Instantaneous access to information has been contributing to ever more collaborative and interdisciplinary models of academic research and scholarly activity. The New Life Sciences and Social Sciences Initiatives are two major cross-disciplinary university initiatives that reflect this changing academic environment at Cornell University. The New Life Sciences Initiative (NLSI), launched in Fall 2002 to further strengthen support for a highly collaborative model of the life sciences, implements a “department open” faculty hiring policy. The Institute for Social Sciences (ISS) was established in 2004 to reflect the inter-disciplinary mandate of the Social Sciences Initiative (SSI). Among the organizing principles of these initiatives is interaction, and the shared goal of catalyzing a network of campus-wide research and educational activities which continue to draw together scholars from a variety of disciplines “...in an atmosphere where traditional departmental and college boundaries become secondary to the intellectual work itself.” (NLSI website: http://www.lifesciences.cornell.edu). Other academic fields (engineering, physical sciences, mathematics, and the humanities) increasingly reflect these principles as well.

In order to work successfully within this new model, academicians today must have the ability to take an integrated view of disciplines from across the intellectual spectrum, and to transform that view into a research program calling on multiple disciplines. There are currently 14 colleges on 4 geographically distant campuses at Cornell, with faculty, staff, and students working on issues of interest to life and social scientists, engineers and physical scientists, doctors, veterinarians, and humanists in almost every college. Consequently, these scholars—as well as those attempting to showcase or publicize their research (e.g., the News Service) or attract donors (e.g., the Office of Alumni Affairs and Development)—find themselves in poorly charted terrain, facing problems in multiple arenas, including:

- Presenting an integrated representation of their broad subject area (e.g., life sciences) to the Cornell community and beyond (the public, prospective donors etc.)
- Identifying appropriate collaborators/area experts, courses, events, and research technologies and facilities within and beyond their domain
- Following recent Cornell research activities and publications
- Staying competitive in recruiting faculty and students

In response to concerns expressed by faculty involved in the New Life Sciences Initiative, the Cornell University Library recognized in early 2003 that as a neutral entity with a clear mandate and strengths in the curation, management, and dissemination of information—both print and digital—it could alleviate many of these problems. To that end, the Life Sciences Working Group (Appendix 2a), a multi-disciplinary group of science librarians with expertise in fields ranging from chemistry to veterinary and human medicine, was created. The group envisioned an electronic life sciences community serving the needs of students and faculty at Cornell, by
helping to connect people to each other and to educational and research activities at Cornell and beyond.

VIVO (http://vivo.library.cornell.edu), is this virtual life sciences community, and was created using an entity-relationship ontology model to organize and present information on faculty, research, and educational activities. VIVO transcends campus, college and department structure to provide an integrated view of the life sciences at Cornell. Its primary goals are to offer Cornell faculty, students, and administrative and service officials, prospective faculty and students, donors, and the public a wide-ranging perspective on multiple facets of the life sciences within all of Cornell’s colleges.

There are multiple websites at Cornell with content reflecting the life, social, or physical sciences, engineering, and the humanities. What would yet another site or more information in these realms provide that the existing services do not? In addition to VIVO there is another primary life sciences site associated with Cornell: the NLSI campaign-based site (www.lifesciences.cornell.edu) administered by the Office of Alumni Affairs and Development and targeted primarily to alumni and other potential donors. This site showcases the Initiative from a publicity and fund-raising viewpoint, and as such, it highlights giving opportunity-related information and events. VIVO’s mandate, on the other hand, is to seamlessly reflect the inter-related people, activities, and resources of the complete life sciences community regardless of department or college or focus area affiliation. In doing so, it comes closest to electronically representing the full potential of Cornell’s life sciences presence. The VIVO model is now being extended to allow such seamless, searchable views of Cornell research no matter what subject area a particular topic belongs to.

Cornell’s faculty and administration from multiple disciplinary areas have clearly indicated the importance of a consistent, research-focused discovery tool that fulfills the needs of researchers, students, administrators, and donors. Consequently, VIVO draws on content from a single database that reflects the entirety of faculty research and educational activity, including multiple department and field affiliations, grants, courses taught, and publications regardless of which academic unit, college, or campus the searched entity resides in.

