DESIGN OF A UNIVERSITY RESEARCH NETWORK:
ANALYSIS, SELECTION, AND IMPLEMENTATION PLANNING

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TITLE: DESIGN OF A UNIVERSITY RESEARCH NETWORK:
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PLANNING

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ABSTRACT

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This report focuses on the design of a university knowledge management system (KMS), and how such a system can provide the framework for students and faculty to partake in, share, and collaborate on research activities. The collaborative environment of a university KMS, or research network, must be established in order for a university to maintain its reputation as a competitive research institution and to develop its faculty and students outside the classroom. A research network may contain a variety of features, some of which include faculty profiles, forums, communication portals, publication links, biographies, faculty keywords, interest areas and contact information. Several web-based systems provide the capabilities required for a well-functioning research network, including creating a customized system in-house. Thus, the existence of various alternatives often leads to great difficulty selecting, designing, and/or customizing a feasible system. The systems engineering process allows a university to evaluate and select the most desirable research network to suit its needs while maintaining decision objectivity. Once a system is selected, the university must integrate the research network into its existing research organization through a structured implementation plan, which includes system implementation schedule, functionality, required resources, and cost analysis.

In addition, this report includes a case study performed at California Polytechnic State University, San Luis Obispo (Cal Poly). In this case study, the KMS design and systems engineering process are applied to Cal Poly, in an attempt to satisfy Cal Poly's need for a robust research network. An implementation plan developed for Cal Poly is presented, as well.

Keywords: research network, systems engineering process, implementation plan, customer requirements, knowledge management

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Chapter 1: Introduction

1.1 Problem Statement

Research provides the opportunity for academics to discover, interpret, and develop new knowledge. Therefore, universities—whose purpose is to provide higher education—hold research as one of their top priorities in faculty and student educational development.

Furthermore, collaboration among three entities often involved in research at an educational institution (faculty, students and industry) greatly benefit a university's research caliber by inviting alternate funding channels and allowing access to state-of-the-art equipment and materials [10].

In order for a university to support research collaborations among the three research entities, a knowledge management framework—or a research network—must exist that provides visibility into all research interests and efforts performed by the faculty members. Without such a system, the three entities are not able to independently locate information needed to establish competitive collaborations and partnerships. This potential communication gap can negatively affect the research development rate, the public image of the university, and the benefits ensuing from collaborative efforts [10].

Additionally, without a research network universities may otherwise pay for an employee to be responsible for knowing the vast and dynamic information related to all faculty and student research. Using this method brings forth the risks associated with human error and knowledge transfer from one employee to the next.

Therefore, in order for a university to foster research awareness, dynamic collaborations, increased research reputation, and non-disruptive knowledge transfers among employees, a robust research network must be established.

Once the decision has been made to establish a research network, the following questions ensue:

- What alternative research networks exist? Or, does one need to be created in-house?
- How should the most suitable research network be chosen?
- Once a system is chosen, how should it be integrated into the university's existing research framework?

It is difficult for a university to take on the establishment of a large-scale software system, including the conceptualization, evaluation and implementation, without the utilization of a structured methodology.

1.2 Purpose and Scope

The purpose and scope of this report at a top level is to provide a structured methodology for universities to utilize when establishing a research network. This includes the following:

- To reveal the importance of a knowledge management system to a university, and why each university should establish a research network to remain competitive.
- To explain the conceptual design of a knowledge management system and its general functionality.
- To describe and evaluate the alternative systems available to universities.
- To determine an evaluation method used to decide on the most suitable alternative for a university given specific requirements.
- To outline an implementation plan for integrating a software system into the university's current research framework.

- To demonstrate the previously discussed concepts and methods through a case study on the establishment of a research network at California Polytechnic State University, San Luis Obispo.

Chapter 2: Literature Review

2.1 Knowledge Management

Recently, many organizations recognize the value of sharing individual and collective knowledge within an organization [9, 20]. With efficient sharing practices, an organization will achieve a competitive advantage as shorter learning and development cycles are facilitated [20]. However, in order for information to flow through an organization, a framework must exist. Such a system is commonly referred to as a knowledge management system (KMS), and is defined as the “development of structures that allow [an organization] to recognize, create, transform, and distribute knowledge” [12]. The following cycle in Figure 1 captures the flow of knowledge necessary for knowledge management to exist.

FIGURE 1. KNOWLEDGE MANAGEMENT CYCLE, ADOPTED FROM [8]

Without a knowledge management system, the cycle above is difficult for an organization to maintain resulting in a reduction of knowledge sharing and collaborations. Some reasons include the issues involved with identifying those who may be able to benefit from a set of knowledge, becoming aware of existent knowledge, and displaying knowledge in a way that can be understood by a wide audience [9]. As a result, in order for an organization to build off their

acquired knowledge and gain a competitive advantage, a knowledge management model must be adopted.

2.2 Systems Engineering Process

The systems engineering process is “the orderly process of bringing a system into being and the subsequent effective and efficient operation and support of that system throughout its projected lifecycle” [3]. This process provides structure in a complex and rapidly changing environment that system design, implementation and maintenance inherently embodies. The tasks involved in what is referred to as the system engineering process are revealed in Figure 2.

FIGURE 2. THE SYSTEMS ENGINEERING PROCESS, ADOPTED FROM [13]

In order for the preceding process to be applied, the need for a system must exist, and therefore it is important to define a system. The International Council on Systems Engineering has agreed on the following definition of a system:

A system is a construct or collection of different elements that together produce results not obtainable by the elements alone. The elements, or parts, can include people, hardware, software, facilities, policies, and documents; that is, all things required to produce systems-level results. The results include system level qualities, properties, characteristics, functions, behavior and performance. The value added by the system as a whole, beyond that contributed independently by the parts, is primarily created by the relationship among the parts; that is, how they are interconnected [1].

Along with the complexity related to the system itself revealed in the preceding definition, the initial conceptualization and creation of the system also results in significant challenges. In fact, the evaluation phase shown in Figure 2 tends to be the most important and most commonly overlooked part of the systems engineering process. Owners and developers struggle to establish the end user's needs beginning with defining the initial problem, and often skip to designing the system without aligning the design to any baseline customer requirements. Therefore, it is important for the systems engineer to recognize their primary goal during the evaluation phase is to illicit all information related to the customer's problem [3].

2.3 Software Design, Selection, and Implementation

2.3.1 Software Evaluation

This report focuses on the evaluation phase of systems engineering process beginning with "Definition of the Problem" and ending with "System Feasibility Analysis" while applying it to the evaluation of software systems. This may seem like a small percentage of the process;

however the completion of these tasks constitutes the creation of effective system requirements. Without thoughtfully completing these initial steps, the stakeholder's actual needs may not be understood and a less-than-ideal system will ensue as discussed in the previous section. The following paragraphs outline and explain the evaluation phase, expanded in Figure 3.

FIGURE 3. THE EVALUATION PHASE

In the first step—defining the problem—a system should only be considered if its existence will fill an absence, improve an insufficiency, or essentially solve a problem. Therefore, the problem must be clearly defined to meet the customer's need. Defining the problem should include the description of the absence or insufficiency and the risks involved if the problem is not addressed. Second, in the identification of the need step, the system stakeholders must determine their needs, or what must exist to solve the problem. This activity is commonly called a “needs analysis.” While completing the needs analysis, it is important to focus on the “what” component of the system, rather than the “how” component. The stakeholder needs must then be analyzed and translated into the system's functional requirements. The following questions will guide the conversion of customer needs into system requirements:

- What functions are required in the system to completely solve the problem?
- Which of these are mandatory functions?
- Which of these are preferred functions? [13]

Finally, the System Feasibility Analysis step begins with determining the alternatives. At this point, brainstorming and researching are necessary to determine potential technological approaches. The different approaches usually originate from buying, making, or adopting a system. A helpful place to start is researching what other companies or institutions use to solve a similar problem. If a similar system does not exist, then brainstorming will be the main method of idea generation. Additionally, talking to experts in the area, professional contacts, and stakeholders will result in the generation of many ideas and perspectives on the available technology.

Once the technological approaches are determined, the alternatives can be evaluated for feasibility of fitting the university's requirements. This evaluation is performed through two matrices: (1) the functional requirements matrix and (2) the project management requirements matrix. Both matrices are shown in Table 1.

