personal safety issues. This problem is endemic at UCD because of the large number of research projects involving animals. Training programs for all students involved with animal research are

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<sup>102</sup> *U.S. News and World Report America's Best Colleges*, 2010 edition.

<sup>103</sup> 2008-2009 data from Table 3a (graduate enrollment) provided by UCD to the review team prior to the campus visit.

<sup>104</sup> UCD website at <http://facts.ucdavis.edu/distinctions.lasso>.

<sup>105</sup> 2008-2009 data from Table 3b (graduate students by gender and ethnicity) provided by UCD to the review team prior to the campus visit.

<sup>106</sup> 2008-2009 data from Table 3c (graduate students by citizenship) provided by UCD to the review team prior to the campus visit.

strongly encouraged if these are not mandatory today. These programs should include appropriate training in personal safety and how to deal with animal rights activists.

Another concern was the large number of graduate programs and graduate groups. Several students felt very confused by the number of graduate groups and how they were related. Although the review team felt that overall the graduate group concept is nimble and creates flexible options for interdepartmental research, more could be done to provide students with updated information on graduate groups, with appropriate metrics.

Recommendations:

- Consider expanding mentorship training programs for faculty.
- Provide students with more updated information on graduate groups with appropriate metrics.
- Provide for regular review of graduate groups to ensure that they operate properly and fill an important function.

#### **4. COMMENTS ON SELECTED ISSUES**

##### **4.1 Interdisciplinary Research**

Because many peer institutions have as strong or stronger disciplinary departments as UCD, one competitive advantage can be supporting interdisciplinary research, particularly as many of the major funding agencies are putting larger grant opportunities in the interdisciplinary arena. Essentially, UCD can excel in the Pasteur Quadrant sense of emphasizing “use-inspired basic research.” Fortunately, UCD with its strong collaborative culture is well-prepared to take advantage of these growing opportunities and has done so in a number of instances, engineering specifically. We heard repeatedly from each group we talked to how collegial UCD is and how easy it is to strike up interdisciplinary teams. In fact, several times we heard UCD “has the best interdisciplinary culture anywhere in the U.S.” Perhaps one source of this culture is in the historical problem solving focus of UCD. Because UCD grew out of an agricultural experiment station, involvement with the greater agricultural community on identifying practical problems and then setting out to use research to solve these real world problems naturally leads to an interdisciplinary team approach. One important representation of this culture is that the Deans meet as a group to decide on cost sharing for proposals, a very unusual process, but one with highly leveraged outcome.

While a number of impressive examples of interdisciplinary successes were described, there were some areas that seemed underdeveloped. NIH has emphasized that radical advances will be made at the intersection of medical sciences with physical, chemical, and mathematical sciences. Yet we heard that there was less collaboration between the

SOM and CL&S than is needed to take advantage of funding opportunities. Similar statements could be made about lost opportunities between the physical and biological sciences. Perhaps most surprising was the statement that the SOM had little interaction with the Genome Center, since there seems to be a lack of human genome specialists. It seems likely that as in other research institutions, some of these barriers could have arisen historically as scientific ideology or personality disputes. Leadership from the Chancellor's office is needed to encourage these important new areas of collaboration, so that UCD can realize the promise of such interdisciplinary collaboration.

However, there are other barriers we heard about repeatedly that are not driven by personalities or divergent scientific points-of-view, but rather unnecessary self-constructed administrative barriers, which limit the ability of the faculty to take advantage of UCD's collaborative cultural advantage. These have been discussed elsewhere in this report as have the cultural problems and the need for a PR campaign.

If interdisciplinary high-quality research becomes part of the strategic planning process, then this can feed directly into a public relations campaign. Furthermore, the Chancellor needs to speak frequently about "getting beyond your comfort zone," and exerting leadership, since these don't seem part of the core culture.

#### **4.2 ORUs, Centers, and Institutes**

As is the case in many research universities, ORUs, centers, and institutes have flourished at UCD. In talk after talk we saw lists of them, with some under the VCR and some under Deans. In spite of repeated questioning by the review team no clear logical structure emerged defining the rules for formation or review of such units. We are familiar with the UC ORU concept—this seems to have a well defined review process. However, many of the other centers and institutes seem to be more ad hoc and outside of the ORU rules. Our concern is not to make UCD more strictly bureaucratic and rule-bound, but rather to ensure there is an appropriate review process to assure high quality and relevancy in all of these non-departmental entities.

