MODELLING USER NEEDS: STUDENTS AS ENTERPRISE ANALYSTS

Gianmario Motta - motta05@unipv.it
Thiago Barroero - thiago.barroero@unipv.it
Daniele Sacco - daniele.sacco01@ateneopv.it

Dpt. of Industrial and Information Engineering
University of Pavia, Pavia, Italy

***Abstract* – We illustrate a set of case studies, where graduate and undergraduate students designed enterprise architectures, that were not only welcome but successfully implemented. The success key was threefold. First the analysis framework, that integrates all the aspects of the systems that are relevant to users, namely user interface, rules, and information. Second, the analysis approach, that guides, trough confirmatory sessions, to elicit real requirements from users. Third, the model-to-model transformation, that assures consistency from the highest aggregate abstraction down to an executable model.**

Keywords : Enterprise Architecture, User Requirements, Requirements Collection Analysis, Systems Analysis, Software Engineering Education, Business Process Analysis, User Needs

I. INTRODUCTION : THE APPROACH TO USER NEEDS

In a previous paper [28], we presented our approach to the analysis of user needs, that we assume as indispensable for architects of services and systems. Specifically, effective analysis techniques are critical to capture the needs of users, especially in innovative business approaches, and can be considered a standard ingredient of service science curricula [10].

In our case, we have selected a set of analysis techniques with a twofold characteristic: time efficiency and assessment. Let us point out what we mean by "assessment" and "time efficiency".

The term "assessment" indicates that needs should be appraised: i.e. they are compared against a normative model, that shows an ideal configuration. The analyst can therefore determine the distance between the current and the ideal situation, thus performing the so called fit-gap analysis.

The term "time efficiency" underlines that the analyst can spend only a limited time of users, which also do not like IT oriented notations, and hardly express what they want.

Moreover, an ideal analysis should have some further characteristics: (a) should cover all the aspects of a system the users perceive, (b) should be based on a user oriented language that helps user to express requirements and (c) should be structured enough to generate structured statements that can be implemented.

In the subsequent sections we illustrate the analysis grid we have used and we discuss three projects that were performed by a team of students as an internship / thesis work.

II. THE ANALYSIS GRID OF USER NEEDS

From what we have assumed in the previous section, an ideal analysis grid (a) should include multiple abstraction layers that go, seamlessly, from an aggregate and user oriented view to a detailed and technology oriented definition (b) cover the aspects that are relevant to user and neglect those that are not relevant.

Let us consider the question (a) "abstraction layers". At the highest level, e.g. when you talk with a Vice President, the notation cannot be detailed. On the other side, the notation should be structured enough to be converted in a rich semantic model, that, in turn, shall be transformed in an executable language – as it happens with BPMN (rich semantic model) and BPEL (executable language). In short, we assume three abstraction layers:

1. Aggregate Strategic Layer (ASL), where needs are aggregate and expressed by very simple notations, as grids or lists;
2. Rich Semantic Layer (RSL), where needs are detailed and expressed by diagram notations; RSL is still conceptual, since it neglects the implantation of requirements; however it is hard to understand for end user since it I very detailed and the language is typically far from the usual user business;
3. Software Engineering Interface (SEI), that transforms the RSL into a notation that is understood by software engineers and defines software functions; in most case the notation used is executable.

For the sake of clarity, we summarize the profile of layers in Table 1.

Layer	Purpose	Notation
ASL	Aggregate Needs	List / Grid
RSL	Detailed needs	Diagrams
SEI	Software functions	Diagrams / Languages

Table 1 - Analysis Layers

On the other side, the analysis should cover all the aspects of the system the users perceive, that we term as "domains". We assume three domains of information needs, respectively (a) the information the system shall use, (b) the workflow of the business processes and related execution rules, and, finally, (c) the user interface, through which information is distributed to (or collected from) users.