TABLE 1. EVALUATION MATRICES, ADOPTED FROM [25]

		Alternative	
Functional Requirements	Weight (%)	Rating (%)	Score (%)
Functional Requirement 1			
Functional Requirement 2			
Functional Requirement 3			
Functional Requirement 4			
Functional Requirement 5			
Functional Requirement 6			
TOTAL	100%		

Project Management Requirements	Weight (%)	Rating (%)	Score (%)
Functionality			
Cost			
Schedule			
Personnel / Capability			
TOTAL	100%		

Each requirement should be assigned a weight of importance; the greater the weight, the greater the importance. The importance of each requirement should be defined by the original customer needs, or the functions that are most necessary to solve the existing absence or insufficiency. Next, assignment of a rating to each alternative and requirement combination is performed. A “do nothing” alternative should also be evaluated to establish a baseline rating. The rating should be a percentage indicating how well the approach will satisfy the requirement. The score is calculated by multiplying the weight by the rating, and the resulting value should be less than 1, or less than 100%. The scores are added up to determine the total score per approach. This process is completed for both matrices; however, the Functionality rating in the project management requirements matrix is always equal to the total score in the functional requirements matrix for a given alternative. This reveals the purpose of two separate matrices, which is that the functional requirements as a whole should have a similar weight to each of the project management requirements separately.

After successfully completing both the functional requirements evaluation matrix and the project management requirements evaluation matrix, the alternative with the highest total score in the project management requirements matrix will be the most suitable research network for the university.

2.3.2 *Software Implementation*

Many implementation models exist to specifically guide the development of software systems, some of which include waterfall, rapid prototyping, spiral, incremental, and agile models. Much literature exists that further explains the different processes and their evolution [9, 20]. The purpose and importance of such a model is revealed in the following paragraph from Bijaya Mishra and A. Uday Bhaskar's article, called "Knowledge management process in two learning organizations:"

The software development process model describes structural framework of whole process and task in developing software, providing the specific work steps completing task and reflecting the method and tools adopted in process of developing software. It gives solutions to obtaining high-quality software. Correctly to select or to build the software development process model is a key factor for the success of developing software. [20]

Therefore, in the development of a software system, a structured process as explained above must be adopted.

The waterfall model, which is the first software development model [9], provides a simple and linear process map as seen in Figure 4.

FIGURE 4. SOFTWARE DEVELOPMENT LIFE CYCLE, ADOPTED FROM 24

The waterfall model is further explained thorough a description of each task and milestone shown in Figure 4. Tasks occupy a duration of time, whereas milestones occur at a point in time. For example, painting a house constitutes as a task, while an electrical inspection relates to a milestone. Milestones typically represent a checkpoint, and therefore, signify the completion of one task and the start of another.

The tasks are represented by rectangles in Figure 4. They are divided up to create smaller, achievable “chunks” of work and to ensure checkpoints, or milestones, occur throughout software development. A brief description of each task is included below.

- System Requirements Definition – defining the system requirements from the customer needs. The systems engineering process can be utilized to assist with the generation of the requirements.
- Software Requirements Analysis – converting the system requirements at the top level perspective into more detailed architectural, structural, functional and design requirements. This task should encompass the conceptual planning performed by the

programmer as to how they will program the system requirements into the expert system [8].

- Preliminary Design – developing the conceptual planning designs resulting from the Software Requirements Analysis. This includes creating the basic framework of the system and established the general relationships among the subsystems, which will be described in the Functionality section of this report.
- Detailed Design - developing more detail and functionality into the previously established framework and subsystems. Additionally, user interfaces and integration points are developed during this task.
- Coding and Unit Testing – verifying coding functions result in the correct output given a certain input, ultimately meeting system requirements. Testing at this level occurs in two different stages: (1) black box testing, which ensures the functionality works without looking into the processing of information and (2) white box testing, which ensures the internal processes and workflows to the function are properly connected and related [6].
- Integration and System Testing – verifying subsystems and external systems interact with one another correctly, ultimately meeting system requirements. This is performed based off the assumption that the subsystems and external systems operate correctly and independently. Testing at this level must ensure data flows across subsystem and system boundaries as conceptualized in the Software Requirements Analysis task and programmed in the two design tasks [7].
- Maintenance and Support – providing resources to ensure long-term existence of the expert system. According to Canfora and Cimitile [5], four main areas of maintenance and support exist:

1. Corrective maintenance: reactive modification of a software product performed after delivery to correct discovered faults.
2. Adaptive maintenance: modification of a software product performed after delivery to keep a computer program usable in a changed or changing environment.
3. Perfective maintenance: modification of a software product performed after delivery to improve performance or maintainability.
4. Emergency maintenance: unscheduled corrective maintenance performed to keep a system operational.

Each of these activities must be considered throughout the lifecycle of the system, and will be owned by the Maintenance and support admin (further explained in the Resources section).

Milestones, depicted by stars in-between two tasks, include the main checkpoints occurring throughout the systems life cycle. These checkpoints will occur in the form of a meeting among the research organization, the system programmer, and the maintenance and support admin in order to evaluate the current status of the system's development. A brief description of each milestone is included below.

- System Functional Review – establishing the system requirement to be final and all-inclusive. This milestone may also include the selection of the most suitable alternative for a university. This is the final feasibility analysis before the technical development of the system begins [8].
- Software Specification Review – confirming the software specifications, converted from the system requirements and established by the programmer, will meet customer needs.

Discussions about the architecture and functionality of the system must be discussed, edited and finalized to create a baseline conceptual model for the programmer to follow throughout development.

- Preliminary Design Review – inspecting the top-level functionality and interrelatedness of the system. Discussions about subsystem functions and interactions should be explained as to how they contribute to the system requirements [26].
- Critical Design Review – evaluating the overall functionality of the system and if it indeed meets the system requirements. Discussions should occur about the completeness of each function, subsystem, integration point and system as a whole.
- Test Readiness Review – explanation of the performed coding and unit tests and results. Discussions should occur about the balance between testing length and value obtained. In addition, the programmer should provide the maintenance and support admin with recommended testing processes to be performed throughout the life cycle of the system.
- Software Release – explanation of the performed integration and systems tests and results. Discussions should occur about final edits to the system and a system release date. The programmer and the maintenance and support admin are recommended to plan a follow-up meeting to discuss the system code, functions, subsystems, and integration points in detail in order to ensure the ownership of the system back-end seamlessly shifts to the maintenance and support admin.

An important part of the waterfall software development process includes feedback loops, which act as control mechanisms [11]. Figure 5 shows a pictorial representation of a feedback loop.

FIGURE 5. FEEDBACK LOOP, ADOPTED FROM [11]

Feedback loops occur during the milestone checkpoints as all stakeholders meet and discuss their current status and potential issues. The feedback loop in Figure 5 should be discussed in relation to the following areas:

- Potential and imminent risks and challenges
- Past risks and challenges
- Functional requirements adherence
- Project management requirements adherence

Using feedback loops as a control mechanism will allow for issues to be discovered early in the development process, and therefore mitigated before the issue significantly affects the system development.

Chapter 3: Methodology

3.1 Design Requirements of the Knowledge Management System

By taking the knowledge management concept and applying it to a university and the related research activities, a research network ensues. The model in Figure 6 describes a research network as containing three different environments that interface with the core knowledge management system (KMS).

FIGURE 6. THE RESEARCH NETWORK

Each environment is organized based on the corresponding stakeholder's unique relationship with the KMS. Starting with the center of the diagram, the KMS includes the knowledge infrastructure and processes required to support knowledge management at a university and lives within all three environments [19]. The KMS is owned by a university's research organization since the vision of the KMS aligns with the vision of a research organization. The research organization manages the implementation, support and maintenance of the system. The associated stakeholders within the research organization environment include the employees working within the university's research organization, with the largest stakeholder being the leader, or commonly the

Chief Research Officer, of the organization. Next, the surrounding organization, or the university as a whole, interfaces with the KMS differently. The stakeholders at this level, namely faculty and students, are considered the end users of the system as they are the entities working through the knowledge management cycle. In addition, the users provide the content of the system as their personal and communal research knowledge populates the system. Since the KMS is also of interest to entities outside the university setting, a final and all-encompassing environment exists labeled as the research environment. At this level, entities such as industry members and government organizations interface with a university's KMS in search of research partnerships and collaborations with the university. As a whole, the three environments and their corresponding stakeholders comprise a collaborative environment focused on research development within a university.

3.2 Knowledge Infrastructure Alternatives

The technology piece of a KMS is important to understand as it “enables the integration of information and knowledge in the organization, as well as the creation, transfer, storage and safekeeping of [the organization's] knowledge resource” [19]. Many information technology (IT) systems provide the capabilities needed to support knowledge management for a university. Therefore, a university is faced with deciding on a system that fits their specific needs. The following options each include many alternative systems that a university can use.

- **Option 1: Buy** - Many companies sell knowledge management software, some of which include InfoEd's GENIUS and RefWorks. These alternatives require minimal maintenance for a university to perform themselves since the company performs the maintenance. However, a bought system is not conducive to the changing and specific requirements a university may have and customization often is not possible.