A number of these institutes or centers seem to be quite strong. The Institute for Transportation Studies (ITS) holds its own or perhaps exceeds its counterparts at Berkeley and Irvine. It has a strong plug-in vehicle center, which is going to be a critical growth area. The Energy Efficiency Center has almost unlimited potential. U.S. buildings account for 40% of our greenhouse gas emissions from electrification, heating/cooling, and lighting. There is a cooling and lighting area of focus within this Center. The new Energy Institute seemed a little more problematic. It does not have a building in which to consolidate all the diverse research and seems a bit more like a "naming convention," that is a pulling together, under one name, a set of activities that don't have synergy. This needs to be looked at by UCD more closely given the potential upside of doing it right and given the long history of energy research at Davis.

From what we were told, a number of these constructs have a continuing fiscal obligation from the campus. We believe it would be useful to have a clear delineation between permanently funded entities and those which would have a finite lifetime with a clear sun setting. Although termination of campus funding can be challenging to these entities, clear sun setting rules encourage entrepreneurship to raise the funds necessary for continuation of the research activities. It also frees up funds from the campus that can be used to start new entities when opportunities arise. We were told that the VCR has closed down 2-3 ORUs, which is perhaps more than other UC campuses, so this is a good precedent which needs to be repeated.

Finally, an important issue for raising the rankings of UCD is that the grants generated by faculty who put their grants through the centers need to be counted in the home departments of the PI and co-PIs. The centers do nothing to raise the rankings, but they can detract from the rankings the department or school would otherwise get. This can be done without double counting if the grant is reported through the appropriate department, but the center gets credit for it as well, but without double counting the dollars.

### **4.3 Industry Relations**

Based on our discussions on the campus and review of background materials, it appears that UCD is a latecomer to establishing a positive relationship with industry. While there are two groups in OVCR concerned with technology transfer, namely “Innovation Access” and “Technology Innovation Alliances,” we did not get the impression that UCD has taken this general subject of intellectual property rights (IPR) and technology transfer (TT) very seriously. A task force has been established at UCD to examine this issue. Since their report is not yet available, we want to outline here what we consider to be issues to keep in mind.

The organization responsible for this area of industry relations needs to include:

- Technology transfer and commercialization
- Intellectual property administration and licensing
- Patent portfolio and invention disclosures / evaluations
- Research contracts with industry
- Industrial affiliate programs
- Policies governing the conduct of the above activities and the pursuit of opportunities in these areas
- Incubator or Research Park (if in existence or planned)

The scope of these activities involves extensive and complex issues. It is proper that this function reports to the VCR and not to the Chancellor or other point of contact. It also needs to have close working relations with departments and faculty.

These units can be titled “Office of Intellectual Property, Technology Transfer and New Ventures,” “Division of Technology Transfer,” “Intellectual Liaison Program” or other

names indicating their function. Good examples of effective organizations that we are familiar with are found at MIT, RPI, Northeastern University, and the University of Wisconsin.

It is important to have staff in the unit who are familiar with industry, not just academia, and who have a background in the subject matters that are part of the function of such an office. Moreover, the leader of this activity should be an experienced senior manager with previous experience in the functions listed above.

Operating an effective unit is expensive and it is important that the organization become self-supporting in a short time period to keep control over this expenditure. We assume that the UC System has some involvement with and strictures applicable to these functions, which could add other complexities.

#### **4.4 Information Technology**

One of the defining characteristics of 21<sup>st</sup> century research is a fundamental transformation from analog to digital methodologies. This historic transition could only be happening now because of the vast exponential global growth during the 1990s of PCs, servers, visualization, Internet, and Web. The “second wave” of this digital revolution is now taking place as virtually all scientific instruments have gone digital and so their data generation capabilities are exponentially increasing. A simple example illustrates why this phenomenon is critical for a life sciences campus like UCD. Only ten years ago it cost over a \$1B to sequence the first human genome. This year several companies will offer services for sequencing that same genome for \$10,000, heading to \$1,000! This means that virtually every species of animal and microbe will be sequenced over the next decade, completely restructuring animal, plant, and human health sciences. Indeed, in almost every discussion the review team had during its three days at UCD, we heard researchers discuss how their research was “going digital,” particularly in the biomedical, agricultural, and environmental sciences, but also in the humanities and arts.

This has a profound implication for infrastructure strategic planning and funding at all research institutions. Because academic research is becoming digital in nearly all disciplines, there is the need for a universal campus-wide digital infrastructure. The first phase of this was the build-out of the Internet across the campus, linking up all the desktops, laptops, servers, and the increasing number of mobile wireless devices. This shared digital infrastructure is optimized for megabyte-sized objects and provides excellent support for much of the routine communication, web browsing, and social network activities of UCD’s faculty, staff, and students.

