Improving Software Investments through Requirements Validation

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Abstract

IT organizations are increasingly being expected to provide business-solutions faster and with better return on investments (ROIs). Their limited technology focus on software fails to deliver predictable, relevant and cost effective solutions.

*The electronic customer contact management (eccm) toolkit was designed **to rectify the most pervasive problem in software development** that is, the known fact that requirements specifications are **always** incomplete, inaccurate and wrong. The toolkit was used to implement a **human-centric solution** in a wireless center. The solution was driven by productivity improvements in center operations and not by technology. The solution produced **measurable improvements** in the robustness and effectiveness of center operations, providing the business an **ROI** of less than 18 months. The eccm toolkit tackles this business challenge by delivering:*

1. Validated software requirements in areas such as service, operations and marketing while guaranteeing the investment's ROI through faster cycle times (e.g., one software release per week or faster).

2. Tools required by work center management to professionally manage both center resources and enhancements to the team's process-maturity level.

3. Effective change management capabilities to maintain center productivity during the ongoing demand for new capabilities. This need became apparent only after the software bottleneck was eliminated.

1. Investment in Software Solutions

Businesses find themselves today under significant economic pressures to deliver products/services to generate new revenue streams. As a consequence, IT organizations are increasingly being expected to provide business-solutions faster and with better ROIs. The technology focus of IT organizations on **software** fails to deliver predictable, relevant and cost effective **solutions**. This has reached a crisis level in the communications industry. The process responsible for translating the business needs into requirements specifications is ad hoc, without well-defined success criteria for either completeness or accuracy [1]. This is a major challenge as a result of two primary reasons:

1. There is great difficulty in translating high level business needs to detailed requirements specifications that drive the development process (e.g., increase share price by $1.5, improve the yearly productivity of a Rep by 30% in throughput and 15% in quality, improve cycle time of product delivery by 25%). This is further complicated by the lack of communication between the business and the technical staffs; *usually* no member of the team has an understanding of the effective use of the newly planned capabilities. Finally, the requirements are always specified under significant schedule pressures because they are a key bottleneck for budget and development planning [2,3].

2. The requirements-driven investment paradigm incorporates the **wrong economic incentives** to deliver a business solution cost effectively. The business unit is responsible for both the requirements and ROI delivery. The IT organization is responsible for delivering quality software on schedule based on the baselined requirements. The limitations of the deployed solution are clearly the business unit's "fault", generating an *economic model that rewards the internal development organization with additional development resources while it continues to deliver limited/no return on the investment.* This environment facilitates for example, a new release that contains *only COTS updates* (no new capabilities that benefit the business) while causing operational disruptions with severe financial penalties to the bottom line (e.g., loss of Rep productivity caused by system down time, Rep over-time charges to recover lost time, and potential regulatory penalties for non-compliance). That is the primary reason why even system integrators (e.g., Accenture, Cap Gemini, IBM, EDS) with extensive business knowledge *prefer to deliver software* and not business solutions.

It is therefore not surprising that in **all** projects the requirements are **incomplete, inaccurate and/or wrong**. In **Figure 1** we demonstrate this point in regard to the

Figure 1: Prem to Prem MEGALINK BRs Validation
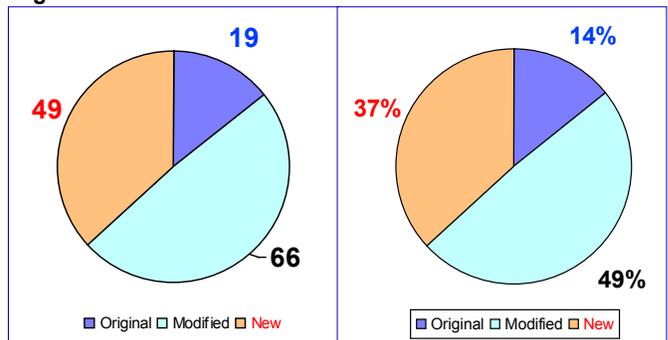
business rules (BRs) that define field relationships associated with a particular order type used by the wireless center. The BRs were being maintained by a team of competent experts and were *considered accurate and complete* (the rules are posted on the company web site with the related customer order form). It took *five* releases to validate the correctness of the BRs. Only **14%** of the BRs were used as is; **49%** of the rules were modified and **49 new rules** (37% of the final total) had to be added as part of the validation process. The process has proven that BRs *cannot be validated* effectively through the standard reviews of textual descriptions. The *eccm* toolkit has demonstrated that BR validation can be reduced from a typical cycle time of 2-3 weeks to 2-4 hours. **Figure 2** shows that business solutions delivered through the current software investment model are being "debugged" through *slow* and *expensive* development cycles making ROI delivery impractical (1:20 is the

