E-Business System Operations: A Concurrent Engineering Approach

Walter Rodríguez, Ph.D., P.E.
Alico Chair Professor in Operations and Director of the Institute for Technological Innovation,
Florida Gulf Coast University, Fort Myers, FL 33965-6565 wrodrigz@fgcu.edu

Abstract - This paper presents the design of a new web-based course titled “e-Business Operations.” The course explores the design and development of electronic enterprise systems and its operations using a concurrent engineering approach— including project activities, such as, needs-assessment, conceptual-design, operational-design and prototype implementation. Students apply the acquired knowledge and creativity to the development of their own e-business enterprise projects and associated system operations—including a Java-based portal and an electronic logistics and purchasing system. In the first course offering, the students developed solutions that enable virtual enterprises to create and monitor online portals and stores. The web-based solutions include templates, inventory management, payment gateway support, shipping calculation, and an integrated shopping cart.


THE BACKGROUND

During spring 2006, forty students majoring in business, computer science and engineering, information systems, and health sciences, among others, participated in a new cross-disciplinary course titled “e-Business Operations.” The instructor arranged with the university registrar to cross-list the course, allowing 20 undergraduates and 20 graduate students to participate in this web-based course.

The purpose of this arrangement was to emulate real-life experiences by creating a closer-to-reality environment of students at different levels of maturity and technical skills. The students worked in two major projects, per syllabus at http://itech.fgcu.edu/cis/assign-eBiz.html. In addition, students had to participate in weekly asynchronous (electronic web board) and synchronous (electronic chats) discussions.

The instructor divided the students in teams, based on their backgrounds, as determined by their self-assessment on a posted “Roll Call” discussion forum. The project teams included at least one student from a technical field (i.e., computer science, information system, or engineering) and at least one business major. The lesson forums were posted in the Course Management Systems at http://elearning.fgcu.edu.

To support the instruction, the author developed a model for the integration of Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Supply Chain Management (SCM) applications and strategies. The following sections describe the course content as well as the challenges and opportunities.

THE WEB-BASED COURSE CONTENT

The e-Business Operations course applied concurrent engineering design methodology to the design and development of e-business enterprises and its systems. The premise was that there is lack of a rational, methodological approach to e-business design, akin to the product-development followed in concurrent engineering that has distressed the infant Internet industry [1][2][4][8][9].

During the roaring 90s, the e-business industry was experimenting but was ultimately designed for failure since many of the e-businesses were developed without a rational business plan [5][13][17]. For this reason, the instructor decided follow to the concurrent engineering methodology for designing and deploying electronic enterprises—a step beyond intuitive or rule-based approaches [11][12][19].

As a starting point, the course utilized a cyclical-model consisting of three e-business development phases: conceptualization, simulation, and implementation [12]. Essentially, since an e-business “idea” rarely springs forth complete and ready to go, realizing the idea [16]—that is, turning it into a commercial product, system, process, or profitable enterprise—requires business development. Business development requires analysis of the potential organizational structures, IT architectures, HR policies and procedures, strategies, market niche, partnership agreements, and so on, until a satisfactory enterprise design is found. Such consideration and experimentation can be done mentally (intuitively), or by drawing on a napkin (informally), or more logically using strategic and marketing analysis, revenue/cost/asset/operational business models, computer simulations, and other quantitative and qualitative management practices and techniques. In any case, only rarely is the result of the first development effort completely satisfactory, perhaps the business system or process will be too difficult to develop, too complex, or too costly to implement, maintain, or sell. So, once again the business idea goes into the cycle of developing, testing, redeveloping, implementing, and re-testing. Succinctly, the methodology advocated in this paper provides a framework for guiding the e-business development process.

During the first few discussions, the class explored this rational model that shows that the e-biz development process...
The following sections discuss the three major course modules. The e-biz design process are discussed briefly below. It is difficult to know when one phase finishes and the other starts; that is, the process phases can overlap with one another. The model also defines the process is concurrent, that is, the developers may develop both the e-business “product/system/process” and the procedures/rules by which it is to be implemented at the same time. The stages of each phase of the e-biz design process are discussed briefly below.

Table I lists the course objectives and materials used. The following sections discuss the three major course modules.