- **Option 2: Make** - A university can also decide to make a system in-house. This will allow for customization to the specific needs of the university. Creating an in-house system often leads to longer implementation time and a greater responsibility and cost related to system maintenance.
- **Option 3: Adopt** - A university may belong to a larger organization that has a KMS. For example, the California State University (CSU) system owns a KMS called CSU Fresca that can be used by any of the universities within CSU system. In addition, some companies provide free knowledge management systems online, like Mendeley. However, despite the low cost, these alternatives become less than ideal when the university wants the research environment to only contain their university rather than multiple other universities.

With the existence of many knowledge management system alternatives, a university should only consider those alternatives that fit the conceptual model of a research network and will cater to the different stakeholders and their unique relationship with the KMS.

Chapter 4: Results and Case Study

By integrating the above three areas of research together—knowledge management system, the systems engineering process, and the software development life cycle—a novel approach to evaluate and implement a research network at a university is created. This includes defining customer requirements, analyzing alternative systems, and implementing the chosen system using a structured process that can be used at any university. Figure 7 reveals four of the models mentioned above. They each contribute to the evaluation and implementation of a university's research network.

FIGURE 7. RESEARCH NETWORK MODELS AND PROCESSES

The conceptual model of a research network, in quadrant 1 of Figure 7, is important for a university to understand before embarking on the establishment of a research network. This model allows a university to recognize the systems scope and stakeholders: university faculty, students, research organization and outside interest (industry and government entities). Next, a

university utilizes the evaluation phase of the systems engineering process (quadrant 2 in Figure 7) to decide on the most suitable system. Once chosen, an implementation plan must be created with the software development life cycle (quadrant 3 in Figure 7) as the driver of the plan. Finally, once the system is established, the knowledge management cycle commences resulting in increased awareness and collaboration among research network users.

4.1 Case Study

The following sections describe the application of the knowledge management cycle, the systems engineering process's evaluation phase and the implementation oriented waterfall software development model to California Polytechnic State University's establishment of a research network. By combining the models, the university is equipped with a framework to develop, establish and maintain a research network throughout its life cycle.

4.1.1 Evaluation

The systems engineering process allows for the structured generation of customer requirements and a resulting decision on the most suitable system alternative for California Polytechnic State University to implement. The following sections outline the utilization of the systems engineering process's evaluation phase.

4.1.2.1 Definition of the Problem

The problem—as initially described in the Introduction—is that Cal Poly currently does not have one central system that contains all faculty information related to research. As a result, interested faculty, students and industry members are not able to find simple information about faculty research on their own, which often leads to them contacting Cal Poly's research organization. Faculty, students, and outside interest should not be dependent on the research office to obtain information necessary to further their research efforts as such information should be readily available.

4.1.2.2 Identification of the Need

The problem stated above reveals that a need exists to implement a research network at Cal Poly to provide faculty, students, and outside interest with instant research awareness and connectivity.

Therefore, at the top most level, Cal Poly needs to implement a system that fits the conceptual model shown in Figure 6.

On a more detailed level, the recommended system must include the requirements outlined in Table 2 in order to successfully fill Cal Poly's absence of a research network.

TABLE 2. CAL POLY'S FUNCTIONAL REQUIREMENTS

Functional Requirement	Definition	Weight
Easy and accurate searching	the ability to search the system through a raw search or through different categories	20%
Collaboration	the ability for faculty, students, and external users (industry) to collaborate with one another through forums, postings, and other tools	20%
Faculty profiling system	a expertise management system that focuses on profiles of faculty	15%
Research facility profiles	the ability to treat research facilities as an "entity" that has a profile of its own	15%
Efficient information transfer	ease of transferring currently held information into the new system	10%
External visibility into the system	the ability for interested users external to the system to browse through and collaborate within the system	5%
Curriculum Vitae generation	the ability to generate CVs based on the information entered into the system, can also be links to CVs	5%
Simplicity of aesthetics	intuitive, well organized, simple user interface	5%
Links to published works	links to faculty articles and publications through documents or the web	5%
Total Weight		100%

The requirements listed above were determined thorough extensive research of existing systems and analysis of Cal Poly's needs, which was performed the research organization. Each requirement received a weight of importance, which was determined by the requirements effect on the research network's success.

Along with the functional requirements, the research network needs to be evaluated against the project management requirements outlined in Table 3.

TABLE 3. CAL POLY'S PROJECT MANAGEMENT REQUIREMENTS

Requirements	Definition	Weight
Functionality	The Total Score from the Functional Requirements matrix.	45%
Personnel / Capability	The relative resources available to program, implement, support, maintain, and/or transfer information.	40%
Cost	The relative cost of using this system. May include costs associated with purchasing, programming, and/or implementation.	10%
Schedule	The relative time for the system to be released for use at Cal Poly.	5%
Total Weight		100%

The conceptual model, functional requirements, and project management requirements provide a structured and objective methodology for the research organization to determine the evaluation criteria, or requirements, for potential alternatives.

4.1.2.3 System Feasibility Analysis

Once the evaluation requirements are established, the system alternatives are determined. The research organization must first determine the different actions—or options—for Cal Poly to take in implementing a research network, which include (1) do nothing, (2) make, (3) buy, or (4) adopt a system. Next, each option may have a corresponding alternative(s) to evaluate due to the alternative's close fit with the conceptual model. The chosen alternatives are shown below in Table 4.

TABLE 4. RESEARCH NETWORK OPTIONS AND ALTERNATIVES

Options	Alternatives
1) Do Nothing	DigitalCommons Department Websites
2) Make	Self-created system
3) Buy	InfoEd's GENIUS
4) Adopt	CSU Fresca

The following sections provide a brief description of the alternatives in Table 4.

DigitalCommons@CalPoly DigitalCommons@CalPoly is an online database of scholarly works created at Cal Poly. The DigitalCommons website allows worldwide access to promote “discovery, research, cross-disciplinary collaboration and instruction” [4]. DigitalCommons is publication driven, meaning the database maintains records of scholarly works as opposed to faculty profiles. Faculty profiles do exist; however, the information contained in the profiles focuses on scholarly work as seen in Figure 8.

FIGURE 8. DIGITALCOMMONS@CALPOLY PROFILE PAGE

DigitalCommons users find it difficult to navigate to profile pages; and therefore, publication pages are the most useful component of the system as seen in Figure 9.

FIGURE 9. DIGITALCOMMONS@CALPOLY PUBLICATION PAGE

From the publication page, users can review, download, email, or print the scholarly work. Furthermore, the searching capabilities are relatively robust for scholarly work, not faculty profiles, as seen in Figure 10.

FIGURE 10. DIGITALCOMMONS@CALPOLY SEARCHING CAPABILITIES

Overall, DigitalCommons@CalPoly provides good visibility into scholarly works, but not faculty profiles and collaboration.

Department Websites Cal Poly's department websites include an area where faculty and staff information can be found. Each department owns their own webpage, and therefore, faculty information is scattered across all Cal Poly department websites. For example, Figure 11 shows two faculty pages from different departments.

FIGURE 11. DEPARTMENT WEBSITE PROFILE PAGES

Cal Poly's department of Psychology and Child Development chooses to display information about the faculty members' contact information, education, courses taught, research interests, and publications, which seems to be directed towards outside interest. Alternately, the Industrial and Manufacturing Engineering department primarily displays contact information and office hours, which seems to be directed towards students. The different information and targeted audiences among department websites reveals the currently existing lack of standardization.

Self-created System A self-created system would be programmed by a Cal Poly staff member, allowing the system to be customized according to Cal Poly's specific needs. The systems can either be programmed as a database or as an expert system. An expert system enables the system to act as a "subject matter expert" since the system continuously creates stronger and

weaker relationships among data sets. Furthermore, as Cal Poly Industrial Engineering student Conner Johnston explains:

The program applies a given set of rules to retrieve or manipulate the appropriate information from the knowledge base. The means in which the engine can perform this process are generally broken down into two ways: forward chaining and backward chaining (Gallacher, 1989). Forward chaining involves taking input from the user and applying rules to reach a conclusion. Backward chaining involves having a conclusion and using the user to confirm criteria to match that conclusion. [15]

This reveals interaction with the system almost seems as if the user is communicating with the subject matter expert in person.

Since neither a database nor an expert system exist during evaluation, University of California, Berkeley's (UC Berkeley) Faculty Expertise system and an Access database mock-up were used to evaluate this alternative. UC Berkeley's Faculty Expertise profile pages offer faculty contact information, expertise areas and keywords, and a small bio as seen in Figure 12.