The resulting grid of domains and layers has nine quadrants, and each one identifies an analysis segment with a given purpose, notation and domain[1]. Hence, each quadrant

[1] *Alike segmentations of analysis were popular some decades ago, e.g. in Information Engineering [11], but got gradually lost in the Nineties, with the advent of a different analysis paradigm, focused on the gap between a normative application platform, as ERP*

deserves a specific analysis technique. In Table 2 we have listed the techniques we have been using. Here below we give also a short description of each one.

Layer	Domain		
	Information	Processes/Rules	User Interface
ASL	SIRE	GEF	Not applicable
RSL	ER, DFM	BPMN, UML- EP	GOA
SEI	Relational	BPEL, UML	Various

Table 2 - The Analysis Grid

SIRE (Strategic Information Requirements Elicitation) is a catalog of the information domains of an enterprise. Domains are layered into information levels, namely (1) master information, that represents structural properties of an object (e.g. the customer name) (2) event information, that describes transactions concerning the object (e.g. orders by made the customer) (3) analytic information, that describes statistical properties of the object (e.g. the amount of sales). Graphically the SIRE skeleton is a table with a column for each information type and as many rows as the information domains, as shown in Table 3. The analyst customizes the generic catalog and obtains a catalog of the specific information the enterprise should use for its business. Since the customized catalog lists the ideal information, the analyst can measure the related IT coverage by mapping actual computer databases. SIRE is universal and simpler than industry oriented models, as SID [1] in telecommunication, ARTS [6] in retail, and Energetics in Petro-technical. SIRE was developed in University of Pavia [5].

GEF (General Enterprise Framework) lists the layers of business processes an enterprise performs. Ideally, an Enterprise Business Process (e.g. Sales) shall include (1) a planning layer (Sales Planning), (2) an execution layer (Proposal and Selling tasks), (3) a monitoring layer to check the execution workflow (where is the order of Mr. Smith?), (4) a control layer to appraise the actual results against the plan (are we on budget?), and, last not least, (5) an information layer, that contains information management activities (collection, storage and distribution). Graphically the GEF skeleton is a table with as many columns as the processes being analyzed and with a row for each layer, as shown in Table 4. In an ideal enterprise, all these layers shall be structured and computerized. By surveying the current situation, the analyst measures the related IT coverage by mapping actual systems. GEF, also developed in University of Pavia, re-frames some concepts of the SCOR framework [18] and resurrects the "normative concept" from the theory on enterprise systems by Anthony [16] and Blumenthal [17].

Information Domain	Information Type		
	Master Info	**Event Info**	**Analytic info**
Domain 1			
……			
Domain n			

Table 3 - Skeleton of the SIRE table

Layer	Business Process		
	Process 1	**Process …**	**Process N**
Planning			
Execution			
Monitoring			
Control			
Information			

Table 4 - Skeleton of the GEF table

The RSL layer of the information domain transforms and structures the list of information entities, that have been identified at SIRE, into semantically rich diagrams [7] [8] [9]. ER (Entity Relationship) [25] models event and master information, but it is not very practical with analytic information. We do not illustrate ER given its overwhelming popularity. DFM (Dimensional Fact Model) models effectively analytic information by a specific notation. It is a conceptual technique that was developed by University of Bologna[2].

BPMN (Business Process Management Notation) is a popular technique to model the flow of business processes; it is described by many papers [15] [19] [20] [21] [23] [24] . Typically a BPMN flow details a GEF quadrant. UML-EP (Unified Modeling Language Erikson Penker) is a business oriented extension of UML, that adds models to represent the flow of a Business Process and supports the elicitation of Use Cases and Candidate Database Entities [3]. It can be used as a supplement or alternative to BPMN.

GOA (Goal Oriented Analysis) elicits the actions performed by users onto the system - i.e. use cases - from an analysis of their goals. Instead of identifying use cases by a detailed analysis of a workflow, the analyst considers the goals of each user class and identifies the information implied [26]. GOA was developed in Politecnico di Milano. Easy to understand, it is effective with information-intensive and procedure-loose contexts, as information portals, knowledge repositories and document management systems [4].