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<th>Main Objectives</th>
<th>Materials</th>
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<tr>
<td>1</td>
<td>Learn the process and techniques for developing successful e-business enterprises and their operations---including needs-assessment, conceptual-design, operational-design and implementation.</td>
<td>Kalakota, R. et al., e-Business 2.0: Roadmap for Success, 2nd ed., (New York, NY: Addison-Wesley, 2001)</td>
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<td>2</td>
<td>Apply the acquired knowledge and creativity in the development of your own e-business enterprise project and its demand/supply-chain management operations.</td>
<td>Rappa’s Managing the Digital Enterprise at: <a href="http://digitalenterprise.org/">http://digitalenterprise.org/</a></td>
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<td>3</td>
<td>Apply IT strategies in the design and implementation of an Internet-based enterprise (e-Business) ---including online presentation of e-business plan and creation of a Web resource using html coding, or Front Page, or other friendly applications and tools.</td>
<td>And numerous e-business articles, provided by the instructor, such as: Rodriguez, W. “E-Business Method: A Cyclical Model for Internet Commerce Development, Journal of Internet Commerce, Vol. 2, No. 3, 2003.</td>
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### COURSE MODULE ONE: CONCEPTUALIZATION

As defined in the course, conceptualization or ideation is the ability to identify a problem, need/want or business challenge and imagine ways to address it (or improve on it) to make a profit. The "idea person" (usually, an entrepreneur ---not necessarily the analyst or software developer) is the first person to conceive of an e-business product or system or process that will be later developed and implemented. In the e-business design paradigm, conceptualization is the ideation phase of the process. Students start the ideation phase by doing market research on identified needs/wants. This would be akin to the “systems investigation” phase in the traditional e-business or information systems’ development process [14]. Simply put, the student (entrepreneur or marketer) needs to find out what people want or need. But, at this stage, the e-business “designer” must determine what the issues and opportunities are and if it is worth pursuing it. Research consists in surveying the market to determine consumer trends and demands. Students may also observe existing e-businesses (successful and failed), as well as systems, or processes being used, to determine deficiencies or possible improvements.

Next, the course discussed the generation of preliminary ideas (another brainstorming session with the e-business designer, customers, partners, potential investors, and others.) At this point, each of the students’ design teams brainstorm for alternative solutions or opportunities without ruling out “illogical” solutions. The brainstorming session consisted simply on meetings where students identified or proposed alternative solutions to a given issue or actually think of possible ways to address it or solve it. For instance, the lack of hospital emergency rooms may require 911-operators to access a Web-enabled system similar to the hotel industry reservation system.

Of course, the ideation phase may also begin with an opportunity to assist a customer with a specific problem or by organizing a group brainstorm (or, focus group) session to identify a “need” or a “want.” This was followed by a feasibility study---including the analysis of revenue models.

### COURSE MODULE TWO: SIMULATION

According to the e-business concurrent methodology used in the course, once the student/entrepreneur defines the concept, s/he needs to determine the business “goal.” Goal definition (including the leaders’ vision) stage consists of writing a clear statement of the entrepreneur’s vision and goals. The statement is rewritten as many times as necessary - in a concise and comprehensive way - so that it does not favor a preconceived e-business solution. In the traditional methodology, the conclusion of this phase is the identification of the problem or opportunities that will help achieve the business goal. The model advocated also seeks to determine the functional requirements (FRs) of the problem [15]---something rarely seen in e-business plans.

To explain this concept, the instructor asked the students to consider a web-based development example: Let say that our customer needs a wireless web-enabled tracking software system to help contractors reduce transportation costs in a construction site. The FRs may be stated as (1) provide timely web-based information on equipment operations; and (2) minimize distance traveled by equipment (crane and so on). FRs are usually missing in traditional systems development models ---- even when FRs are considered by many web developers and software engineers. Another example, consider that an entrepreneur has identified a need to connect knowledge seekers (students) with knowledge providers (universities). One of the FRs will be “identify course overcapacity” (that is, identify the university e-learning courses that do not have enough enrollment) and match with unmet corporate training needs. The result could be an
emerging e-business matchmaker of knowledge seekers and knowledge providers.