However, as we heard from a number of faculty, today’s scientific instruments produce data with volumes in gigabytes to terabytes, 1000 to one million times larger than the megabyte sized objects the shared internet is engineered to support. Thus many campuses are rapidly planning for and building out a separate campus-wide cyberinfrastructure to support their data-intensive researchers – let us call it a research

cyberinfrastructure (RCI).<sup>107</sup> We were told that many of the older UCD buildings still have 10 Mbps wiring. It takes ten days to move a terabyte file over a network with that speed – no one will do it! In contrast, a number of UCD’s peer campuses have a separate 10 Gigabits/sec (Gbps) fiber optic data network. Over such dedicated channels the same terabyte file can be moved in ten minutes. For instance, UCSD has a switched 10Gbps optical network with over 60 links, connecting to centralized cluster condominiums and shared petabyte rotating storage.

We were told by the UCD CIO that UCD has had a good fiber infrastructure underground for over a decade, although many buildings do not have fiber from the “manhole” to the labs in the building – thereby underutilizing the transmission capability of the campus-wide fiber. Thus there are very few, perhaps none, of the faculty who have optical fiber connections directly from their lab, across the campus, and onto the CENIC (Corporation for Education Network Initiatives in California) network to access state, national, or international data-intensive assets at 10Gbps. This is in spite of over three years of internal planning and external consulting about how to build-out a world-class RCI.

Without the RCI, data generated locally is essentially “imprisoned” where it is produced. For instance, next generation gene sequencers, many of which are already in use at UCD, can produce a terabyte of data per run, in less than a day. If it takes ten days to transmit the terabyte of data over slow shared Internet, then it just “piles up” locally, with faculty having to spend precious research funds on sub-optimal local storage, which is often not backed up.

We were told by faculty some of the ways in which the lack of adequate bandwidth hampers UCD researchers:

- Because older buildings are concentrated within CA&ES, this has increased costs by not being able to do GIS work on a shared facility, and instead requiring additional licenses of expensive software.
- It has hampered the ability of the campus to provide web services where the campus is a leader in the emerging field of environmental informatics.
- Many faculty have been reluctant to move their computing to more central clusters because of the lack of bandwidth—resulting in 50 scattered clusters on campus, driving higher electrical bills, which the central campus pays.
- Efficient backups and security updates of desktop machines require sufficient bandwidth.

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<sup>107</sup> For instance, see the study being implemented at UCSD at [research.ucsd.edu/documents/rcidt/RCIDTReportFinal2009.pdf](http://research.ucsd.edu/documents/rcidt/RCIDTReportFinal2009.pdf)

We discussed whether in a cost-constrained environment it would work to just pull fibers or gigE cables to individual offices. However, we were told that it is much better to uniformly outfit the building since faculty move, new faculty are hired, new labs spring up, and students and staff who work with the data-intensive faculty are spread all over the building – as are the data generating instruments.

In contrast, once the data-intensive RCI is in place and data can flow freely, interdisciplinary research is much more possible, particularly in the life sciences which dominate UCD. Given the complexity of dynamic biological systems, competing effectively today requires the integration of genomic, proteomic, cell network, etc. datasets to yield understanding. This is critical in the areas of plant and animal sciences in which UCD excels, as well as in the emerging digital health sciences. Another level of collaboration that could be activated is a 10Gbps optical link between UCD, UCB, and UCSD via a CITRIS/Calit2 telepresence linkup. This would enable a whole new level of collaboration between North and South California. Security is important in this more free-flowing data world, but UCD has a strong computer science department in security and they should be asked to help suggest innovative security protocols to provide data security.

It appears that the primary bottleneck is the funding issue – that the CIO office does not have the money to support a modern data-intensive RCI. Yet this is just another way of saying that the campus has not made a commitment to providing its faculty, staff, and students the “fifth utility – a data utility” the way it provides water/sewage, electricity, telephone, and shared Internet utilities.

A few highly ranked UCD programs, for example the informatics programs in CA&ES, have, in fact, been relatively successful in securing extramural funding supporting partnership activities (over \$6 million/year in GIS and remote sensing alone<sup>108</sup>), but they operate primarily on soft money. Thus, the faculty stated several times that any funding model for the RCI either needs to draw from central funds, or properly draw upon indirect costs.