**Rationale and Significance**

The benefits of a university-wide database of faculty, research, and education information are manifold. Data available in VIVO are currently compiled through several mechanisms including automated downloads of publications from life sciences and medical databases and grants (currently applicable only to CALS—the College of Agriculture and Life Sciences), manual curation, and the college faculty reporting structure (currently applicable only to CALS—although working relationships are being pursued with faculty reporting and sponsored programs administrators at Weill Cornell Medical College (WCMC), the School of Hotel Administration, and the Colleges of Human Ecology, Veterinary Medicine, Engineering, Arts and Sciences, and Industrial and Labor Relations). For example, the Office of Academic Computing at WCMC is currently developing an enhanced WMC Research Profile System that would maintain content at WCMC and could potentially provide regular data feeds to VIVO. While each college at Cornell has a distinct blend of information and tools to manage it, we have been successful in working
out initial data exchanges using direct database access, exchange of spreadsheets, and some direct data entry into VIVO. We are already processing CALS updates from their 2007 faculty reporting process and are preparing to generalize our tools to support a data exchange model that will scale well to the larger university. We have also had very positive discussions on showcasing Cornell patents with staff at the Cornell Center for Technology, Enterprise, and Commercialization (CCTEC), although this feature has not been implemented yet. Information curated in these diverse ways can in return be displayed and searched as in VIVO, but could also update multiple web sites at the university, college, and individual unit levels—including faculty profiles on department web pages—improving both the visibility and the consistency of Cornell’s research presence and providing more immediate incentives for faculty and departments to keep web sites updated. Thus, we have attempted to create a harvestable database to reflect the entirety of our faculty affiliations, research, and scholarly work in a variety of subject areas at Cornell while avoiding duplication of effort and content on the parts of faculty and administrators.

As already stated, VIVO transcends Cornell’s campus, college and department structure to provide an integrated view of the life sciences at Cornell; our short-term goals are to improve VIVO and provide similarly unified content for other subject areas. The primary goals of the overall project are to offer Cornell faculty, students, and administrative and service officials, prospective faculty and students, donors, and the public a wide-ranging perspective on multiple facets of faculty activity within all of Cornell’s colleges and research units. More data—such as grant information and publications—will be available as relationships are established with sponsored program and faculty reporting officers in the various colleges. This data, along with manually-curated information such as affiliations to departments, fields, or research units, research project descriptions, seminars, and facilities will enrich faculty profiles and provide:

- A resource for researchers at Cornell or beyond, looking past their immediate field for activities or collaborators relevant to new explorations
- A powerful recruitment tool for prospective faculty to investigate sources of research support and potential collaborators
- A means for current or prospective students to discover fields of study, advisors, and research opportunities based on interests that cross traditional discipline and departmental boundaries
- A tool for industrial partners and donors to evaluate the depth and breadth of Cornell’s involvement in areas of common interest, and seeking points of contact
- A resource for administrators or journalists seeking information and expert commentary on current hot-button issues or more general scientific background, or for conference planners looking for speakers or continuing education instructors

As in VIVO, database curation for other research areas does not replicate or replace the many currently active research and public information web sites at Cornell, but provides a rich resource layer across these, allowing users to follow connections across Cornell based on common subject areas, affiliations of individual faculty and researchers, organization units, or resources. A unique search function similar to that currently available in VIVO would also be part of this service. Unlike in most search engines, a VIVO search returns results from across Cornell’s diverse departments, colleges, and campuses organized into categories such as people,
activities, organizations, online resources & publications. Each of these entries then links directly to the original resource, whether the full text of a recent article or the web page describing a faculty member’s research or a new genomics service.

The value of a resource like VIVO owes much, if not everything, to staying current. The database-driven nature of information and the ability to enter and modify content without any programming knowledge means that the distributed model we are proposing to eventually maintain the database is eminently possible. Much of the content is currently accumulated through automated downloads from individual university and college-level databases; we hope to employ more of these as the University progressively moves to more consistent machine readable faculty reporting systems and a centralized calendar of events. To facilitate this, we have organized a working group of several colleges to establish baseline faculty reporting data collection and exchange standards. Further, the modified database will soon allow direct updating of keywords, publications, and research statements by individuals.

We are applying techniques to permit web-based information to be "harvested" and accessed or delivered as needed to other portals. Accomplishing this effectively involves working with stakeholders, not only as data providers, but also as data disseminators. Thus, we are working with college communications offices, departments, Human Resources Systems and Records administrators, the Office of Sponsored Programs, the Office of the Vice Provost, Alumni Affairs and Development, the News Service, the Cornell Center for Technology, Enterprise, and Commercialization (CCTEC), the Mario Einaudi Center for International Studies, Cornell Information Technologies (CIT), and the Offices of Academic Computing and Research and Sponsored Programs at Weill. These partners have recognized how a unified database such as VIVO can add important new functionality to Cornell’s web presence and have expressed interest in collaborating to achieve mutual benefits. In addition to the faculty reporting working group, our initial efforts include participation in a CIT task force on web services and ongoing discussions with the Office of Web Communications project team regarding events and a more unified search presence.