Figure 2: Current Software Investment Model
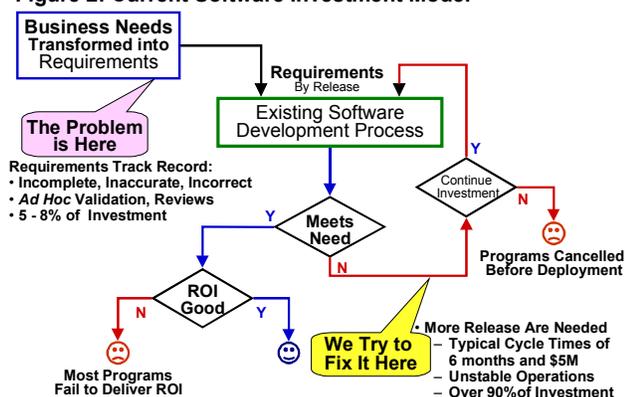
typical investment ratio between requirements specifications and development).

Though this phenomenon was recognized and studied by Boehm et al [4, 5, 6, 7] for the last two decades, the technical organizations prefer to maintain the status quo. This analysis shows that over 50% of the projects terminated **before completion** were caused by requirements that failed to capture accurately what the business needed (e.g., incomplete requirements, lack of user involvement, changing requirements, absence of need, unrealistic expectations).

Software investments will start delivering ROI only after business units change current economic incentives, and **start demanding solutions** with measurable benefits (e.g., in areas such as operational processes, user productivity, training, effective change management, and new product cycle time). Change will happen faster in tough economic conditions that demand a more timely and relevant contribution by IT organizations [8, 9]. The recent **dot.com revolution** made a significant contribution in the "education" of both investors and technical staff on the limitations of narrow technology-based solutions in the market place [15, 16]. In the

software educational system Denning [10, 11] and Dertouzos [12] recognize that human and customer centric success criteria must be addressed if we are to continue the phenomenal growth of the software industry.

Most of the educational system is too isolated from real world programs that are constrained by schedule and ROI. While Dertouzos [12] recognizes the need to *"finish the revolution through human centric solutions"*, he dislikes **predictable and incremental solutions** *("If the project is safe, it is not worth tackling, for it makes only incremental improvements"*). He prefers projects that "*could fail just as easily as succeed*," not recognizing the impact of such statement on graduating software-engineers that will be working on these "unworthy" projects for the rest of their lives. In business the predictability of programs is priceless [2, 8, 12].

A similar disconnect is present in the 1999 ethical standards published jointly by IEEE and ACM [14]. On a philosophical and academic level they are both comprehensive and impressive, but their adoption will cause the disruption or cancellation of most/all large programs. For example, when was the last time that a large project was able to staff all its positions with project-relevant expertise? Given the analysis presented in this paper, how many system engineers could approve the requirements specifications as being complete, accurate and meeting all customer needs.
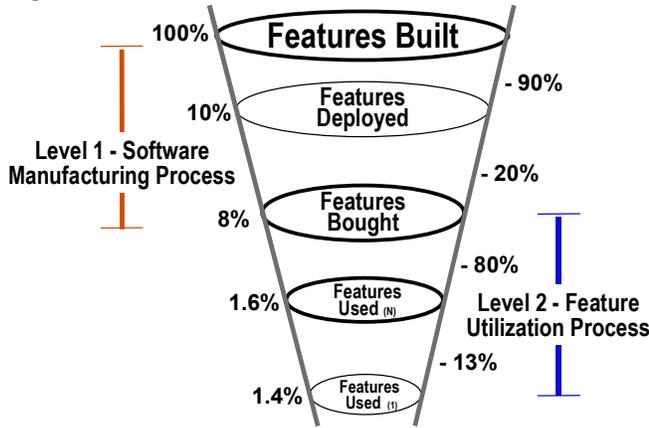
The following two sections describe the Software Pollution and Business Knowledge Management models used by the *eccm* team to expand the requirements to deliver ROI based business solutions.

1.1. Software Pollution™ Model

The *eccm* toolkit was originally implemented as a system-engineering tool to validate the completeness of requirement specifications [1, 4]. In the late 1980's we recognized a phenomena that we termed **software pollution™**. During a period of 15 years we examined over four hundred projects in sizes from 10-500 person-years per release. In every project evaluated there was a large deviation between the number of lines of code (LOC) developed and tested (e.g., investment) compared with the LOCs deployed in the field (see **Figure 3**).