The SEI layer is the final transformation stage, into which conceptual notations are transformed into executable

(Enterprise Resources Planning) systems, and the flow of a business process. This analysis approach, that concentrated on the gap between the needs of users and the functions provided by the platform, got the name of "fit-gap analysis". It certainly shortened the project times, but it also flattened the creativity for software solutions and the ability to support innovative services and processes. A vivid account of the ERP driven approach is given by Davenport [14]. In recent years, a return to a systematic modeling of user needs is witnessed by the interest on Enterprise Architecture, whose methods are defined by popular frameworks as TOGAF 9 [1] and various essays [12][13].

languages and real software engineering starts. Tough it is beyond our scope, let us recall some popular models as BPEL (Business Process Executive Language) for workflow implementation and the panoply of UML (Unified Modeling Language) for object oriented development [21] **Errore. L'origine riferimento non è stata trovata.**.

The grid we have briefly described supports Model to Model Transformation (MTM). This happens with both information and processes. In the former case, each individual quadrant (or quadrant subset) of the SIRE grid is transformed (and refined) into a data entity. In turn, each quadrant of the GEF is transformed into a root of an UML-EP structure chart or, alternatively, into a BPMN flow.

After we have sketched out the analysis grid, let us consider three cases in which it has been used.

III. CASE 1 : THE CUSTOMER CARE COMPANY

The Customer Care Company (CCC) is a mid-size business that operates a call center and services a selected set of enterprises, that demand high quality services. An example is a service to football clubs, where they help customers in ticketing, finding the way to stadium and alike assistance tasks. Given the variable size of customer enterprises, a same agent may serve multiple enterprises and a same enterprise may be served by multiple operators. To deal with these many to many relations, agents work in clusters that group enterprises of similar profile. The service process is supported by a sophisticated home-made ACD (Automatic Call Distribution) platform.

A previous research analyzed the problem of the workload balance among multi customers agents [29]. While real time work allocation was sophisticated, operations were planned barely on experience. The problem was twofold. On one side, Operations forecasted on experience and lacked of a computerized and flexible term forecasting model. On the other side, detailed information did not flow smoothly from Sales to Operations. Sales information was on paper and stored in private folders. Contracts were forwarded by mail, and seldom updates were sent to operations. So based on this business diagnosis, we started the analysis project, with a team of two bachelor and one Ph.D. student.

So the CEO asked an assessment of CCC business processes and define a system to support the cycle from Proposal to Operations, that was reasonably complete at all layers (as defined by GEF). The overall scope of the study is mapped on Table 5.

	Domain		
Layer	Information	Processes/Rules	User Interface
ASL	SIRE	GEF	N.A.
RSL	ER, DFM	BPMN, UML- EP	GOA
SEI	*Relational*	*BPEL, UML*	*Various*

Table 5 - The analysis scope in Customer Care

First, business processes were mapped current Sales, Operations, Human Resources on GEF. The related fit-gap analysis highlighted processes to implement and deficiencies in the existing ones. Second, we worked out a SIRE to identify strategic information. At the subsequent semantic level (RSL) business processes, that were listed on GEF, were modeled by BPMN; also the information listed in SIRE was detailed by ER diagrams. Finally, GOA was performed by keeping cross reference to information and process domains. GOA diagram is shown by Figure 1. Finally, the team developed a prototype. Stakeholders validated it and the system is nowadays being implemented. Figure 2 depicts the study roadmap. The study was carried out by a team made of two undergraduate and one doctoral student.

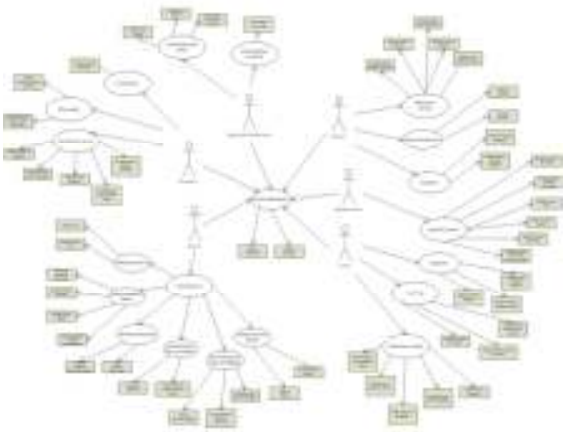

Figure 1 - Integrated GOA Diagram: each stickman is for an actor class and each rectangle is for an action on the system (i.e. Use Case)