We were impressed by the understanding of these issues by the UCD CIO, Pete Siegel, who has had experience at both the NSF Supercomputer Centers and UIUC, a large Midwestern research university that is also a land-grant university. As an example of Siegel’s innovation approach, the lack of a substantial modern machine room at UCD has led him to investigate the feasibility of outsourcing the housing of many of the UCD computers and storage to machine rooms elsewhere in the UC system (such as SDSC at UCSD). It is our belief that these UCD plans are among the most aggressive UC-wide outsourcing planning exhibited by any UC campus. Again, however, implementation of such plans requires that an RCI be established on the UCD campus so that access times to remote IT resources are similar to what they are with the machines locally housed. A

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<sup>108</sup> Data provided by Allan Hastings, faculty member in CA&ES.

good sign was that Siegel seems to be working well with the CIO of SOM, which bodes well for developing a strong digital medicine program at UCD.

Another advantage is the historically close relationship that UCD has had with the Lawrence Livermore National Laboratory (LLNL). Expanding opportunities for closer collaboration between UCD and LLNL will create a win-win situation, particularly as the DOE greatly increases its funding of “green” technologies. With a proper campus RCI, the unclassified LLNL computer facilities will appear to be on the UCD campus, greatly expanding computational science and engineering opportunities for UCD faculty, staff, and students. These could amplify the interdisciplinary teaming the UCD is well positioned to exploit.

Finally, we should point out that the UCD's computer graphics research is very well known and highly regarded in the visualization community. UCD's computer science department ranks 39<sup>th</sup> in the *U.S. News* (2011 edition) graduate school rankings. However, we believe the computer graphics research group would rank much higher if computer graphics were separately rated. The unit at UCD is, in our view, as impressive as their counterpart at the University of Utah, which we consider one of the top graphics research units in the country. This group's basic research is augmented by the Keck Cave, UCD's virtual reality environment located in the geology department. Computer graphics, visualization, and virtual reality are key components of a campus RCI and this UCD strength would be greatly leveraged by an RCI, so that large data sets could flow freely between the application investigators and the visualization faculty and staff.

#### 4.5 Indirect Cost Recovery (ICR)<sup>109</sup>

Indirect cost recovery (ICR) is the subject of comments by faculty and management alike. ICR and its allocation has evolved into a complex system that is not well understood and raises questions and comments that are not well informed.

Much of the dissatisfaction and confusion stems from discrepancies between (a) actual indirect costs incurred and those recovered; (b) negotiated and effective ICR rates; and, (c) ICR amounts recovered from funders of UDC research grants and those returned to the campus and to various UCD units.

The large direct cost amount and what might be expected as the ICR amount generated from this base is in fact whittled down to much smaller amounts by the details of the ICR generation and allocation process as illustrated in a simplified description of the process and the results for 2008-2009:

1. The negotiated ICR rate with DHHS in accordance with OMB guidelines for the campus is 53% (indirect costs/direct costs), going to 54% in 2013. Although this rate is well-known to researchers at UCD, what is not as apparent is the fact that

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<sup>109</sup> Information in this section is taken from *Research Indirect Costs – Fall 2009 Update*, UC Davis Office of Research Management & Planning, Budget Resource Management (Fall 2009).

not all costs are eligible for recovery at this rate and this rate is not applicable to all research grants. For example, USDA does not recognize the negotiated federal rate, neither does the state, and private sector funders many times ask for and receive relief from funding indirect costs from program officers.

2. After accounting for the differences noted in the paragraph above, the actual indirect cost recovery rate is lower than the negotiated rate. ICR is tracked based on the research sponsor and for 2008-2009 the effective recovery rates and amounts were:

<b>Sponsor Category</b>	<b>Direct Costs</b>	<b>Indirect Costs Recovered</b>	<b>Effective ICR Rate</b>
Federal	\$256M	\$71M	28%
Private and Local	\$101M	\$21M	21%
State	<u>\$ 65M</u>	<u>\$ 6M</u>	9%
<b>TOTAL</b>	<b>\$422M</b>	<b>\$98M</b>	<b>23%</b>

3. Of the total indirect costs recovered as a result of UCD research activity, 25% is retained at the UC system level, reducing the effective recovery rate at the campus level to 17% (\$74M on direct costs of \$422M).
4. The campus in turn allocates the indirect cost dollars it controls to five general areas budgeted for 2009-2010 as follows:

Research Programs / Administration	33%	\$24M
Capital and Debt	43%	\$32M
Graduate Support	10%	\$ 7M
Faculty Recruitment	14%	\$10M
Academic Outreach	1%	\$ 1M

5. Allocations under Research Programs / Administration include returns to deans and chairs. The budgeted use of ICR funds for 2009-2010 includes a return to academic departments of 7-8% of the amount generated by federal research and 15-17% of the amount generated by private research, totaling 7-11% of the total campus ICR. Returns to PI's through research match and bridge programs and faculty research grants total 6% of campus ICR.