### Functionality

Tabs in VIVO—such as “Home”, “People”, “Education and Training” and other top-level entry points on the home page—shape the presentation of its content to users who may not initially understand the scope of the site. These tabs draw out individual entries by type or by explicit links under the control of the curators for the site, who enter content into the database via a form that can be used with minimal training and no knowledge of programming. Everything that is not a tab in VIVO is an entity, classified on entry according to its “type”; i.e., a seminar title is classified in a pull-down menu on the editing form as the type colloquium, talk, seminar. A url for the entity is entered, along with anchor text, and a 1-2 sentence “blurb”, and/or short description when appropriate. Images can be saved onto the curator’s computer and uploaded; a “citation” field whose content appears when the image is moused-over allows the curator to acknowledge image copyright, or enter a name or description of the image as appropriate. For time-sensitive entities like seminars, news releases, and certain events, “sunrise”, “sunset”, and “timekey” fields determine when an entity first becomes visible and stops being visible, and the date and time associated with it, which is also the order in which it sorts, respectively.
The type of an entity determines what relationships may be made to other entities – the seminar example above typically has links to a person's entry via the relationship "speaker at", to a research center or department as "sponsor of", to a room as "takes place in", and to a seminar series as "part of". After entering the basic information for the seminar itself, a curator selects each desired relationship and picks the appropriate entity to link to from people, departments, rooms, or seminar series matching the entity type or types defined by the relationship chosen, or has the option of creating new entries where none yet exists. These relationships and their connected entities form part of the display of a completed seminar entity in VIVO, while also creating the bi-directional web of connectivity that distinguishes VIVO from the typical top-down web site design. Whenever a seminar is displayed, the user can navigate directly the speaker's display to see what else her research entails, to the seminar series display to see what other presentations are coming up, or to the research center's display to view their larger programs and resources. Each of these displays in VIVO includes links to personal or departmental or center-hosted web sites outside of VIVO, allowing users to navigate with a minimum of clicks to the most appropriate and up-to-date information available.

Many of these individual entries and associated relationships in VIVO are populated through automated and semi-automated data feeds, including downloads of recent journal article citations from Biosis and PubMed, grants from the Cornell Office of Sponsored Programs data warehouse, and keywords and subject area affiliations self-identified by faculty as part of their annual reporting. When a new principal investigator on a grant is not already in VIVO, we tap the Cornell online directory to create a basic entry for the person with their title and department affiliation. This blend of manual and automated entry is a critical element in achieving sustainability for the site.

To facilitate viewing and searching entities in different ways, they are also flagged to appear or belong to certain portals, colleges and geographic campuses simply by checking the correct boxes, with multiple designations possible. Most entities in VIVO are auto-linked to one or more tabs in the public user interface based on their type. Thus, once a seminar entry is completed and the “entry form” submitted, information on the seminar immediately appears at the appropriate place in the public view, along with links to the seminar host, sponsoring department/s, and other relevant information.

VIVO’s content can be browsed through the curator-defined tab entry points or discovered directly via searches:

Browsing: VIVO’s home page includes information on VIVO, the NLSI and its focus areas, faculty interest groups that do not fit into any formal academic structure, the life sciences in the library, search examples, and current and archived Cornell news releases pertinent to the life sciences. Top-level tabs on the home page direct the user to particular areas of interest within the life sciences at Cornell (Figure 1) as outlined below.

People: This content category provides profiles of faculty, researchers (including research and senior research associates), and administrative staff supporting the life sciences. People may be viewed alphabetically, through a gallery of images, or via searches. They are not arranged by
Unlike typical faculty web pages at Cornell, these profiles are not department-centered, but acknowledge the diversity and richness of a person’s activity and academic life. One way of doing this is to identify all of a faculty member’s department, field, and research center affiliations at Cornell (Figure 2). These academic affiliations are in the form of urls that take the user out of VIVO as well as links which provide the user with a bird’s eye view of the academic unit chosen within VIVO—with information about member faculty and affiliated units. In addition, each faculty page includes:

- a thumbnail image of the faculty member
- all departmental, field, research unit affiliations
- grants administered or co-administered
- news releases they or their research may have been featured in
- courses they teach, with links to all cross-listing departments so that the user may find information about the department or other courses offered by it
- recent articles downloaded from the databases *Biosis* and *PubMed*
- other information pertaining to their life at Cornell; e.g. leadership of academic initiatives, organization of an academic event like a workshop or conference etc.
Figure 2. Sample faculty profile page in VIVO.