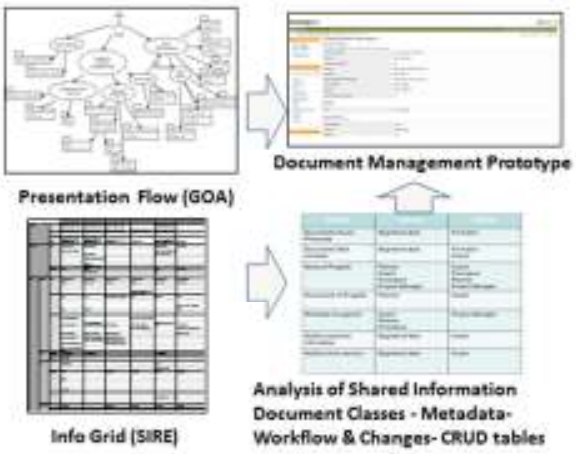

Figure 2 - Analysis roadmap in Customer Care Company

IV. CASE 2 : MANAGEMENT CONSULTING

A large management consulting company (500 consultants in Italy and Latin Countries) decided to rethink from scratch their Knowledge Management System (KMS). KMS is critical in a consulting company, since it gathers and distributes the practices the consulting teams develop in projects and research. So, a KMS not only allows to store the knowledge, but also to improve it continuously, thus building

a competitive advantage. However, a previous system, based on ad hoc input, was empty, because of the time needed to upload documents and unfriendly navigation. So the needs had to be re-assessed and KMS functions defined [28].

The management consulting company has a customer base made of very large corporations. A project produces a huge amount of PPT presentation, and typically includes the following phases:

- Proposal: it typically includes presentation, quotation, negotiation and finalization of the actual proposal. Key information includes:
  - References in similar projects and companies
  - Project overall plan and organization
  - Technical proposal
  - Costs
  - Resumes of consultants
- Planning: after the proposal is accepted, the project is staffed, while deliverables and milestones are detailed.
- Execution: consultants develop documents and meet with clients. Generally this phase generates a lot of progress reports and it ends with a final report.

Stakeholders reflect professional levels, namely:

- Business Analyst: a little more than a trainee, actually write documents.
- Consultant / Senior Consultant: deals with more complicated issues.
- Manager: manages project teams.
- Senior managers: put together proposal and plans.
- Partner: manages large customers and/or a specific domain (e.g. Governance).

Knowledge is a primary asset. Actually a Knowledge Management System (KMS) shortens the time of delivery by pre-configured documents and references, and easies education of junior people by providing best practices and document templates. Finally, it enables cross fertilization of teams and transforms individual knowledge into a corporate asset. Hence the project scope was mainly on user interface as we map in Table 6.

Layer	Domain		
	Information	Processes/Rules	User Interface
ASL	SIRE	GEF	N.A.
RSL	ER, DFM	BPMN, UML- EP	GOA
SEI	*Relational*	*BPEL, UML*	*Various*

Table 6 – The analysis scope in Management Consulting

To define the system, the team, made of two graduate students and one doctoral student, used the GOA model and a confirmatory approach. For each stakeholder, based on the analysis of documents and informal interview, students pre-defined a tentative GOA and a set of mock-ups, that were validated by two interviews. For instance, senior managers work on proposals and they are interested to find out similar proposals while business analysts use templates and document examples to produce reports. So the respective GOA diagrams are totally different.

GOA diagrams resulted not only very rapid to draw but also immediately understood by everybody and easily integrated by screenshot, navigation schemas and use case descriptions. Unexpected results were additional goals added by interviewed people (1-3 for each stakeholder class). An example is the idea of tagging documents based on the dynamic navigation of the documents by the user. This successful and rich analysis hardly would have been feasible with traditional structured approaches, that lack of participation, or informal participative techniques, that lack of structured output.