The screenshot shows the 'BerkeleyResearch' website header with navigation links: RESEARCH HIGHLIGHTS, NEWS, RESEARCH OFFICE, RESEARCH UNITS, FACULTY EXPERTISE, RESEARCH POLICIES & ADMINISTRATION, RESOURCES FOR VC RESEARCH UNITS, UNIVERSITY / INDUSTRY RELATIONS, and FUNDING OPPORTUNITIES. The profile is for Lotfi A. Zadeh, Professor in the Graduate School, Computer Science, Division of Computer Science/EECS. It includes his Faculty/Personal URL (http://www.cs.berkeley.edu/~zadeh/), email (zadeh@cs.berkeley.edu), and phone number ((510) 642-4959). A search link for 'UC Berkeley Directory' is provided. The 'Research Expertise and Interest' section lists: artificial intelligence, computational theory of perceptions and precisiated natural language, computing with words, control theory, decision analysis, expert systems neural networks, fuzzy sets, linguistics, logic, soft computing. The 'Description' section provides a detailed biography of Lotfi Zadeh, mentioning his work at Columbia University, MIT, and SRI International.

FIGURE 12. UC BERKELEY'S FACULTY EXPERTISE PROFILE PAGE

UC Berkeley's system also includes a simple search engine, as seen in Figure 13, where users can search the system through any combination of the three fields.

Berkeley Research
UNIVERSITY OF CALIFORNIA

CONTACT US | HOME

RESEARCH HIGHLIGHTS | NEWS | RESEARCH OFFICE | RESEARCH UNITS | **FACULTY EXPERTISE** | RESEARCH POLICIES & ADMINISTRATION | RESOURCES FOR VC RESEARCH UNITS | UNIVERSITY / INDUSTRY RELATIONS | FUNDING OPPORTUNITIES

Home / Faculty Expertise

Faculty Expertise

You can search faculty research profiles by using research interest or expertise keywords (e.g. genomics, cognitive development or toxicology). Alternatively, you can search for a particular faculty member's research profile by entering his or her name.

- Search will look for partial words or names. For example:
 - Entering nano in the expertise box will return entries that match Nanocrystals, Nanoscience, etc.
 - Entering Koe in the name box will return entries that match Koehl, Koenig, and Koenigsberg.
- Searches are not case sensitive; entering Robert or ROBERT or rOBERT or robert will yield identical results.
- For name searches, we recommend that you search by last name only.

Name Faculty Expertise and Interest Department

Apply

For U.C. Berkeley Faculty

- [Add a new entry](#) to the UC Berkeley Faculty Research Interests & Expertise database.
- To modify an existing entry, please find your existing page and click the "Update your profile" link.

FIGURE 13. UC BERKELEY'S FACULTY EXPERTISE SEARCHING CAPABILITIES

UC Berkeley also includes a separate but similar Research Unit area where information about different research facilities can be found. The main Research Unit page is shown below in Figure 14.

Research Units

Research at Berkeley is undertaken within several types of organizations—academic departments, institutes and centers, museums, and field stations.

- **Academic departments** offer courses and grant degrees, as well as sometimes housing laboratories and other research infrastructure. They are organized according to academic disciplines (e.g. Sociology, Economics, Physics).
- **Research Centers and Institutes**, sometimes referred to as Organized Research Units (ORUs), are organized around broad substantive research topics (e.g. international affairs, information technology, the environment). As such, they draw into their research programs faculty and students from multiple departments and disciplines. Berkeley has more than 100 such research units.
- **Museums** also serve as important research sites on the campus. Berkeley has eight museums with strong collections in a variety of fields, including anthropology, paleontology and entomology.
- In addition, Berkeley manages a number of biological **field stations**. Most are in remote locations within California ideal for the study of ecosystems, botany, zoology, and forestry.

For information about research activities within an academic department, go directly to that department's webpage from this [list of departments](#). For information regarding institutes, centers, museums, and field stations, use the drop down lists below to filter by field of research and type of research unit. A list for [research centers and institutes by subject area](#) is available here.

To provide a new unit profile or update an existing profile, please send an e-mail to research@berkeley.edu.

Field of Research: Research Unit Type:

RESEARCH UNIT	DIRECTOR	EMAIL	TELEPHONE
Angelo Coast Reserve	Mary Power	mepower@berkeley.edu	643-7776
Archaeological Research Facility	Laurie Wilkie	lawilkie@berkeley.edu	642-2212
Arts Research Center	Shannon Jackson	shjacks@berkeley.edu	642-3895
Beatrice Bain Research Group	Charis Thompson	charis@berkeley.edu	643-7172
Berkeley Center for Cosmological Physics	George Smoot	smoot@cosmos.lbl.gov	486-5505
Berkeley Center for Criminal Justice	David Sklansky (Faculty Director)	dsklansky@law.berkeley.edu	510-643-3506
Berkeley Center for Law and Technology	Robert Barr	rbarr@law.berkeley.edu	643-6960
Berkeley Center for Law, Business and the Economy	Ken Taymor	ktaymor@law.berkeley.edu	643-6936
Berkeley Institute of the Environment	Inez Fung	inez@atmos.berkeley.edu	642-1385

FIGURE 14. RESEARCH UNIT HOME PAGE

Along with using UC Berkeley's system as an example expert system, the System Evaluation Managers created an Access database mockup to reveal the potential functionality and aesthetics a self-created system may embody. Figure 15 shows the mockup's profile page with faculty contact information, bio, keywords and interests, websites and affiliations, awards, publications, and more.

Faculty Profile

Research Network
Cal Poly - San Luis Obispo

Faculty Photo

Jordi

Puig-Suari

Professor

Aerospace Engineering

41A-129

(805) 756-6479

jpuigsua@calpoly.edu

This Professor is currently working as a faculty member at Cal Poly, San Luis Obispo in the Blank department under the College of Blank. He/she teaches lectures and labs related to a subject area and leads the Special Interest Lab. This professor has worked closely with industry including Company, Firm, and Organization. In addition, this professor studied this Area at this University.

Keyword and Interests

systems engineering
thermodynamics

Related Websites and Affiliations

www.lie.net www.calpolysae.org	Institute of Industrial Engineers Society of Automotive Engineers
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Institute of Industrial Engineers Society of Automotive Engineers	San Luis Obispo, CA San Luis Obispo, CA	2000 2008	Present Present
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Awards

Best Teacher Ever Great Research	Cal Poly - SLO Research Place	2006 2009
-------------------------------------	----------------------------------	--------------

Publications

LastName, FirstName. Year. Title. Institute. Page.
LastName, FirstName. Year. Title. Institute. Page.

FIGURE 15. ACCESS MOCKUP'S PROFILE PAGE

In addition, the mockup's search page includes four searchable fields and the search output in one page as seen in Figure 16. Any combination of the four searching fields can contain search criteria.

FirstName	LastName	Department	FacID
Andrew	Davol	Mechanical Engineering	218
Anurag	Pande	Civil & Environmental Engineering	212
Daniel	Walsh	Materials Engineering	213
Dean	Arakaki	Electrical Engineering	214
Gregg	Fiegel	Civil & Environmental Engineering	208
James	Hanson	Civil & Environmental Engineering	209
Jeffrey	Gerfen	Electrical Engineering	215
Jordi	Puig-Suari	Aerospace Engineering	205
Kristen	Cardinal	Biomedical and General Engineering	206
Lily	Laiho	Biomedical and General Engineering	207

FIGURE 16. ACCESS MOCKUP'S SEARCHING CAPABILITIES

Because a self-created system is customizable by the programmer, the Access mockup also included a collaboration page, similar to that shown in Figure 17, to demonstrate potential collaboration topics.

FIGURE 17. ACCESS MOCKUP'S COLLABORATION PAGE

Both UC Berkeley's Faculty Expertise system and the Access database mockup reveal that a self-created system allows for complete customization. In addition, a self-created system can be programmed in a way that allows the system to interface with other existing and new systems, like DigitalCommons@CalPoly. To download a copy of the Access database mockup, go to the Access Database Mockup section in the Appendix.

InfoEd's GENIUS InfoEd is a software company that facilitates research through their products as they connect researchers to each other and to research resources. Their expertise management program is called GENIUS, which gathers and displays faculty information found on curriculum vitae as shown in Figure 18.

FIGURE 18. GENIUS'S PROFILE PAGE

You can see that the GENIUS profile page contains a slight amount of general contact information and links to more detailed information. InfoEd also includes robust searching capabilities in their GENIUS product as seen in Figure 19.