Barrett, Christopher | Professor | Applied Economics & Management profile | Barrett web page

faculty member in
- Applied Economics and Management (AEM) | Cornell department | AEM web page | Applied Economics & Management courses
- International Programs (IP/IALS) | academic program office | IP/IALS web page

member of graduate field
- International Agriculture and Rural Development | graduate field | IAD web page | IP/IALS/International Agriculture & Rural Development web page

International Development | graduate field | IAD web page | IP/IALS/International Development web page
- Natural Resources | graduate field | IAD web page | IP/IALS/Natural Resources Graduate program web page | IP/IALS with Peace Corps Option web page

primary investigator of
- AFRICAN FOOD SECURITY AND NATURAL RESOURCE MANAGEMENT - SECOND COHORT FIELD RESEARCH | Research Grant
- AGRICULTURALIST'S ASSET AND INCOME DIVERSIFICATION PATTERNS TO ENSURE SUSTAINABLE LIVELIHOODS | Research Grant
- CONCEPTUAL AND STATISTICAL FOUNDATION FOR THE ESTIMATION OF POVERTY TRAPS | Research Grant
- CORNELL AFRICAN FOOD SECURITY AND NATURAL RESOURCE MANAGEMENT PROGRAM | Research Grant
- DOCTORAL DISSERTATION: MARK F. BELLEMARE - RESEARCH IN ECONOMICS: THE THEORY AND PRACTICE OF REVERSE SHARE TENANCY | Research Grant

4 more

co investigator of
- CORNELL AFRICAN FOOD SECURITY AND NATURAL RESOURCE MANAGEMENT PROGRAM | Research Grant
- CORNELL AFRICAN FOOD SECURITY AND NATURAL RESOURCE MANAGEMENT PROGRAM | Research Grant
- HOMESTEADS AND DEGRADATION IN FRAGILE TROPICAL AGROECOSYSTEMS | Research Grant
- NEW PROTOCOLS: FIELD RESEARCH SUPPORT FOR STUDENTS IN THE FOOD SECURITY AND NATURAL RESOURCE MANAGEMENT PROGRAM IN EASTERN AND SOUTHERN AFRICA | Research Grant

teaches
- Contemporary Controversies in the Global Economy | 3 credit course | IAD 500
- Development Microeconomics Graduate Research Seminar | 1-3 credit course | IAD 755
- Microeconomics of International Development | 1 credit course | IAD 797

research areas
- applied economics | collaborative research area (CALS)
- biocomplexity | collaborative research area (CALS)
- biodiversity | collaborative research area (CALS)
- food system and/or policy | collaborative research area (CALS)
- international agriculture | collaborative research area (CALS)

5 more

affiliate in
- African Food Security and Natural Resources Management (AFSNRM) | academic program office | AFSNRM web page
- Center for the Study of Inequality (CSI) | research center | CSI web page
- Institute for African Development | research institute | IAD web page

has geographical research area
- Africa | continent

speaker at
- AEM Roundtables: The Disintegration of the Doha Development Deliberations | AEM Seminar | Wed 11/01/2006 11:00am
- Agricultural Technology, Productivity, Poverty and Food Security in Madagascar | CIFAP Seminar | Wed 02/15/2006 12:00pm
- Social Network Capital, Economic Mobility and Poverty Traps | JSS Networks seminar | Fri 10/20/2006 10:30am
- Stagnant Smallholder Agriculture? Rice Yield Dynamics in the Highlands of Madagascar | CIFAP Seminar | Wed 09/24/2007 12:00pm

Chris Barrett teaches and conducts research in the areas of international development, environmental and resource economics, international trade, markets and price analysis, agricultural production and distribution, and applied economics. Professor Barrett has published more than 125 journal articles, books, and book chapters, and has been principal investigator or co-principal investigator on research grants totaling more than $15 million.

There are three basic, interrelated thrusts to Professor Barrett’s research program. The first concerns poverty, hunger, food security, economic policy, and the structural transformation of low-income societies. The second considers issues of individual and market behavior under risk and uncertainty. The third revolves around the interrelationship between poverty, food security, and environmental stress in developing areas.