Software pollution is defined as the "scrap" by-product that occurs during the software (manufacturing) development process. For example, software pollution at level 10 means that we invested in the development of *ten LOCs* for every *one LOC* in the deployed release. The level of software pollution measured in these programs was in the range of 10-100, in line with the complexity, size and the team talent associated with each project. In general, larger and more complex projects had higher pollution levels. A similar effect was observed also in feature utilization. No project reviewed had a

Figure 3: Software Pollution Model

Figure 3: Software Pollution Model

Features Built — 100%
Features Deployed — 10% / - 90%
Features Bought — 8% / - 20%
Features Used (N) — 1.6% / - 80%
Features Used (1) — 1.4% / - 13%

Level 1 - Software Manufacturing Process
Level 2 - Feature Utilization Process

Figure 4: Requirements Validation Releases

feature utilization (from all the features deployed) that exceeded 20%. This means that after all the effort, cost and **pain** to deliver a feature to the users, there is a high probability (e.g., over 80%) that no user anywhere will ever utilize it.

The analysis identified five major pollution sources:

1. Incomplete understanding and capture of customer needs in the format of requirements specifications.

2. Traditional system engineering cannot effectively transfer the customer need to the development team. There are several human barriers for information transfer and on the average the features captured by the requirements represent less than 20% of the capabilities included in the deployed product and subsequent service.

3. The development team attempts to implement a system that will support a very large user base in a **long** single release. Long projects are attractive to development organizations because of the less frequent interaction with end-users (e.g., success criteria). Business needs evolve rapidly and continuously in response to the market, relegating most software delivered irrelevant.

4. The development team attempts premature utilization of "bleeding edge" technology ignoring its current level of expertise. Unknowingly, the project turns into a job-training program.

5. Users have a limited capability to absorb new features. Features will be utilized if and only if they fit into an effective operational process and are still relevant to the business upon delivery.

The *eccm* platform has evolved over the last four years into an effective *software pollution fighter*. *Cost effective product enhancements are possible to reflect the newly acquired insight.* This is not practical or even possible when the cycle times are 4-6 months or longer, and the cost of each release is millions of dollars [2, 3]. **Figure 4** shows the release cycle times during the first phase of the requirements validation process.

The second benefit of this faster cycle time is the ability to *detect earlier* issues that are somehow missed and were not included in the project plan. These surprises
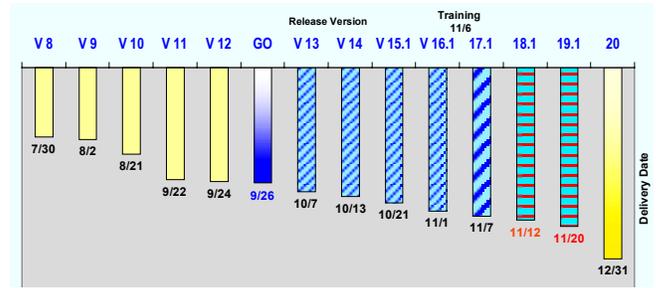
that show up late in every program are key contributors to deployment delays and cost overruns [16, 17, 18]. The *eccm* architecture includes two pilot platforms and one operations platform (see **Figure 5**). It supports a robust change management process by avoiding damage to operational effectiveness through incremental scalable pilot deployments.

The toolkit, using generic Microsoft technology (e.g.,

Figure 5: Wide Deployment Architecture


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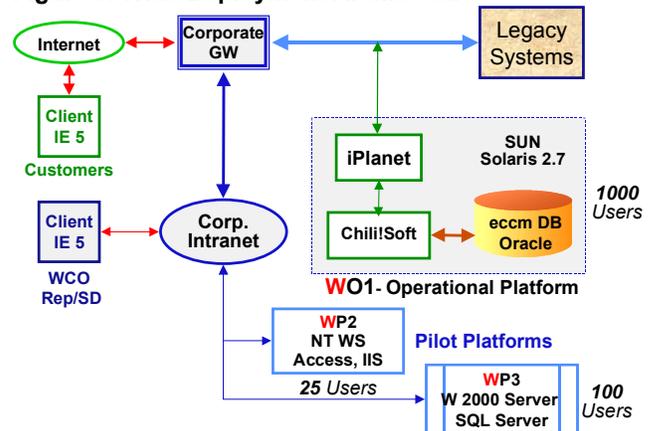
W2000, W2000 SQL Server, IIS), allows scalability to support limited deployment (e.g., 100s of users) to validate the robustness of the solution (e.g., usability, productivity, system operations) while in use.