The false notion some faculty and others have is that the 53% federal rate applies to the totality of research awards and should result in a more substantial allocation of funds to the department and researcher.

It is important that the Blue Ribbon Committee on Research critique the present allocation scheme, which was implemented in large part in 1999, and offer suggestions

for improvement. UCD together with other UC universities should also seek relief from the system cut and take on in return some of the cost burden the system carries for the campus. Local control is more effective and trustworthy than imposed taxes from a higher level.

Making faculty aware of the complexity of the system in turn would reduce fruitless and endless debates. The idea that ICR is a black box needs to be counteracted by open discussions and education on the subject.

## **Appendix 1**

### **Charge to the Review Team**

#### **Research Assessment University of California, Davis**

Consultant will serve as a member of the team conducting an external review of the research and education programs at the University of California, Davis. The review will be conducted on campus over a period of three days and will provide an opportunity to review the relevant programs and meet with relevant faculty and academic leadership. Each member of the review team will contribute to verbal feedback during the visit and prepare written input following the visit. Background materials on the university will be sent to the team for review prior to the campus visit as made available by UC Davis. The review is currently scheduled to be conducted March 31 through April 2, 2009 with a dinner with the Chancellor scheduled for March 30, 2010.

This outside review of UC Davis and the WAG report will supplement the findings and proposed actions of an internal Blue Ribbon Committee, established in December 2009 by the Chancellor, to give advice how Davis can “focus and significantly grow its research enterprise.” The to-date activities of the Blue Ribbon Committee will be discussed in one of the review sessions during our visit.

The areas specifically scheduled for the The Washington Advisory Group review are:

- Engineering
- Geo- and physical sciences
- Life and medical sciences
- Social sciences
- Agriculture
- Veterinary science
- Computer and computational sciences, and
- Humanities

The review is designed to assess

- UC Davis’ strengths and weaknesses in the above areas,
- Goals, strategies and priorities
- Available resources, especially in faculty and researchers, space and equipment
- Competitiveness to peer institutions
- Administrative support
- Quality of educational mission
- Relations with funding sources

In preparation for the review team’s fact-finding visit on campus, members will review information provided by UC Davis, which should include existing strategic plans, organizational charts, information on education and research programs, sources and trends in research funding, enrollments, faculty numbers by department and

percentages engaged in research, numbers and distribution of graduate students, faculty recruiting plans, and technology transfer and economic development data.

The Research Assessment site visit will be conducted by a team of five experts under the leadership of Erich Bloch. In addition to Erich Bloch and Frank Press, the team will include experts in the medical/life sciences, animal sciences, and computer/computational sciences.

A report will be prepared at the conclusion of the visit documenting the review team's assessment, conclusions and recommendations in the 8 review areas defined above.

## Appendix 2 Agenda for Site Visit

Date	Brkfst	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	Evening
Tuesday March 30, 2010											6:30 pm Dinner at the Chancellor's Residence
Wednesday March 31, 2010 (all mtgs in Mrak 203) Room will remain open until 6 pm		<b>7-9</b> Mrak 203 <b>Provost Enrique Lavernia; Barbara Horwitz-VP Acad Pers; Kelly Ratliff-AVC Budget Rsch Mgmt</b>	Mrak 203 <b>VC Barry Klein-Office of Research; Asso VC Bernd Hamann; Assist VC Leslye Hays; Exec Dr Ahmad Hakim-Elahi; Exec Dir InnovationAccess David McGee; Dir Inst Review Bd Eric Mah; Dir Ca Nat'l Primate Res Dallas Hyde; Dir Inst of Trans Stud Dan Sperling; Dir Energy Inst Bryan Jenkins; Chief Sci Off Ctr for BST Steve Lane; Dri J Muir Inst Mark Schwartz; Exec Dir Anne Moyer</b>	Mrak 203 <b>Dean Jessie Ann Owens-Humanities/Art/Cult; Asso Prof Am Studies Carolyn de la Pena; Co-Dir CA Light Tech Ctr Kosta Papamichae</b>	Mrak 203 <b>Lunch with Grad Studs*</b>	Mrak 203 <b>Dean Winston Ko-Math &amp; Phy Sci; Fac Assist/Res &amp; Grad Prgs Susan Kauzlarich; Dist Prof Physics Tony Tyson</b>	Mrak 203 <b>VC John Meyer-Admin &amp; Resource Managmt; Stan Nosek-Leader/APRI; Jill Blackwelder Parker-AVC Safety Srv; Mike Allred-Acct &amp; Fin Srv</b>				