In the above examples the student (future e-business designer) posed questions like this: "What are the functional requirements of the proposed system?" or "How do we propose to solve this problem/issue/opportunity?" In this case, the "idea person" conceived several system solutions including a web-based construction simulator available via wireless devices, onsite. Someone in the group was usually in-charge of recording (or writing, sketching) down the collective statements (or proposed solutions.) The instructor advised that all responses should be written (or sketched) on a board, visible to every group member. Since some of the ideas may need to be refined later in the process, they must also be recorded on paper or computer.

In addition, the e-business designers must perform Web, patent, and copyright searches. It consists of looking up similar e-businesses or systems that may have been registered in the patent office, registration sites (register.com) and so on.

The next stage was to make a preliminary decision of the best alternative solutions to analyze. This was done before performing "systems investigation" or "systems analysis". Here is where existing systems and business processes are investigated to identify opportunities for improvement. Concurrently, at this point, students explored the marketing strategy as well as the financial, human-resource and operations systems.

This is followed by the specification of alternative designs or, traditionally, the "systems design phase". The best solutions must be evaluated, selected and planned and tested to feed into a realistic "e-Business Plan." However, to make a design decision, we need to determine the relevant factors for the system. Things such as supply-chain, operations, cost, reliability, esthetics (user interface), and ethics (privacy issues) are important. Also, the entrepreneur needs to assess their relative importance in attaining the specified design (functional) requirements of the opportunity/problem. Selecting the best idea(s) to be modeled and evaluated (analyzed) and then choosing the best design in an objective way are two of the most challenging tasks that an entrepreneur faces. In the model advocated here, a table called a decision matrix is used to compare the various design alternatives. In this table, numerical values are assigned to each specific design factor, according to the importance of the factors. The design with the greatest cumulative value is the "winner." Many failed e-businesses never took the time to analyze various alternatives. They simply went ahead with their preconceived idea!

That’s good advice but: how do I get there? From the traditional management point of view, we must develop a business plan. From the information systems development point of view, we must be in the "systems design" phase. However, more and more e-businesses and e-products are being designed as integrated systems incorporating both software and hardware (case in point, the combination of a wireless device and web-enabled application in the previous construction site example.) And, these new businesses have very little financial history to develop a rational business plan. This is why the proposed concurrent model suggests going into this intermediate phase: simulation/experimentation. It involves modeling and analyzing the system: trying out various simulated environments and financial projections. This is where economists and financial experts will create forecasting models and perform what-if and breakeven analyses. And, where software developers, in the design team, may create computer visualizations to simulate the software product's performance, or simulate the full e-business operations before going online. This may involve the creation of inter-organizational processes that leverage IT throughout the value chain. Here we can explore best business practices and cases as well as business processes.

Further, in this stage is where “making the transition from e-Commerce to e-Business to e-Enterprise means understanding and anticipating the changes that must occur in every aspect of the enterprise: culture, people business model, organizational model, applications model, management processes, and technology” [4].

Simulation/Experimentation represents the design maturation phase. One often begins this phase by performing analysis, which consists in part of determining the configuration of the system being designed. The web designer needs to determine any other visual information required to implement the system, since the Web browsers are visual tools.

The instructor explained that, at this stage, one may need to use html coding and java scripting, or more sophisticated, xml, or vrml coding, depending on the web application being developed to support the e-business. In some cases, it requires developing “Flash” presentation or constructing geometric models showing the three-dimensional surface of the objects or items on the site (see www.landsend.com). In this simulation phase, we also perform value-chain analysis to explore IT opportunities for lowering costs, improving efficiency, and so on. It consists of linking suppliers (supply chain management) and improving the processes based on the simulation results - always seeking to optimize the system.

**COURSE MODULE THREE: IMPLEMENTATION**

The students then arrived at the "final" phase of their e-business design process, implementation, which refers to deploying, testing, and documenting the e-business system. This is where the various components and objects are detailed and "assembled" into a prototype and a new e-business system is put in operation. This stage involved building a real web system, or prototype, of the e-business system. The prototype is tested with "real" customers in a given advertised region or test market, and is evaluated for its market appeal and "feel." Students checked again the project feasibility and cost-benefit analysis performed in the simulation stage. Reason: The original assumptions may have changed after completion of the prototype system design. In this case, the student used techniques such as the creeping commitment approach [7] [18]. Actually, the instructor explained that the implementation process never ends: Feedback and continuous improvement of the system is required to remain competitive in today's “new-new economy.” Sometimes the
process fails due to extrinsic factors beyond the entrepreneurs control (say, all the sudden the item being marketed loses market appeal), and the e-business design process begins all over again by redefining the opportunity - or by going to any other phase, as necessary.