Reps and System Designers (SDs) use the pilot platforms WP2 and WP3 for requirements validation and limited deployment respectively. The operational platform is used for order processing by customers, Reps and SDs. Reps/SDs have access to both operational and pilot platforms according to their responsibilities. For example, a small group of twenty Reps/SDs may participate in the validation process of a *new product* (e.g., BRs, processes) while using the operational platform **WO1** for normal order processing. This proved to be an attractive approach to immediately start harvesting the productivity benefits of a solution while the IT organization develops a certified solution that meets the unique architectural guidelines of the corporation [20]. This guarantees that upon deployment, the IT provided solution will be relevant to the business. The software pollution model improved software quality, schedule and business relevancy, but *was not sufficient* to deliver ROI.

1.2. Business Knowledge Development Model

During the 90's we had the opportunity to analyze over *sixty* telecommunications services that have met customer needs (e.g., successful customer trials) but failed in the market place representing an investment of over 800 million dollars. The results of this analysis were mapped into the traditional "idea pipeline model" for innovation [11, 19]; ideas flow sequentially through a pipeline comprising of peer reviews, prototype development, manufacturing and marketing. The model showed that this slow process required ongoing R&D investments as new success criteria were being encountered during service evolution. Even in a regulated environment the ROI of these services was not acceptable because it was difficult to keep up with the ongoing changes in both technology and customer needs. The model was modified to monitor incremental progress using *number of customers* as the primary success criteria; the updated "idea pipeline model" includes peer review of new ideas, prototype development, user market trial, limited deployment and wide deployment (see **Figure 6**). Ideas advance from state to state by meeting

Figure 6: Business Knowledge Development Model
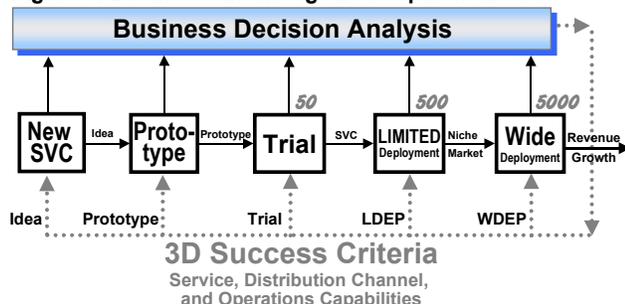
the success criteria we harvested from our analysis. This significantly improves the project's ROI because of *concurrent investments* in **service, operations and marketing** (the three dimensions - **3D**) capabilities must be in line with both the number of customers using the service and the accumulated business insight. Repeatedly it was demonstrated that business insight/customer size scales by a **factor of ten** or less; that is, for example, if we can cost effectively meet the needs of 500 customers we will use this insight to develop the infrastructure for 5000 customers (or alternatively 70/700 respectively). A 5000-customer infrastructure can be replicated to maintain business growth that is not constrained by our business insight. The reassessment of these failed programs using this enhanced business development model showed that *large investments were made* in new capabilities based on limited (or no) business insight (e.g., based on a 50-user trial), always expecting wide acceptance of the service by millions of customers. In every case it became difficult and costly to evolve the initial (incorrect) infrastructure as the business insight

was acquired, thereby, experiencing high software pollution levels.

The primary success criteria categories that prevented success in the market included*:* **lack of champions** (e.g., R&D champion, sales channel champion) **and/or resources** (e.g., capital for operations platforms, training, development staff, travel) and **the inability to cost effectively deliver the necessary 3D capabilities** (*service capabilities* (e.g. ease of use, cost, reliability, feature set); *operations capabilities* (e.g., help desk support, billing detail or frequency, maintenance, trouble resolution) *and marketing capabilities* (e.g., cost of sale vs. revenue monthly revenue stream, lower cost competitive service offerings, inability to sign up distribution channels). In this enhanced investment model there are no "bad ideas", only ideas that may be ahead of their time to meet the business success criteria; ROI is improved by slowing down the investment rate if success criteria are not met.

This model was used successfully to guide eight startups in industries such as advertising, education, healthcare and telecommunications [21]. Every one of these business entities was able to reach limited-deployment and to break-even financially within a year or less. **Appendix A** includes the detailed success criteria of the business-knowledge development model [23]. The models were also used to update the software-investment paradigm to be **ROI driven**, as shown in **Figure 7**.