Date	Brkfst	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	Evening
Thursday April 1 2010 (pm in 203) Room will remain open until 6 pm	7:20 am van pu for Sac ■	Ed Bldg, 4610 X St, Sacto Rm # 3103 <b>VC / Dean Clair Pomeroy-Medicine with Fred Meyers-Exec Assoc Dean; Thomas Nesbitt- AVC-Strat Tech &amp; Alliances; Heather Young-AVC &amp; Dean, Nursing (8-10 only)</b>				12:10 van pu for Mrak ■	Mrak 203 Lunch	Mrak 203 <b>Dean Van Alfen-Ag &amp; Environ Sci; Andrew Waterhouse-Ch-Viti &amp; Enol' Luiz Guarnizo-Ch-Hum &amp; Comm Deve; Anita Oberbauer-Anim Sci; Deborah Golino-Found Plt Sci; Pam Ronald-Plt Path; Beth Mitchum-Plt Sci</b>	Mrak 203 <b>Dean Bruce White-Engineering with Prasant Mohapatra-Ch-Comp Sci; Kyriacos Athanasiou-Ch- Biomed Eng; Karen McDonald-Asso Dean-Rsch &amp; GS; Bruce Hartsough- Assoc Dean-Acad Pers &amp; Plan; Michel Fulton-Asst Dean Admin/Fin</b>		
Friday April 2, 2010 (all mtgs in Mrak 203)		Mrak 203 <b>Mt with Sr faculty &amp; Dept heads**</b>	Mrak 203 <b>Dean Ron Mangun-Soc Sci &amp; Human</b>	Mrak 203 <b>Dean Ken Burtis-Bio Sci</b>	Mrak 203 <b>Mt with newly hired***</b>	Mrak 203 Lunch	Mrak 203 <b>Meet with Chancellor Katehi</b>	Mrak 203 <b>Dean Bennie Osburn-Veterinarian Med; Rob Atwill-Dir W Instit Food Safety; Xinbin Chin- Dir Compar Cancer Ctr; Kent Lloyd-DirAssoc Dean Res &amp; Grad Ed; Jonna Mazet-Co-Dir Wildlife Health Ctr; Clare Yellowley-Co-Invest Regen Med Lab</b>	Mrak 203 <b>Andy Hargadon -Hd of Tech Transfer; Steve Currall-Grd Schl Man</b>		

- \* Wed, March 31 12-1 Lunch with Graduate Students: Graduate Student Association Leadership: Malaika Singleton, Chair; Marrah Lachowicz, External Chair; Abbie Boggs, Graduate Student, Assistant to the Dean **Postdoctoral Scholars Association Leadership:** Eliza Bliss-Moreau, Ph.D., Chair - Psych/ Behavioral Sci; Sevinc Sengor, Ph.D., Vice-Chair - Civil & Environ Engin; Anke Schennink, Ph.D., Secretary/Treasurer - Animal Sci
- \*\* Fri, April 2 8-9 Meeting with Sr Faculty and Dept Heads: Robert Huckfeldt-Dist Prof Poli Sci; Alan M. Taylor-Prof Econ; Richard McElreath, Asso Prof Anthropology; Craig Tracy, Mathematics; Alan Hastings-Environ Sci; Ralph de Vere White - Assist Dean, Cancer Ctr Prog; David Amaral - Prof Psychiatry & Beh Sci; Bahram Ravani-Mech & Aero Engin ; Katherine Ferrara-Biomend Engin ; Neville Luhmann-Applied & Elect/Comput Engin; Hegher Watenpaugh-Hist; Martha Macri-Nat Am Stud; Robert Irwin- Span & Classics ; Gino Cortopassi, Physiological Chemistry; Bart Weimer, Food Microbiology / Pop Health & Repro; Warren Pickett-Physics
- \*\*\* Fri, April 2 11-12 Meeting with Newly Hired Faculty: Susan Rivera-asso Prof Psych/MIND ; Charan Ranganath- Prof Psych/Neuroscience; Annelies Franz-Chemistry; Ben Houlton-Lnd/Air/Water Resources; Maria Marco-Food Sci & Tech; Liz Miller - Assist Prof Pediatrics; Kim McAllister – Assoc Prof Ctr for Neuroscience; Julie Schweitzer - Asso Prof, Clinical Psychiatry; Carl Whithaus -Un Writing Prog; Beth Rose Middleton-Native Am Stud; Dori Borjesson- Diagnostic Clinical Pathology; Pam Lein- Neurotox/Mole Biosci (leaving at 11:45); Jan Nolta-UCDHS Hematol & Oncol (Sr faculty member)

### **Appendix 3**

#### **The Washington Advisory Group Team**

##### **Erich Bloch**

##### **Director, The Washington Advisory Group, an LECG Company**

The Honorable Erich Bloch advises on corporate R&D management and strategic planning for academically based research enterprises and other not-for-profit organizations. He is the Distinguished Fellow at the Council on Competitiveness, and recently served as a member of the President's Council of Advisors on Science and Technology (PCAST).