FIGURE 19. GENIUS'S SEARCHING CAPABILITIES

In addition to the functionality that InfoEd’s GENIUS provides, it also already exists at Cal Poly as a “sister product” to InfoEd’s SPIN+, which is currently being utilized by Cal Poly’s grant organization. Therefore, the system would not actually have to be purchased, but rather adopted. However, InfoEd’s GENIUS remains in consideration under the “buy” option because all aspects besides the actual transaction are that of a purchased product. For example, the programming is owned by another company (in this case InfoEd) and not Cal Poly. Therefore, the customization and maintenance component of this system is similar to that of a purchased system. Furthermore, InfoEd’s GENIUS does not include a collaboration area where faculty, students, and outside interest can post questions and comments to one another.

CSU Fresca The California State University system created a research network out of San Francisco State University called CSU Fresca. CSU Fresca includes “research expertise, scholarship, and creative activities of faculty and affinity groups across the 23 campuses of the CSU” [4]. Any CSU faculty member can create a profile and interface with the system; however, it currently is not widely used at Cal Poly. In addition, CSU Fresca is still in its early stages of development and is being piloted at many CSUs. The profile page contains the information shown in Figure 20.

FIGURE 20. CSU FRESCA'S PROFILE PAGE

In addition to what can be seen above, the blue panel on the left contains other areas where further detail is listed. Because CSU Fresca is a statewide system not limited to any particular school, the searching capabilities are different than a typical search engine. For example, as seen in Figure 21, the school(s) you wish to search through must be selected.

FIGURE 21. CSU FRESCA'S SEARCHING CAPABILITIES

You can also use the same selection method among disciplines, regions, and keywords. However, CSU Fresca does not contain a collaboration area and does not contain seamless transitions among pages due to its current beta state.

Now that the alternatives are determined and defined, they are evaluated against both the functional and project management requirements from Table 2 and Table 3. The final ratings and scores were obtained through two rating iterations and an intermediary meeting of the alternatives described in Figure 22.

FIGURE 22. ALTERNATIVE EVALUATION PROCESS

The Evaluation Matrices Template can be seen in the Appendix. The final functional requirements score and a final requirements score from the second iteration performed by the research organization are shown in below Table 5.

TABLE 5. EVALUATION MATRICES

		Digital Commons & Dept Websites		Self created system		InfoEd's GENIUS		CSU Fresco	
Functional Requirements	Weight (%)	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score
2 Easy and accurate searching	20%	10%	2%	90%	18%	85%	17%	75%	15%
3 Collaboration	20%	0%	0%	90%	18%	0%	0%	10%	2%
1 Faculty profiling system	15%	20%	3%	90%	14%	85%	13%	75%	11%
6 Research facility profiles	15%	5%	1%	90%	14%	75%	11%	15%	2%
5 Efficient information transfer	10%	0%	0%	50%	5%	5%	1%	50%	5%
4 External visibility into the system	5%	65%	3%	50%	3%	0%	0%	15%	1%
7 Curriculum Vitae generation	5%	0%	0%	90%	5%	75%	4%	10%	1%
8 Simplicity of aesthetics	5%	25%	1%	90%	5%	75%	4%	25%	1%
9 Links to published works	5%	100%	5%	90%	5%	75%	4%	50%	3%
FUNCTIONAL REQUIREMENTS TOTAL	100%		15%		84%		53%		41%

Final Requirements	Weight (%)	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score
1 Functionality	45%	15%	7%	84%	38%	53%	24%	41%	18%
4 Personnel / Capability	40%	25%	10%	25%	10%	10%	4%	10%	4%
2 Cost	10%	90%	9%	10%	1%	90%	9%	90%	9%
3 Schedule	5%	90%	5%	50%	3%	90%	5%	10%	1%
FINAL REQUIREMENTS TOTAL	100%		30%		51%		41%		32%

An explanation of the ratings for each alternative and requirement combination is included in the Appendix. The final requirements scores reveal the self-created system is the most suitable system for Cal Poly with a high score of 51%.

4.1.2 Implementation Plan

Following the completion of the system engineering process's evaluation phase, the implementation plan details how Cal Poly should implement the system given the allowable schedule (following the software development life cycle), system functionality, available resources, and total cost. This plan essentially acts as the driver—or the controller—of implementation activities for the research office. Therefore, this document should be referred to throughout implementation and provide guidance and direction to the stakeholders. In addition, the following sections will provide insight into the technical components of the system, like the software development life cycle, system functionality, and integration points.

This implementation plan is divided into the following main categories, and the categories' scope is explained below:

- **Schedule** – The implementation schedule is based off the software life cycle in Figure 4. The Systems Requirements Definition task includes all activities described in the first part of this report, and the schedule will primarily be concerned with the design, testing, release, and maintenance. Therefore, the system disposal task will not be considered in this report.
- **Functionality** – The system functionality described in this plan only includes a conceptual look at the features and integrations, and is not concerned with programming or IT details. Specifically, the front end functionality of the subsystems is discussed, and therefore, the back end editing (ex: updating profiles, adding a post to the collaboration page, etc) is not included in this report.
- **Resources** – The resources required for implementation are explained through three direct labor positions and one management position. General roles and responsibilities will be described.
- **Cost Analysis** – The costs considered in this report include those associated with the resources required to program the expert system, transfer data into the system, and maintain the system. Assuming that IT costs and overhead will not be transferred to the research office, these costs to the system are zero.

This plan will provide information about what is included in the scope, and anything outside of the scope will be determined by Cal Poly’s research office.

4.1.2.1 Schedule

The system implementation schedule is based off the software life cycle in Figure 4, and is catered towards Cal Poly’s application. The schedule includes both tasks and milestones. Table 6 reveals the schedule catered to Cal Poly’s establishment of a self-created system.

TABLE 6. IMPLEMENTATION SCHEDULE

Monday of Week ->		pre 6/3	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26
Task Name	Duration (in months)	-24 to 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 - ∞
1) System Requirements Definition	24																
2) Software Requirements Analysis	2																
3) Preliminary Design	4																
4) Detailed Design	4																
5) Coding and Unit Testing	3																
6) Integration and System Testing	1																
7) Maintenance and Support	∞																

The black vertical line signifies the time at which the system evaluation (task 1) is complete and the implementation (tasks 2 through 7) is about to begin. The dark green cells represent the duration of the tasks along a timeline, with the week number and date of the Monday of that week in the corresponding top rows. The blue X's signify the milestone dates, which will fall on the Monday of the week to the right of the X. For example, the Software Specification Review, occurring after task 2 and before task 3, is planned to occur on the Monday of the week to the right, or July 4th, 2011. This schedule does not take into account holidays, and therefore, a milestone falling on a holiday, such as the Fourth on July, is planned to occur on the following business day.

The schedule serves as a recommendation, and therefore, is a suggested plan of action. The research office is ultimately responsible for maintaining the schedule and embodies the decision making control to alter the schedule in the case of delaying or expediting tasks and milestones.

4.1.2.2 Functionality

The functionality of the system has been explained from a top-level perspective through the report. However, this section will provide more detail about the system breakdown and subsystems, which refers to the main functional areas of the system. The subsystems are based off the customer requirements, and therefore, each requirement should be accounted for within at least one of the functional areas, or across the system as a whole. Figure 23 shows a pictorial representation of the subsystem breakdown.

FIGURE 23. RESEARCH NETWORK BREAKDOWN OF FUNCTIONAL SPACES

The expert system will be programmed according to the breakdown structure, and each subsystem will be described in the sections below.

Home Page and Searching The home page and searching subsystem acts as the “umbrella” to the system, and therefore all other subsystems are navigated to through this page. A general layout of the system is shown in Figure 24 below.

System Name Cal Poly-SLO's Research Network	
Brief description of and instructions for using the system	
Profile search criteria <ul style="list-style-type: none"> •Faculty/facility name •Department •Keyword •More... 	Subsystem links <ul style="list-style-type: none"> •Collaboration •Integration points •Other resources
Profile search results	

FIGURE 24. HOME PAGE AND SEARCHING LAYOUT

This page includes either direct functionality or indirect links to most of the system's functional requirements. It is important to note that the search results are included on this page rather than in a new page. This ensures system simplicity and ease of use.

Profile Pages The profile pages include two separate but similar pages: faculty and facility. With the existence of these pages, students, faculty, and outside interest are able to search through faculty information independent of Cal Poly's research organization. The faculty and facility profile pages will be laid out similar to general layouts shown in Figure 25.

Faculty Profile	
Faculty picture, name, basic info, and contact info	Keywords and interests
	Bio
Publications, awards, affiliations, websites, etc	

Facility Profile	
Facility picture, location, director name, link to director's profile	Keywords and equipment
	Bio (about the lab)

FIGURE 25. FACULTY AND FACILITY PROFILE PAGE LAYOUTS

In addition to what is seen in Figure 25, links to the home page and collaboration page will be included in the top right hand corner of the pages. Once again, the system's simplicity and ease of use will be maintained through standardization among the profile pages.