Figure 7: ROI Driven Investment Model
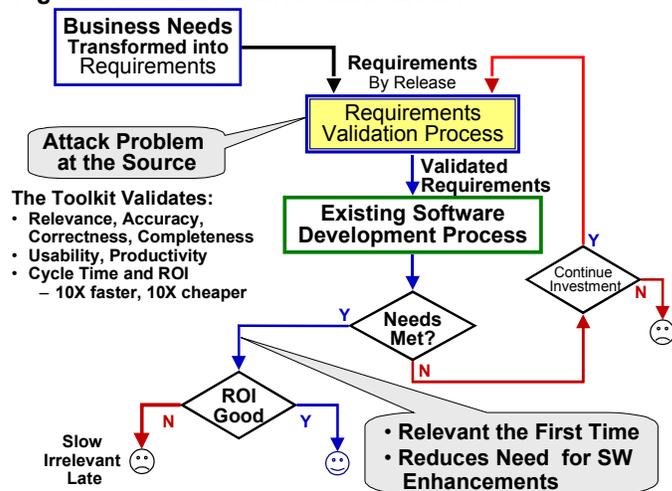
2. Wireless Center Operations

The Wireless Center is responsible for processing approximately 120,000 orders per year. Each order is for the provisioning of a transmission circuit that will provide interconnection between wireless network elements such as switches and antennas (e.g., AT&T Wireless, Cingular, Nextel, Verizon, etc.). Some orders are for a single trunk circuit while others may include a fiber ring within a city or a state.

In the original operations environment without *eccm*, orders were submitted by over 500 customers using faxes and emails. The center had no effective tracking mechanism for the orders received. It was the responsibility of ~60 Reps and ~50 System Designers (SDs) to process the orders received in the center and issue orders to the network provisioning team responsible for the physical delivery (deployment, testing) of the service. The cycle time for provisioning may be less than a week in the case facilities were in place, or it may take 4-6 months if new facilities are required.

Order processing requires the data entry of each order into a set of **legacy systems** such as service order systems (SOS) and billing systems (BS). Each system validates the order information for both accuracy and completeness (e.g., telephone numbers, addresses, contract information, etc.).   In some cases error processing may require contacting the customer for clarifications ("clarifies") to ensure the accuracy of the data. These "clarifies" were transmitted in the past using telephone calls, faxes and/or emails. Similarly, customers unhappy with the progress in their order processing are provided the option, through "escalations", to increase the processing priority for a particular order.

The limited order tracking capability in the center combined with an ever-increasing number of escalations resulted in a crisis mode of operations with high stress levels and reduced Rep productivity. For example, it would take on the average 2-3 days to receive a response on an order status inquiry. Center management was provided only monthly quality and throughput (summary) reports delivered usually 2-3 weeks after the end of the month. On the average it takes six months to train a newly hired Rep. The yearly business growth of ~30% per year required a parallel staff growth to meet the order processing load. All previous software investments have failed to improve Reps' productivity. *The objective of this project was to increase the center's order-processing throughput without staff growth [22].*

3.   *eccm* Capabilities in Support of Requirements Validation

The *eccm* toolkit supports requirements validation capabilities in six key areas related to the wireless center solution: architecture, configuration management (CM), web based user interface (UI), business rules (BRs), operational processes and center productivity management. **Figure 8** identifies these **key validation areas** that were expanded in conjunction with demand (a capability was usually added if we experienced churning of the requirements in an area).

eccm provides an environment in which users are delivered *clearly defined and measurable benefits* instead of *software features* [8, 21]. The *eccm* solution

Figure 8: *eccm* Toolkit Validation Capabilities
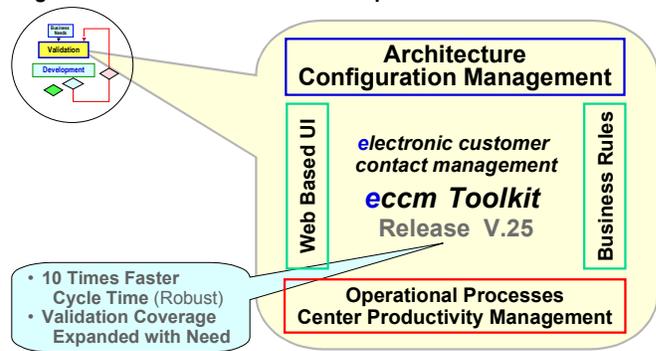
was deployed in the wireless center as a management tool to support the order management processes in three phases:

1. Order management processes

2. Teleworker mode of operations (reduces Rep/SD cost while improving their quality of life)

3. Flow thru integration (providing an effective solution to order fall-out processing, a byproduct of imperfect automation-software implementation).

The rest of this paper focuses primarily on validation capabilities in the area of configuration management and center productivity management. The other validation areas (architecture, web based user interface, business rules and operational processes) are only briefly summarized with detailed examples provided in [22].

3.1.   Architecture

The architecture guarantees that all validated functionality is tested for robustness and that it delivers the productivity objectives specified. The two pilot platforms are used for both requirements and solution benefits validation. This eliminated most center disruptions associated with new release deployment. For example, a typical two-hour outage in a 100-person center results in a productivity loss of at least 2 Reps/years (this estimate does not include impact on future customer orders).