**E-COMMERCE SOFTWARE SYSTEM**

In order to develop their e-commerce solutions, the students used web-enabled languages and tools, such as, asp, html, xml, Flash, Java scripting, as well as an e-commerce system developed by a former student (who now owns his own web-marketing-performance company). The system provided comprehensive adaptability [3] and functionality, such as, an order management system, data storage capability, store design control, integrated credit card processing, among others. A navigation tree directed the students to all aspects of the online store settings. And the links to the graphical user interface for the store, allowed the students to see all changes concurrently. Below are some of the basic system functions and features used by the students to create their e-business projects:

**I. E-Commerce Store Design Tools**

- Control over e-commerce store design geometry.
- Use of pre-defined html pages and ability to add custom pages created in html and so on.
- Ability to position of each store components on every web page.
- Ability to insert third party module components into the e-commerce store pages.
- Capability to change content of HEAD and BODY tags on each page individually or globally.
- Use ready-made design for their stores, or create a unique look based on a default template.
- Point + Click mode control over fonts, colors, buttons, default navigation bar, product layouts, and more.
- Advanced mode control over navigation bar code, buttons, product layouts, login links, and more.

**II. Administration Tools**

- Web accessible administration interface. Nothing to install on your computer.
- Ability to review history records for each change for all store design components.
- Ability to recall and experiment, and create alternate versions.
- Navigation tree directs the student to all aspects of the online store settings.
- Links to the students’ store provides a way to view changes as they develop their system.

**III. Catalog Management**

- Ability to display unlimited number of products and services.
- Unlimited categories and sub-categories.
- Ability to create detailed product descriptions with text or html.
- Ability to create student-defined custom fields for each product, such as ISBN, UPC, Manufacturer, etc.
- Ability to assign thumbnail and full-size images to each product.

**IV. Inventory and Merchandising**

- Ability to determine Low Stock and Out of Stock inventory levels for each product.
- Customized inventory level messages for each product or universally.
- Ability to hide out-of-stock products from customers.
- Ability to receive email notifications for low or out of stock products.
- Associate unlimited related products.
- Offer upsale products based on order total, items purchased, or both.
- Define product characteristics with attributes.
- Add additional prices or weight to individual attribute options.
- Multiple attribute display types, including drop-down boxes, radio buttons, and text fields.
- Uses attribute templates to assign sets of attributes to multiple products.
• Changes to an attribute template can be copied to all products referencing it.
• Ability to set order minimums based on price, quantity, or both.
• Ability to display custom message for not meeting order minimum.

V. Customer Management

• System encourages repeat business with customer accounts.
• Provide customers easy access to their account details and addresses.
• Create price groups to offer special pricing for specific customers.
• Use availability groups to offer hidden products to specific customers.
• Ability to assign customers to one or multiple mailing lists.

The students enjoyed this system’s capabilities. These features allowed the students the ability to add tremendous functionality to their customized html pages, while concentrating on satisfying the functional requirements of their “customers.” The midterm and final e-business projects are posted at http://www.fgcu.edu/wrodriguez.

CONCLUSION

Since many of the causes of business failure and success have repeated themselves throughout history, over and over again, the author attempted to teach students a methodology for developing e-businesses and avoiding the pitfalls of randomness or following “no process at all.” This is, of course, a first step to request feedback from colleagues and practitioners at the ICEE conference in Puerto Rico, as we move towards a more “generally acceptable” methodology for e-business development. As explained, the cyclical model consists of three phases: conceptualization, simulation/experimentation, and implementation. The model is akin to the scientific method and the concurrent engineering approach for developing new products, systems and processes. This approach might be used to guide new e-business designers and techno-entrepreneurs through the early stages of market analysis, business planning, and even deployment of their Internet-based ventures. Although the model used in this course is still in its advocacy and formation stages, it points to more rational e-business plans as well as experientially based organizational and operational designs.

REFERENCES