Keywords: development economics, conservation, sustainable development, international agriculture, poverty reduction, agricultural economics, environmental and resource economics, microecon analysis, food aid, food insecurity

Education and Training: Information on graduate fields of study, course listings, seminar series, literature resources, workshops, and a chronological list of upcoming seminars, generally entered from seminar series by a student employee. Each of these lists information on where and when the seminar will occur, is linked to its host department and faculty member, includes information on the seminar speaker and his/her academic affiliation, and is associated with the url of the host department’s seminar series listing.
**Research Tools:** This section of VIVO was conceived as a tool box for faculty, staff, and student researchers in the life sciences. Content consists of public domain databases important to life scientists, organized from the micro- to the macro-scale into:

- Biomolecules (primarily online resources on nucleic acids and proteins further organized in a taxonomic fashion);
- Genomics and Proteomics (primarily gene expression databases);
- Cells and Tissues;
- Organisms (primarily online resources on embryology and development, anatomy, and neuroscience);
- Populations (resources dealing with population biology, phylogenetics, and evolutionary biology);
- Database Compilations (database collections compiled by various research and service entities); and
- Literature Resources (bibliographic resources in the life sciences).

Each entity in this section of VIVO includes the entity’s url, a sentence to help the user determine if the resource will be of use to him/her, and a longer description of the resource accessed by following the “more…” link at the end of the short description.

**Facilities:** With the life sciences at Cornell spread over many colleges, departments, and at least 3 campuses, scientists are often unaware of analytical facilities that may be more accessible and/or less expensive than others outside Cornell. The “Facilities” section of VIVO is an attempt to curate facilities by the type of technology (Genetic/Genomic/Molecular Biology; Greenhouses; Nanotechnology/Microfabrication etc.) regardless of which department, research center, or college the facility resides in.

**Search:** Unlike most search engines, VIVO categorizes results and displays appropriate cross-referencing information to place them in a wider context, including information on: educational aspects, researchers, research projects, grants, and facilities, external research tools, and recent Cornell-authored publications.

For example, a search for ‘microarray*’ in VIVO shows results organized into categories such as people, activities, organizations, online resources & publications, providing rapid access to exactly the sort of information sought (Figure 2). Each of these entries then links directly to the original resource, whether the full text of a recent article or the web page describing a faculty member’s research or a new genomics service. The important point to note is that the people appearing here are from departments at Weill Cornell Medical College, CALS, the Veterinary College, NYSAES-Geneva, Arts and Sciences, and Engineering, clearly illustrating the cross-disciplinary functionality of the database. A search on Cornell’s search page will undoubtedly return results as well, but because the context is missing, the user has to spend time scrolling through multiple pages to find information of interest to him/her.
Figure 2. Search for “microarray*” in VIVO.
Content management issues

As already stated, VIVO does not replicate or replace the many currently active research and public information web sites relating to life sciences at Cornell, but provides a navigational layer above these, allowing users to follow connections across Cornell based on common subject areas, affiliations of individual faculty and researchers, organization units, or resources.

Thus far, content curation has been accomplished largely by the authors and a student employee, with significant input from the life science working group. However, maintaining and keeping current a site with such far-ranging content as curated in VIVO is a definite challenge. Yet, it is clear that the value of a resource like VIVO owes much, if not everything, to being current and updated. The database-driven nature of the site and the ability to enter and modify content without any programming knowledge means that a “distributed” model involving content modification and entry by faculty and administrative staff is eminently possible. Further, some of the content is currently accumulated through automated downloads (e.g., grant and publication information); we hope to employ more of these as the University progressively moves to a new content management system and a centralized calendar of events.

Additionally, we plan to work with a variety of stakeholders (e.g., the Office of the Vice Provost for Research, Alumni Affairs and Development, the News Service, CIT) throughout the university in applying new open-source, standards-based digital library techniques to permit web-based information to be "harvested" across the whole initiative and accessed via the portal. These partners have recognized how VIVO can add important new functionality to Cornell’s web presence and have already expressed interest in collaborating to achieve mutual benefits. Our first efforts include participation in a Cornell Information Technology task force on web services and a separate Office of Web Communications project team to develop a shared events model for Cornell.

Conclusion

Rapid, well-organized access to Cornell’s wide range of research information across disciplinary, structural, and geographic boundaries has not been possible until the development of VIVO and its underlying database. By developing these services we seek to reach the widest possible audience by leveraging—not supplanting—existing online descriptive information to allow the materials prepared by information providers across areas of inquiry to be discovered via as many paths as possible. The audience is indeed wide-ranging: existing and proposed content targets current and prospective researchers, administrators, and students, as well as industry professionals, donors, and the public. Our statistics show that even without significant publicity this database has been indexed by major search engines, including Google.

VIVO currently embodies the virtual life sciences community; we are in the process of creating collections that similarly spotlight other virtual communities—the creation of which will provide a hitherto missing but necessary service that enables stakeholders to connect with each other, and to participate in and partake more richly of academic life at Cornell. Apart from showcasing Cornell’s contributions in multiple research areas, such virtual communities could well serve as models to explore synergies with peer institutions, museums, foundations and research consortia to provide access to information on a national scale.