3.2.   Business Rules (BRs)

Business rules validation turned out to be a surprisingly difficult challenge. Initially BRs were provided to the development team in a textual description form. Once implemented in software we discovered that no previously processed order could pass verification. This was due to incorrect and missing information in the BR descriptions. This complex BR knowledge is made available to the users as a standard product related report. The BR's textual description was also integrated with the browser's standard help feature. The user has direct access to this knowledge base just by positioning the

mouse pointer over a selected field. This turned out to be one of *the most valuable aspects of the application* during order creation or verification. It also proved to be an effective "safety net" to the training program. The BR knowledge is updated continuously based on users' feedback without any service interruption. Several new users were able to create and submit complex orders after they were given a brief (10 to 15 minutes) introduction to the application (without training).

3.3. Web Based User Interface

Users access the *eccm* application through industry standard browsers (e.g., IE 5). The training of a Rep prior to *eccm* deployment in the complete WCO operations took over 6 months. Three human centric success criteria were identified for the solution [12]:

1) User training should take a day or less including hands on use of the software capabilities.

2) The application must support the baselining of user capabilities through measurements collected while processing a standard set of test scenarios (qualify Rep's performance before "going live" into order processing).

3) New computer literate users must be able to use the application without training, exposed only to a limited introduction to the application (e.g., 15 minutes).

All three of these objectives have been met.

The following user features made this possible:

a. The BR knowledge base was turned into an effective "help" capability using the standard browser feature (used to create and correct orders).

b. The system maintains a complete trace of *all order* content and status changes; each trace record identifies the initiator of the action as well as the date and a time stamp. This information is available on line to all authorized users *providing **process transparency** - a key productivity factor*

c. The user interface has a *table driven* configuration to select which subset of the order fields (approximately 10% of the total number of fields) will be displayed in the active work list. This allows *ongoing* refinement of the UI based on user experience (see **Figure 9**).

d. The user interface includes a powerful two dimensional **sort capability**. First, any subset of the order fields can be "equipped" with a sort option (the selection is table driven like (c) above bounded only by the display area). So far 16 fields were configured with this option (see **Figure 9**). Second, a column sort is provided for all visible fields that could benefit from such a capability. The combination of these two sort capabilities creates a powerful *ad hoc report generator* that does not require expertise in query processing. This eliminates the need for technical staff in support of this function; this also addresses the difficulty that users experience with boolean logic. We extend this by

Figure 9: *eccm* Display and Sort Capabilities

including three "standard" sort configurations to handle workload by urgency (default), by submitted date and by active orders of the whole team.

e. The user interface **guides** the Rep to carry out work assignments based on their urgency. The priorities are set via table driven rules according to the order-processing performance objectives established by management. If the set objective is missed the work assignment is marked in "red"; if 70% of the interval allocated for processing has already expired, the work assignment is marked in "orange". This provides an effective load management tool for individual and team productivity. **Figure 10** shows the **real time tracking function** for order processing at Rep and Team levels. It tracks workload by category (e.g., assignments, order processing, order tracking and status updates) and performance against objectives.

Figure 10: Real Time Process Monitoring

Order Entry/Project Management

1. Orders (Rep View)

Process	Rep View	Admin View	Full View
Assign	0	0	1 *
Work	0	0	7 *
Status	1 *	0	2 *
Track	0	0	4
Done	0	0	0
Total	1	0	14

f. The user interface has an effective representation of verification errors. All verification errors are captured as a list of active links in a "red background" error frame. Each link includes a numeric identifier of the field that failed the business rule verification. Clicking on any error link positions the cursor at the field to be corrected in line with BR knowledge base. Once the correction is made, the following verify-action immediately removes this link from the active error list.

3.4. Configuration Management

The following are the key configuration management features supported by the *eccm* toolkit (primarily, systems engineers use this features to validate requirements without coding):

1.   Create a new product and the related form/BRs. A new product can be made available to customers within a week a major competitive advantage (in the past it took an average of 4-6 months to introduce a new product).