To foster participation every interviewed people could track his own suggestions on a log table. This was a successful idea for participation and allowed also to prioritize suggestions.

At the end of interviews, the team came out with a document that defined the user scenario of the system. After the requirement phase, prototype activities gave proof of concept. The system is now implemented and successfully used.

V. CASE 3 : SALES MANAGEMENT

Case three concerns the sales management of a vendor of software for Human Resources (HR). Its customers are of different kind, i.e. (a) HR advisors servicing minor companies, (b) organizations running HR software on their premises (c) organizations that outsource the service. The company has a regional network of agents and service centers, with a central sales organization and customer care. As it happens with mature business, most customer information is decentralized, and headquarters have a limited control on customer management. So, management asked a common information base for marketing, document management, sales and control. In short, an enterprise architecture was to be designed. The overall scope of the study is mapped on Table 7.

Layer	Domain		
	Information	Processes/Rules	User Interface
ASL	SIRE	GEF	N.A.
RSL	ER, DFM	BPMN, UML- EP	GOA
SEI	*Relational*	*BPEL, UML*	*Various*

Table 7 - The analysis scope in Sales Management

The team was of five students, respectively three graduate, one undergraduate and one doctoral. Differently from the previous cases, we used a highly interactive approach. So, we met the representatives of the involved departments for 1,5-2 hours. Each interview was on three topics:

1. Organization of the department: Mission, Tasks, Responsibility and Authority
2. Information: SIRE grid
3. Access to information: GOA diagram

To find out the SIRE of each department, we simply sketched on the white board of the meeting room the generic diagram and we customized it until we got something that was “the information we actually use, regardless it is computerized or on paper”. The same happened with GOA.

We put on the whiteboard each stakeholder and started to state related goals (drawn from the description of the organization they just had given to us). Then we assisted the stakeholders in finding what information they needed to fulfil the goal. We took pictures of the notes on the whiteboard and the student team refined it (Figure 3). Finally, by comparing SIRE (taken as a normative model) to existing database, the team performed a fit-gap analysis.

Figure 3 - A SIRE grid put down on the whiteboard

But, as far as business processes were concerned, what business processes should be? We first used collected the evidence on the business process and then we mapped it on GEF that we were using for the first time.

For privacy reasons, we show a disguised GEF form. In an ideal situation, all boxes are green. The coverage shown in Figure 4 reflects a typical paperwork automation, without support to planning and with a limited database (no analytic information and only partial information on events).

With the analysis perimeter well defined, the students team went further and designed a schema for the database, a set of screens for the systems etc.

Results were highly satisfactory for the management that commissioned the project.

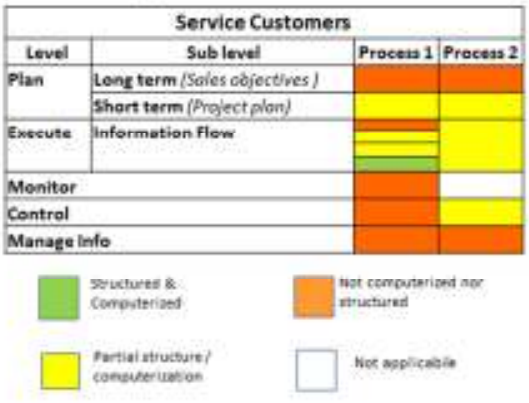

Figure 4 - An example of GEF table

VI. CONCLUSIONS

We have presented three case studies in which a team of students (guided by professors and led by doctoral students) performed a high quality analysis of user needs, in a time ranging from three to six months. The method used is based on a grid that covers the relevant aspects for users, uses easy notations and can be developed in rich semantic models and, ultimately, in executable languages.

This proves that, at least in some cases, students with a software engineering background can successfully deal with "strategic tasks" that are often considered a reservation for business administration students and/or expert consultants. Also it shows also that, at least in some cases, University can contribute to find out innovative solutions.

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