Collaboration The collaboration page allows faculty, students, and outside interest to reach many system users through a single post on the page. The page includes three main areas as seen in Figure 26 below.

FIGURE 26. COLLABORATION LAYOUT

Each area is directed towards a different combination of collaboration initiator and receiver, and all three combinations are explained below.

- Faculty-to-Faculty – One faculty member initiates contact with potentially many faculty members. The anticipated three main type of contact topics include (1) quick advice, which is similar to online forums, (2) short-term collaborations, which may range from a few days to a quarter in length, and (3) long-term collaborations, which may range from two quarters to many years in length.

- Faculty-to-Student – One faculty member initiates contact with potentially many students. This type of collaboration may involve a professor asking for research involvement from students in another department.
- Faculty-to-Outside Interest – One faculty member initiates contact with potentially many faculty members, and vice-a-versa. This type of collaboration may include a company employee asking for Cal Poly students to perform supplemental research for the company. This type of post would not be directed towards students, but rather faculty, because faculty decides whether to take on the project. Then, the faculty member can make a corresponding post on the Faculty-to-Student area once the request from the company is confirmed.

Each post will contain the following segments:

- A heading or title – appears as a link on the main collaboration page, also includes the post date
- Initiator information – the initiator’s name, department, and a link to their profile
- An explanation of the post – usually a description of the project, problem, or collaboration and information as to what the initiator is requesting
- A thread – compilation of replying posts from the receivers in chronological order

Links to the Home Page will be provided on the top right corner of the collaboration page.

About the System The About the System page will include a brief description of the system, a FAQ section and contact information for support and general inquiries. The maintenance and support admin will compile the FAQs as they receive common inquiries. The support contact will be the maintenance and support admin, while general inquiries will be directed towards the research office.

Integration Points The expert system as a whole will integrate with other external systems. This will allow for the system to adopt the existing functionality of other systems and promote the use of one central system for all research related activities at Cal Poly. The following two systems will be discussed in regards to their integration with the expert system:

- DigitalCommons@CalPoly – DigitalCommons allows for other systems to harvest its metadata at no cost through two harvesting standards: OAI-PMH and Z39.50 [22]. This enables the expert system to pull faculty publications already existent in DigitalCommons@CalPoly.
- Learning Management System (LMS) – A LMS is an online classroom resource utilized by faculty and students for access to class materials and related activities. Currently, Cal Poly utilizes Blackboard as their LMS; however, the university is transitioning to Moodle beginning in Fall 2011. Moodle is a free, open source program, and therefore, integration between the research network and Moodle can be done at many points in the systems. Initially, Moodle may benefit from integrating with the expert system’s faculty profile pages.

4.1.2.3 Resources

The resources required for the existence of a research network at Cal Poly as a self-created system include the the owners (the research organization), a programmer, a data harvester and transferor, and a maintenance and support administrator. All the aforementioned resources play a crucial role in the life cycle of the system, and therefore are represented in juxtaposition to the implementation schedule seen in Table 7.

Monday of Week ->	pre 6/3	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26
Task Name	-24 to 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 - ∞
1) System Requirements Definition																
2) Software Requirements Analysis																
3) Preliminary Design																
4) Detailed Design																
5) Coding and Unit Testing																
6) Integration and System Testing																
7) Maintenance and Support																
Resource Name	-24 to 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 - ∞
2) Research Organization																
3) System Programmer																
4) Data Harvester and Transferor																
5) Maintenance and Support Admin																

TABLE 7. RESOURCES AND THE IMPLEMENTATION SCHEDULE

From Table 7, it is clear that research organization holds the largest time investment in the research network as they are the owners of the expert system. The system programmer is involved with developing the system (tasks 2 through 6) for 14 weeks, or 3 ½ months. This duration was decided upon by estimations from programmers in Cal Poly-SLO's IT organization. Two duration estimations were provided (2 and 4 months); however, the final estimation utilizes a slightly more conservative approximation.

Responsibilities and Training The responsibilities and training requirements of each position involved in the expert system life cycle are revealed in Table 8.

TABLE 8. RESOURCE RESPONSIBILITIES AND TRAINING REQUIREMENTS

Resource	Estimated Entry Point	Estimated Exit Point	Responsibilities	Training Requirements
----------	-----------------------	----------------------	------------------	-----------------------

Research Office	initiation	System disposal	<ul style="list-style-type: none"> • Own the system • Hold ultimate decision making authority • Maintain the schedule • Hold others accountable for their work • Ensure the system continues to meet system requirements • Incur system costs • Oversee Data Harvester and Transferor on a daily basis 	Thoroughly understand this report
System Programmer	week 1	week 14	<ul style="list-style-type: none"> • Develop the system according to the concepts outlined in this report • Consult R&GP with any issues or questions as they arise • Adhere to the tasks and milestones outlined in the Schedule section 	None, already acquired through IT organization
Data Harvester and Transferor	week 3	System disposal	<ul style="list-style-type: none"> • Obtain faculty and facility information from currently available resources • Initiate the creation of profiles • Transfer initiated profiles to faculty 	Refer to the Data Harvester and Transferor Workflow in the next section
Maintenance and Support Admin	week 11	System disposal	<ul style="list-style-type: none"> • Perform the four types of maintenance as indicated in the Tasks section of this report throughout the life cycle of the system 	Work closely with the System programmer to understand system code and identify general processes

Communication Plan The communication among the different resource entities will exist to different extents depending on the relationship of the positions. The communication matrix, shown in Table 9 below, reveals all combinations of resource relationships and their corresponding communication level.

TABLE 9. COMMUNICATION MATRIX

Communication between...

	Research Organization	System Programmer	Data Harvester and Transferor	Maintenance and Support Admin
Research Organization		strong	strong	strong
System Programmer	strong		weak	strong
Data Harvester and Transferor	strong	weak		medium
Maintenance and Support Admin	strong	strong	medium	

A strong communication relationship indicates that the two resources will be in close contact with one another and communicate frequently through emails, phone calls, meetings, and more. The weak communication relationship will communicate with one another in the case of questions or process changes, but not on a regular basis. The medium communication relationship will contact with one another somewhere in between the strong and weak relationships, and mainly through email.

Data Harvester and Transferor Workflow The research organization will be directly responsible for the data harvester and transferor, which will comprise of two part-time students. It may be best to put one student will be in charge of obtaining all information related to the following colleges: (1) Architecture and Environmental Design, (2) Business and (3) Engineering. The other student will be in charge of the following colleges: (1) Liberal Arts, (2) Science and Mathematics and (3) Agriculture, Food and Environmental Sciences. Figure 27 shows the workflow of the data harvester and transferor's major tasks.

FIGURE 27. DATA HARVESTER AND TRANSFEROR WORKFLOW

The workflow can refer to the flow of one profile or the flow of a batch of profiles depending on the data harvester and transferor's preference. The following sections explain each step in more detail.

1. Obtain Faculty and Facility Information from Existing Resources – Currently, faculty information related to research is scattered throughout the Cal Poly network in DigitalCommons@CalPoly, department websites, personal curriculum vitae sites, LinkedIn, student group websites and more. Therefore, with the goal of bringing research related information into one central system, the information must be identified and extracted into a temporary file, for example an excel spreadsheet. Each college may contain a student group that can aid in harvesting the college's research data. For example, Engineering Student Council (ESC), which is the College of Engineering's student-body, currently maintains a small database of research facilities. The group has expressed interest in converting their efforts from both population and maintenance of

their own database to data harvesting for Cal Poly's research network. Therefore, it is important for the data harvester and transferor to identify and utilize student groups like ESC.

2. Initiate Faculty and Facility Profiles in the Expert System – Once adequate information has been obtained for a faculty member or a facility, the creation of a profile can be initiated. This includes creating a profile and populating it with a minimal amount of information found in Step 1. In order to create a profile, a username and password must be established. This should be completed by the data harvester and transferor, and the username and password should be made generically. For example, faculty member John Doe can have a username of “jdoe” and a password of “calpolyfaculty” while the Microfabrication Lab can have a username of “microfabrication” and a password of “calpolyfacility”.
3. Notify Faculty of their Initiated Profile(s) – Once a profile is initiated, the data harvester and transferor will send an email to the faculty member informing them of their profile existence. The email should include the following:
 - An explanation of the research network and its purpose – stated in the Purpose section of this report
 - An explanation of the email's purpose – informing the faculty member that a profile has been initiated for them in Cal Poly's research network
 - The initial username and password for the profile – encourage the faculty member to log into their profile, update and add to the existing information, and change their generic password

- An explanation of the collaboration feature – in addition to being able to browse profiles, users can reach multiple people at once through the collaboration space
- An encouragement of system adoption – inform them that use and publicity to other faculty members and outside interest make the system more powerful
- Contact information – include that of the data harvester and transferor, and if the question or concern cannot be answered, provide the faculty member with the research office's contact information

Before sending this email to a faculty member, a draft email template should be created and approved by the research office.