2.   Partition order form into meaningful logical parts with effective **navigation-links** (e.g., some of the order forms include over 130 parameters). The toolkit supports a powerful order-form editor (e.g., moves fields with the related business rules from one logical section to another, modifies headers, modifies business rules, and automatically updates the navigation links to reflect structural changes, etc.). This capability was implemented to speed up new product introductions or make prompt product updates without the traditional "release planning" process. The implementation uses the "section title" concept of a word processor. Once the new structure is saved, the navigation links are automatically updated to reflect the new structure. **Figure 11** how the

Figure 11: Navigation Capabilities
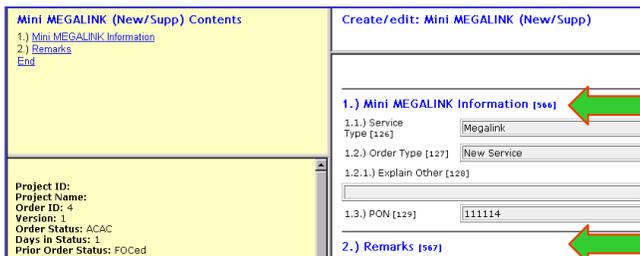
navigation links are implemented using the "section header" concept of a word processor.

3.   Classify data fields as **R**equired, **C**onditionally Required (a user must supply a Required field with an appropriate entry when creating/editing the associated form) or **O**ptional; field names can be modified as needed. Each data field can be assigned integrity constraints and/or BRs.

4.   Modify a variety of system parameters (e.g., time out parameter of an inactive session - 30 minutes; time interval used in active/inactive order reports - 30 days).

5.   The toolkit provides system administrators capabilities to maintain customer accounts, teams, team administrators, users, user sessions, user passwords, database backups, software release updates and projects (professional management of a collection of orders). Throughput and quality reports are provided to administrators to track these CM activities.

6.   The toolkit supports an **UNDO** status capability. The user interface warns the user before an order is cancelled and the action is taken only *with direct user concurrence*.

In the initial implementation of *eccm* once an order was cancelled it could only be restored to an active state through a newly resubmitted order (e.g., resulting in new customer due dates). The "*natural*" usage pattern in the center showed that Reps mistakenly cancelled orders in spite of the required confirmation step. The UNDO command was implemented to restore an order, a clarify and/or an escalation to its previous state if cancelled by mistake; the UNDO capability was extended to remedy numerous other status change mistakes by users. In addition the UNDO function had to be implemented so that user actions that are "undone" are disregarded when reporting on user and/or team performance measurements. **Figure 12** shows the user interface to the UNDO function.

Figure 12: UNDO Action Function

3.5. Operational Processes

The operational processes have a dominant influence on the organization's productivity. They define the organization's internal and external interfaces. Each one of these interfaces represents a handoff between organizations and/or people, a *potential cause for delay and/or confusion*. Therefore, the *eccm* application allows monitoring of operations processes both before and after deployment. High priority was given to process definitions because they are required to *verify completeness* of the functional requirements. A typical project misses about **30-40%** of the needed requirement specifications if the baselined operations processes are not defined and documented. This is the primary reason that most requirement documents do not include throughput and quality objectives since they can be specified only in the context of an operations process.

Initially all process changes using *eccm* required software development that negatively impacted operational productivity and robustness. Currently, table-driven state machines control all order management processes. Most process changes (e.g., create new states, or make changes in the state transition matrix) can be implemented through CM updates.

3.6. Center Productivity Management

The WCO is partitioned into 12 teams; each team is assigned a supervisor that has the role of center team administrator (CTA). Each team includes 10-14 Reps. Accounts are assigned to teams trying to load balance the center load across the teams. The CTA assigns each order to a specific Rep. It is also the CTA's responsibility to reassign orders between Reps if a particular Rep is absent or in over-load condition.

Periodically, changes in the business may result in an account transfer from one team to another to further balance the workload. Because of the unpredictable nature of the order work-load, a Rep from one team may be assigned temporarily to assist another team for a period of time or to process a block of orders.

On the average a Rep processes approximately 1500 orders per year (orders have a large variance in complexity). Given the average 1822 working hours per Rep per year, it means that on the average it takes the Rep 1.26 hours to process an order. Differences across product types combined with differences in Rep experience results in major variance in Rep throughput within a team during a day. Variations of 1:20 in performance are not unusual.

In this fluid environment it is critical to track accurately the contribution of each Rep or team. The trace database maintained by the *eccm* application contains a detailed record of all the content and status changes of an order. It also contains a trace of the all users' session activities. **Figure 13** shows the historical **session analysis** for a specific user in within a time interval. (e.g., session with no activity, session that timed out and a session in which a clarify #3 is processed). The productivity-management

Figure 13: Historical Session Analysis

reports, are accessible by all authorized users (e.g., within an account), provide detailed insight into the effectiveness of center operations at different levels (e.g., user, team, administrator and customer). Anomalies are clearly identified and special "order centric" or "Rep centric" events can be analyzed. **Figure 14** tracks the average time it takes a customer to **create a new order** and submit it for center processing. The report is also used to validate the *quality of the user interface* during requirements validation.