As Director of the National Science Foundation (NSF) from 1984–1990, Mr. Bloch oversaw the Foundation's \$3 billion annual budget and the award of 12,000–14,000 research grants in natural, physical, and social sciences, education, and engineering.

Previously, Mr. Bloch was IBM Corporate Vice President for Technical Personnel Development. His earlier work at IBM included Engineering Manager of the Stretch supercomputer system, head of the Solid Logic Technology Program, Vice President of the Data Systems Division, and General Manager of the East Fishkill development and manufacturing facility.

Mr. Bloch was awarded the National Medal of Technology for his role in the IBM System 360 “developments that revolutionized the computer industry” and is a recipient of the IEEE Founders Medal and NSF's Vannevar Bush Award, and the National Academy of engineering's Arthur M. Bueche Award. He is a member of the U.S. National Academy of Engineering, the Swedish Academy of Engineering Sciences, a Fellow of IEEE, and a foreign member of the Engineering Academy of Japan. He serves on several boards and a variety of non-profit advisory boards.

Mr. Bloch received his education in electrical engineering at the Federal Polytechnic Institute of Zurich and earned a Bachelor of Science degree in electrical engineering from the University of Buffalo.

**Frank Press**  
**Director, The Washington Advisory Group, an LECG Company**

The Honorable Frank Press advises on R&D strategic planning; management and research scenarios for new undertakings in industry and academia; and international research opportunities.

Dr. Press was President of the U.S. National Academy of Sciences and Chairman of the National Research Council from 1981 to 1993 and Science Advisor to the President of the United States and Director, Office of Science and Technology Policy from 1977 to 1980. Prior to that, he was Professor of Geophysics at the Massachusetts Institute of Technology and Chairman of the Department of Earth and Planetary Sciences. Dr. Press was also Professor of Geophysics at the California Institute of Technology and Director, Seismological Laboratory. He is a Life Member of the Corporation of MIT and Board Member of the Woods Hole Oceanographic Institution, the Marine Biological Laboratory, and the Monterey Bay Aquarium Research Institute. He is a Director of a medical diagnostic device company. He was the Cecil and Ida Green Senior Fellow at the Carnegie Institution of Washington from 1993-1997. Since 1993, he has been a visiting Professor at Cornell, Caltech, Stanford, and Indiana universities.

Dr. Press has been elected to fellowship in the American Academy of Arts and Sciences, the Royal Astronomical Society, the Royal Society (London), the Russian Academy of Sciences, and the Academie des Sciences (France). He is the recipient of 30 honorary degrees. Among his awards are the U.S. National Medal of Sciences, the Vannevar Bush Award, and the Pupin Medal from Columbia University. Dr. Press received the Japan Prize from the Emperor in 1993. He was awarded the “great gold” Lomonosov medal, the highest award of the Russian Academy of Sciences.

Dr. Press earned a B.S. from the City College of New York, and a M.A. and Ph.D. from Columbia University.

**Gilbert S. Omenn**

**Affiliate, The Washington Advisory Group, an LECG company**

Dr. Gilbert S. Omenn advises on biomedical research and academic health center projects in the public and private sectors and will focus on the medical and biological sciences.

Dr. Omenn is Professor of Internal Medicine, Human Genetics, Bioinformatics and Public Health at the University of Michigan (UM) and Director of the UM Center for Computational Medicine and Bioinformatics. He served as Executive Vice President for Medical Affairs and as Chief Executive Officer of the University of Michigan Health System from 1997 to 2002. He was formerly Dean of the School of Public Health, and Professor of Medicine and Environmental Health, University of Washington, Seattle. His research interests include cancer proteomics, chemoprevention of cancers, public health genetics, science-based risk analysis, and health policy. He was principal investigator of the beta-Carotene and Retinol Efficacy Trial (CARET) of preventive agents against lung cancer and heart disease; director of the Center for Health Promotion in Older Adults; and creator of a university-wide initiative on Public Health Genetics in Ethical, Legal, and Policy Context while at the University of Washington and Fred Hutchinson Cancer Research Center. He served as Associate Director, Office of Science and Technology Policy, and Associate Director, Office of Management and Budget, in the Executive Office of the President in the Carter Administration. He is a longtime director of Amgen Inc. He is a member of the Council and leader of the Plasma Proteome Project for the international Human Proteome Organization, and served as President of the American Association for the Advancement of Science (AAAS) in 2005-2006.