4.1.2.4 Cost Analysis

The cost of an expert system to a well-established institution such as Cal Poly, includes human resource costs. IT infrastructure is not included since IT already exists at both the university and college level. Additionally, overhead costs are not included since the system does not require any additional overhead. The resource costs are based on the assumptions revealed in Table 10.

Programmer	
Annual Salary	\$ 90,000.00
Months to Program	3.5
Total Initial Programmer Cost	\$ 26,250.00
Total Cost per Week (for 14 weeks)	\$ 1,875.00

Maintenance	
Annual Salary	\$ 90,000.00
Percent of Time	15%
Total Annual Maintenance Cost	\$ 13,500.00
Total Cost per Week	\$ 281.25

Data Harvester and Transferor	
No. of Students	2
Hours per Week	10
Work Weeks per Year	48
Hourly Rate	\$ 12.00
Total Yearly Data Transfer Cost	\$ 11,520.00
Total Cost per Week	\$ 240.00

TABLE 10. RESOURCE COST ASSUMPTIONS

Two programmers from Cal Poly's IT organization estimated the development of an expert system to take 2 to 4 months; therefore, the slightly conservative length of 3.5 months was used. The programmer's approximate annual salary and development length breaks down into the total

cost of the programmer at \$26,250 and the total cost per week over the 3.5 month period at \$1,857.

The programmers estimated maintenance of the system would occupy 15% of their time, or \$13,500. Dividing this among 48 work weeks in a year leads to a total weekly cost of \$281.25.

Cal Poly's research organization estimated the use of two part time student employees to perform data harvest and acquisition. With each employee working two hours a week at \$12 per hour, their total cost comes to \$11,520 per year, or \$240 per week. This cost is estimated to occur for at least a year.

Therefore, from the assumptions described above, the following weekly costs—shown in Table 11—will be incurred by the research organization throughout the life cycle of the system.

TABLE 11. WEEKLY CASH FLOW

Cost of the System by Resource	Weeks			
	1 to 2	3 to 10	11 to 14	15+
System Programmer Cost	\$ 1,875	\$ 1,875	\$ 1,875	\$ -
Data Harvester and Transferor Cost	\$ -	\$ 240	\$ 240	\$ 240
Maintenance and Support Admin Cost	\$ -	\$ -	\$ 281	\$ 281
Total Cost per Week	\$ 1,875	\$ 2,115	\$ 2,396	\$ 521

The translation of Table 11 into a chart is represented in Figure 28 below.

FIGURE 28. WEEKLY SYSTEM COST

Figure 28 shows the research organization will incur a larger upfront cost due to initial development of the system. Once developed, the system costs just over \$500 per week, or \$25,000 per year compared to the first year's cost of about \$51,000.

This system proves to be cost effective since the benefits gained from the existence of a research network greatly exceed the costs. This can be justified by the fact that a university must have a research network in order to successfully develop its faculty and students beyond the classroom [13].

Chapter 5: Conclusions and Future Directions

The appropriate models and processes for the establishment of a research network at a university were studied in depth. Through the combination of a knowledge management system, the systems engineering process, and the software development life cycle, a structured evaluation and implementation process was created to provide a framework for universities to utilize. With the application of the process to California Polytechnic State University, San Luis Obispo, a self-created system proves to be the most effective for the university's research network. In addition, the implementation of such a system was planned including the recommended schedule, system functionality, required resources, and analyzed cost.

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APPENDIX

Access Database Mockup

To download a copy of the Access Database Mockup, do one of the following:

Click on this link: [Download](#), or

Copy and paste this link into your browser:

<http://dl.dropbox.com/u/4259382/Mock%20Up.accdb>

Evaluation Matrices Template

Research Network - Requirements Prioritization

The purpose of this survey is to see how closely the system evaluators (Dr. Freed and Anna Hopper) and Research and Graduate Programs (Dean Susan Opava and Debbie Hart) prioritize the Research Network's system requirements. The following questions will guide you through the different system alternatives and their relation to the system requirements. Please read the information and questions thoroughly in order to produce the most accurate analysis and results.

Part I - Background Information

Problem: Cal Poly does not have one central system that contains all faculty information related to research. As a result, interested faculty, students and industry members are not able to readily receive information related to faculty research.

Purpose: The purpose of creating a research network for Cal Poly—San Luis Obispo is to provide faculty, students, and industry with research connectivity and awareness.

Vision: A collaborative network that will display, connect, and promote Cal Poly—SLO's research efforts.

Part II - Functional Requirements

The customer needs were translated into system requirements, which define what needs to be part of the system in order to (1) exist, (2) live and fulfill, or (3) essentially solve a problem. The following requirements have been defined through research and need analysis. How do you weigh the requirements based on their relative importance? The "Total Weight" should add up to 100%.

Requirements	Definition	Weight
Faculty profile system	a expertise management system that focuses on profiles of faculty	
Easy and accurate searching	the ability to search the system through a free search or through different categories	
Collaboration	the ability for faculty, students, and external users (industry) to collaborate with one another through forums, postings, and other tools	
External visibility into the system	the ability for interested users external to the system to browse	
Efficient information transfer	ease of transferring currently held information into the new system	
Research faculty profiles	the ability to treat research facilities as an "entity" that has a profile of it's own	
Curriculum Vitae generation	the ability to generate CVs based on the information entered into the system, can also be linked to CVs	
Simplicity of aesthetics	intuitive, well organized, simple user interface	
Links to published works	links to faculty articles and publications through documents or the web	
Total Weight		0%

Part III - Project Management Requirements

In addition, the functional requirements as a whole must be weighed against other project management considerations. How would you weigh the project management requirements based on their relative importance? Remember, the functionality row takes into account all the functional requirements from the table in Part II. The "Total Weight" should add up to 100%.

Requirements	Definition	Weight
Functionality	The Total Score from the Functionality Requirements matrix.	
Cost	The relative cost of using this system. May include costs associated with purchasing, programming, and/or implementation.	
Schedule	The relative time for the system to be released for use at Cal Poly.	
Personnel / Capability	The relative resources available to program, implement, support, maintain, and/or transfer information.	
Total Weight		0%

Part IV - Developing Alternatives

After researching many different research networks, the following stood out as those that fit our vision. Please review the layout of each system by clicking on the Alternative links.

Option	Alternatives
Do Nothing	Combination of Digital Commons and department websites
Make	Self created expert system
Buy	InfoB's GENIUS
Adopt	CU Presco

Part V - Evaluating Alternatives

Now, each alternative must be evaluated against both the functional and project management requirements. Rate each alternative for each requirement. Enter notes where an explanation is helpful.

Do Nothing - Digital Commons & Department Websites

Functional Requirements	Rating (%)	Notes
Faculty profiling system		
Easy and accurate searching		
Collaboration		
External visibility into the system		
Efficient information transfer		
Research faculty profiles		
Curriculum vitae generation		
Simplicity of aesthetics		
Links to published works		
PM Requirements	Rating (%)	Notes
Functionality		
Cost		
Schedule		
Personnel / Capability		

Make - Self-Created Expert System

Functional Requirements	Rating (%)	Notes
Faculty profiling system		
Easy and accurate searching		
Collaboration		
External visibility into the system		
Efficient information transfer		
Research faculty profiles		
Curriculum vitae generation		
Simplicity of aesthetics		
Links to published works		
PM Requirements	Rating (%)	Notes
Functionality		
Cost		
Schedule		
Personnel / Capability		

Buy - InfoEd's GENIUS

Functional Requirements	Rating (%)	Notes
Faculty profiling system		
Easy and accurate searching		
Collaboration		
External visibility into the system		
Efficient information transfer		
Research faculty profiles		
Curriculum vitae generation		
Simplicity of aesthetics		
Links to published works		
PM Requirements	Rating (%)	Notes
Functionality		
Cost		
Schedule		
Personnel / Capability		

Adopt - CSU Press

Functional Requirements	Rating (%)	Notes
Faculty profiling system		
Easy and accurate searching		
Collaboration		
External visibility into the system		
Efficient information transfer		
Research faculty profiles		
Curriculum vitae generation		
Simplicity of aesthetics		
Links to published works		
PM Requirements	Rating (%)	Notes
Functionality		
Cost		
Schedule		
Personnel / Capability		

Part VI - Selecting a Solution

Based on the ratings provided above, the following analysis results:

			OP Digital Commons			CSU/Pressco		Self-created Expert System		InfoEd's GENIUS	
Functional Requirements			Weight (%)	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score
1	Faculty profiling system		0%	0%	0%	0%	0%	0%	0%	0%	0%
2	Easy and accurate searching		0%	0%	0%	0%	0%	0%	0%	0%	0%
3	Collaboration		0%	0%	0%	0%	0%	0%	0%	0%	0%
4	External visibility into the system		0%	0%	0%	0%	0%	0%	0%	0%	0%
5	Efficient information transfer		0%	0%	0%	0%	0%	0%	0%	0%	0%
6	Research faculty profile		0%	0%	0%	0%	0%	0%	0%	0%	0%
7	Curriculum Vitae generation		0%	0%	0%	0%	0%	0%	0%	0%	0%
8	Simplicity of aesthetics		0%	0%	0%	0%	0%	0%	0%	0%	0%
9	Links to published works		0%	0%	0%	0%	0%	0%	0%	0%	0%
FUNCTIONAL REQUIREMENTS TOTAL			0%		0%		0%		0%		0%
Final Requirements			Weight (%)	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score	Rating (%)	Score
1	Functional		0%	0%	0%	0%	0%	0%	0%	0%	0%
2	Cost		0%	0%	0%	0%	0%	0%	0%	0%	0%
3	Schedule		0%	0%	0%	0%	0%	0%	0%	0%	0%
4	Personnel / Capability		0%	0%	0%	0%	0%	0%	0%	0%	0%
FINAL REQUIREMENTS TOTAL			0%		0%		0%		0%		0%

An Explanation of Evaluation Matrices' Ratings

Functional Requirements		Weight (%)	Explanation of Weight
2	Easy and accurate searching	20%	Without a robust searching capability the system would not be user friendly, and therefore, not readily adopted. This is the most important tool for the system to embody.
3	Collaboration	20%	This is the most important feature for the system to embody. This space provides a connection point for the different to interface with one another.
1	Faculty profiling system	15%	This feature allows for faculty, students, and outside interest to browse through information on their own, which eliminates wasting Dean Susan Opava's time.
6	Research facility profiles	15%	This feature allows for faculty, students, and outside interest to browse through information on their own, which eliminates wasting Dean Susan Opava's time.
5	Efficient information transfer	10%	In order for the system to be easily adopted, existing information from different sources must be able to easily transfer into the new system through minimal work performed by a student employee.
4	External visibility into the system	5%	In order for interested people outside of the Cal Poly Network to partake in the research network, the system must be accessible to everyone. This received a lower weight because firstly, it's crucial that an internal system exists.
7	Curriculum Vitae generation	5%	Faculty would benefit from CVs to be automatically generated from the information contained in their profile. This is not a high priority because it is not necessary to have in order to connect faculty, students, and outside interest with one another.
8	Simplicity of aesthetics	5%	In order to maintain ease of use, and therefore, a readily adoptable solution, the system should remain simple. This is not a high priority because firstly, it is most important for the system to exist, and then to improve on the aesthetics.
9	Links to published works	5%	The system would benefit from containing links to published works through integrating with DigitalCommons@CalPoly. This is a low priority since the links are currently available and may provide too much information about faculty when trying to make a quick connection with faculty.

Final Requirements		Weight (%)	Explanation of Weight
1	Functionality	45%	The functionality of the system is the most important project management requirement. Without a functional system, it will not be effective in serving its purpose.
4	Personnel / Capability	40%	Having the personnel available to program and maintain the system is necessary for the system's long term life. Without the necessary staffing requirements, the system will not be able to be created well, debugged, updated, maintained and supported.
2	Cost	10%	The system cost proves to be of low priority because the benefits of the system are necessary to the development of Cal Poly-SLO faculty and students. Therefore, the benefits are sure to outweigh the costs.
3	Schedule	5%	The system schedule is of the lowest importance because Research and Graduate Programs has allows for a lengthy deadline in order to ensure the system is efficiently running before release.

DigitalCommons & Dept Websites			
Functional Requirements		Rating (%)	Explanation of Rating
2	Easy and accurate searching	10%	The searching capabilities within DigitalCommons are rigid and confusing. It is very difficult to get to a faculty profile in the SelectedWorks component of DigitalCommons.
3	Collaboration	0%	No collaboration space exists.
1	Faculty profiling system	20%	It is very difficult to get to a faculty profile in the SelectedWorks component of DigitalCommons. Also, the information provided on the profiles primarily includes published works, not contact information.
6	Research facility profiles	5%	Departments commonly include information about their labs. However, the information is incongruent across departments and often does not contain adequate information about equipment and relevant contacts.
5	Efficient information transfer	0%	Transferring information into DigitalCommons and Department Websites is performed by student library employees and department employees, and therefore, is difficult to customize by the individual.

4	External visibility into the system	65%	Anyone able to navigate to the department websites or DigitalCommons has access to their contents. However, it's difficult to get to the sites initially.
7	Curriculum Vitae generation	0%	This feature does not exist.
8	Simplicity of aesthetics	25%	DigitalCommons aesthetics are not very simple, and department websites differ from department to department.
9	Links to published works	100%	DigitalCommons' main purpose is to provide links to scholarly work.
Final Requirements		Rating (%)	Explanation of Rating
1	Functionality	15%	Summation of the above ratings times the weights.
4	Personnel / Capability	25%	The personnel exist to maintain the system as is, but the existing personnel do not have the capability to develop the system into what the final state should be.
2	Cost	90%	Minimal since it already exists.
3	Schedule	90%	Minimal since it already exists, and small developments wouldn't take a significantly long time.

Self-created expert system			
Functional Requirements		Rating (%)	Explanation of Rating
2	Easy and accurate searching	90%	Customizable to meet requirement.
3	Collaboration	90%	Customizable to meet requirement.
1	Faculty profiling system	90%	Customizable to meet requirement.
6	Research facility profiles	90%	Customizable to meet requirement.
5	Efficient information transfer	50%	Will probably have to do manually, but potential to export information from excel spreadsheet.
4	External visibility into the system	50%	If found, anyone can access the system. The difficulty will be to make the system easy to find.
7	Curriculum Vitae generation	90%	Customizable to meet requirement.
8	Simplicity of aesthetics	90%	Customizable to meet requirement.
9	Links to published works	90%	Can be done easily through DigitalCommons metadata harvesting.
Final Requirements		Rating (%)	Explanation of Rating
1	Functionality	84%	Summation of the above ratings times the weights.

4	Personnel / Capability	25%	Would have to hire four people internally to program, populate and maintain the system.
2	Cost	10%	Higher relative cost since we would have to pay four people
3	Schedule	50%	Medium value due to programming time

InfoEd's GENIUS			
Functional Requirements		Rating (%)	Explanation of Rating
2	Easy and accurate searching	85%	Many categories available to search among
3	Collaboration	0%	Non-existent
1	Faculty profiling system	85%	Profile driven, but includes many links
6	Research facility profiles	75%	Can treat as a faculty member but does not contain all the right information
5	Efficient information transfer	5%	Must do manually
4	External visibility into the system	0%	Password protected, only those with an account can enter
7	Curriculum Vitae generation	75%	Links exist, working on generation
8	Simplicity of aesthetics	75%	Relatively simple, many links can clutter pages
9	Links to published works	75%	Will be in the next version
Final Requirements		Rating (%)	Explanation of Rating
1	Functionality	53%	Summation of the above ratings times the weights.
4	Personnel / Capability	10%	Would have to be external, not favorable
2	Cost	90%	Minimal cost, since system already exists
3	Schedule	90%	Minimal, no programming time

CSU Fresca*			
Functional Requirements		Rating (%)	Explanation of Rating
2	Easy and accurate searching	75%	Many categories, some minor glitches
3	Collaboration	10%	Non-existent, but can request to add
1	Faculty profiling system	75%	
6	Research facility profiles	15%	Can treat as a faculty member but does not contain all the right information. Can also use a group profile.
5	Efficient information transfer	50%	Have export methods but only some are useful to CalPoly-SLO
4	External visibility into the system	15%	Anyone can access if found, but must increase the finding rate

7	Curriculum Vitae generation	10%	Does exist, but does not seem to pull info from profiles
8	Simplicity of aesthetics	25%	Layout is not intuitive in some areas
9	Links to published works	50%	Contain published works, but no links
Final Requirements		Rating (%)	Explanation of Rating
1	Functionality	41%	Summation of the above ratings times the weights.
4	Personnel / Capability	10%	Would have to be external, not favorable
2	Cost	90%	Minimal cost, since system already exists, just need to adopt
3	Schedule	10%	Lengthy schedule due to the time spent getting CSU Fresca out of beta phase.

*CSU Fresca rated low in many categories due to their beta state.