Users are able to submit a new order within 5-10 minutes taking advantage of the order copy-function that was developed primarily as a development tool. They discovered that a new order can be created more effectively by making a copy of a *completed order* and making a few required changes (orders from the same account naturally have a large number of fields in

Figure 14: Average Create to Submit Interval
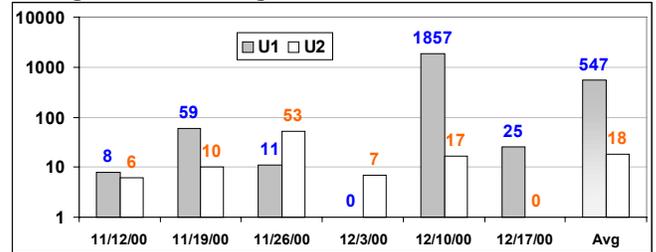
common). Once a few users established this standard of excellence, the center relayed this insight to all other users through advisories. Within two months, all users were performing according to this new performance standard. Management reports are provided to track orders, clarifies, escalations, user sessions, business rules and process state transition rules. Similarly, the toolkit supports throughput, cycle time and quality reports at the user, team and the center levels.

The application currently supports about 150 validated reports. Based on the expertise we acquired, an average time to create a new report is about four hours; iterative validation with the users results in new reports ready to be deployed in the field within 2-3 calendar days. Getting feedback from key users is the gating factor for new report deployment.

4. Conclusions

eccm has proven to be an effective toolkit to:

1. Eliminate software bottlenecks in the delivery of **business solutions**, *shifting the challenge from software development to change management*. Currently, software releases are deployed monthly because of our limited ability to distribute changes effectively to a large number of physically distributed users. The development team continues to operate on weekly release cycles.

2. Improve delivery of *relevant* and *complete* **solutions** to center users. The **cost of a software release has been reduced by at least two orders of magnitude** compared to similar projects in the past. The **weekly-release cycle time is on the average 10-20 times faster** than on similar projects providing an environment in which newly acquired customer knowledge can be deployed in a timely fashion. The **quality of an average release has improved by a factor of 50** using Severity 1 and 2 defects reported from the field. Software defects have not impacted either system availability or data integrity in operations.

3. Enhance productivity at both the individual and team levels using **throughput**, **cycle time** and **quality analysis** supported by real time and periodical reports. The new operational environment supports the establishment of performance standards for transactions, users, teams and the center as a whole. The center productivity improvements have delivered a return on the

software investment of less than 18 months and a significant competitive advantage in the market place.

Acknowledgments

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Appendix A: Business Knowledge Development

Identify A New Application	Prototype New Features	Deploy Market Trial	Limited Deployment (LDEP)	Wide Deployment (WDEP)
		50	500	5000
• R&D Champion • Channel Master • End User Needs • Service Capabilities That Can Satisfy Need • Prototype Resource Needs (capital, people, schedule) • **Prototype Success Criteria** (Business Decision Reports,Contract for trial implementation)	• R&D Champion • Channel Master • Capabilities Demonstration • End User Need Validation • Baseline Customer Need Document • Trial Sponsor • Trial Participants and Their Responsibilities • Trial Resource Need • Patent Application Validation • **Trial Success Criteria** (Business Decision Reports, Business Decision Platform, Operations Capabilities) • LDEP Candidates for Sponsor, Champions and Distribution Channels	• Client Company Champion • R&D Champion • Channel Master • LDEP Service Capabilities (End User Need Re-validation, Customer Need Document - Update) • LDEP Operations Capabilities • LDEP Scope of Deployment (size, physical distribution) • LDEP Sales Script (capabilities, value, pricing, strategy, competition, & training) • LDEP Sponsor • LDEP Participants and Their Responsibilities • LDEP Resource Needs • LDEP Business Model • **LDEP Success Criteria** (Business Decision Reports, Svc. Order, Svc. Provisioning, Data Collection and Billing Interfaces) • WDEP Operations Capabilities • WDEP OSS Development • WDEP Budget Planning	• Business Unit Champion • Client Company Champion • R&D Champion • Channel Master • Customer Satisfaction Metrics • Product/Service Architecture • WDEP Service Capabilities Evolution • WDEP Operations Capabilities Evolution • WDEP Methods and Procedures • WDEP Scope of Deployment • WDEP Sales Script - Update • WDEP Sponsor • WDEP Participants and Their Responsibilities • WDEP Resource Needs • WDEP Business Model - Update • **WDEP Success Criteria** (Business Decision Reports, Sales Objectives, Usability Objectives, Operations Objectives) • Corporate Strategy Update

Success Criteria Areas
– **Champions, Features in 3D, Resources, Think Ahead**