Dr. Omenn is the author of 473 research papers and scientific reviews and author/editor of 18 books. He is a member of the Institute of Medicine of the National Academy of Sciences, the American Academy of Arts and Sciences, the Association of American Physicians, and the American College of Physicians. He chaired the presidential/congressional Commission on Risk Assessment and Risk Management (“Omenn Commission”), served on the National Commission on the Environment, and chaired the NAS/NRC/IOM Committee on Science, Engineering and Public Policy. He served on the University of California President’s Council for oversight of the UC-managed National Laboratories in the 1990s. He received the John W. Gardner Legacy of Leadership Award from the White House Fellows Association in 2004 and the Walsh McDermott Medal from the Institute of Medicine in 2008.

He is active in cultural and educational organizations, and is a musician and tennis player. Omenn received his B.A. from Princeton, the M.D., magna cum laude, from Harvard Medical School, and a Ph.D. in genetics from the University of Washington.

**Harris A. Lewin, Ph.D.**

**Professor of Immunogenetics, Gutsell Endowed Chair, Department of Animal Sciences**

**Director, Institute for Genomic Biology**

**University of Illinois at Urbana-Champaign**

Harris Lewin is Gutsell Endowed Professor of Immunogenetics, with a primary appointment in the Department of Animal Sciences and is a Professor in the Center for Advanced Study at the University of Illinois at Urbana-Champaign. Lewin served as Director of the University of Illinois Biotechnology Center, Founding Director of the W. M. Keck Center for Comparative and Functional Genomics, and is currently Founding Director of the Institute for Genomic Biology.

Professor Lewin's current research interest is in mammalian comparative and functional genomics. He and his team are studying how mammalian genomes evolve and the role of chromosome rearrangements in adaptation, speciation and the origins of cancer. Lewin's research led to the identification of a gene responsible for resistance and susceptibility to bovine leukemia virus infection, the development of high-density comparative maps for mammalian genomes, and co-discovery of a gene affecting milk fat composition. In addition, his group produced the first large-scale cattle cDNA and oligo microarrays, which he and his collaborators have used to study the genomic effects of nuclear transfer cloning, the development and involution of the mammary gland, and the dietary effects on gene expression during the periparturient period.

Lewin is Associate Editor of the journal *Animal Biotechnology* and serves on the Editorial Board of *Physiological Genomics* and *Annual Reviews of Genomics and Human Genetics*. In 2004, he was elected as a Fellow of the American Association for the Advancement of Science and in 2007 he was elected as a foreign member of the Royal Swedish Academy of Agriculture and Forestry.

**Larry Smarr**

**Director, California Institute for Telecommunications and Information Technology  
Harry E. Gruber Professor, Department of Computer Science and Engineering  
University of California, San Diego**

Larry Smarr is the founding director of the California Institute for Telecommunications and Information Technology and Harry E. Gruber professor in the Jacobs School's Department of Computer Science and Engineering at UCSD. For seven years Dr. Smarr has been Principal Investigator on the NSF OptIPuter LambdaGrid project. He is currently PI of the Moore Foundation CAMERA marine microbial metagenomics project and Co-PI on the NSF GreenLight energy efficient cyberinfrastructure grant.

As founding director of the National Center for Supercomputing Applications (1985) and the National Computational Science Alliance (1997), Dr. Smarr has driven major contributions to the development of the national information infrastructure: the Internet, the Web, the emerging Grid, collaboratories, and scientific visualization. His views have been quoted in *Science*, *Nature*, *the New York Times*, *Wall Street Journal*, *Time*, *Newsweek*, *Fortune*, and *Business Week*, and he gives frequent keynote addresses at professional conferences and to popular audiences.

Dr. Smarr received his Ph.D. from the University of Texas at Austin and conducted observational, theoretical, and computational based astrophysical sciences research for fifteen years before becoming Director of NCSA. He is a member of the National Academy of Engineering and a Fellow of the American Physical Society and the American Academy of Arts and Sciences. In 1990 he received the Franklin Institute's Delmer S. Fahrney Gold Medal for Leadership in Science or Technology. In 2006 he received the IEEE Computer Society Tsutomu Kanai Award for his lifetime achievements in distributed computing systems.

Dr. Smarr was a member of the President's Information Technology Advisory Committee and served until 2005 on the Advisory Committee to the Director of the National Institutes of Health and the NASA Advisory Council. He served as chair of NASA's Earth System Science and Applications Advisory Committee and was the first chair of the newly formed NASA Science Advisory Council.