

A NEW PROCEDURE FOR GENERATING REQUIREMENTS REPORTS AUTOMATICALLY IN A REQUIREMENTS ENGINEERING ENVIRONMENT

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Abstract. *In this work we present a new procedure for generating requirements reports automatically in a Requirements Engineering Environment. This environment includes tools for: 1- capturing textual and pictoric requirements; 2- templating reports that can be adjustable to the formats required by the certification authorities or system engineering groups; 3- translating features from/to the main word processors used in the industry (Word, Excel, etc. formats); 4- managing requirements configuration. It provides gains of productivity, correctness, reusability, traceability, coverture, etc, improving the efficiency of the projects. The procedure emphasizes itens 2 and 3, and is illustrated with some examples driven from the aerospace industry. This is an excellent example of the engineering necessary to promote the interaction between univerties and enterprises in the future.*

Keywords: *Requirements Engineering, Reports Generation, Gains of Productivity, Traceability, Reusability.*

1. INTRODUCTION TO REQUIREMENTS

Following the (Easterbrook, 2004) concept, “some human activities may be complex, because they generally involve many different types of people, with conflicting interests. In such situations, it can be hard to decide exactly which problem should be tackled, and it can be hard to reach agreement among the stakeholders.” That is why nowadays it is very important the use of requirements. But, what are requirements?

According to (Dick, 2004) “-Requirements are concerned with anything that affects the quality of a product or service, including performance, design and manufacture and may address function, safety and legality. Usually expressed as textual statements, requirements may also be tables, diagrams or mathematical expressions. Complex products are typically defined by thousands of requirements.”

2. REQUIREMENTS MANAGEMENT

So, for a complex system, we will need a way to match all requirements and guarantee the final product or service quality and the customer satisfaction. For such purposes, it was necessary to introduce and conduct a Requirements Management.

According to (Dick, 2004) “-Requirements Management is the discipline of gathering, expressing, organizing, tracing, analyzing, reviewing, agreeing, changing and validating requirement statements and managing the documents that contain them with the purpose of defining and delivering the right product or service. Requirements management processes span the entire development lifecycle - from inception when requirements are gathered and defined, to the end of development when final testing is carried out with respect to the initial requirements.(...) A decade ago, few engineers would have recognized “Requirements Management” as a discipline in its own right.(...) Today, organizations hire requirements managers to exercise a recognized discipline. There are annual international conferences devoted to the subject; for instance, the IEEE Requirements Engineering conference has been run in Germany, California and Japan over the last few years. There now exists a choice of requirements management tools. Most major engineering companies, and many in the commercial sector, now have requirements management functions.”

But, why this concept became so important recently?

According to (Dick, 2004) the “-Factors that have brought about this evolution include:

- Complexity: Projects have become more ambitious. Software is more pervasive and can be arbitrarily complex.
- Globalization: Companies have become more global through acquisitions, mergers and partnerships. The need to communicate and to create products that satisfy the requisites, regulations and standards of multiple markets increases complexity.
 - Competition: There is pressure to deliver better products to market more quickly and cheaply. Reuse of off-the-shelf components adds complexity to procurement and management.
 - Compliance: An ever-stringent culture of compliance is developing in all industries. Companies are obliged to provide evidence that they comply with regulations such as those mandated by the FDA and Sarbanes-Oxley.”

3. REQUIREMENTS ENGINEERING

To build and apply this concept of requirements management, it was necessary to introduce and perform the Requirements Engineering. This discipline can be further explored in "Hull *et al.* (2002)". But, what are the advantages of using these techniques?

For (Easterbrook, 2004), "Requirements engineering techniques offer ways of dealing with complexity, by systematically breaking down complex problems into simpler ones, so that we can understand them better."

But, why apply these techniques to a project?

Because they help a project manager to take some decisions about quality, cost and time; and, when he have the requirements compiled in an organized way, with a traceability of impact of each requirement, he can find, according to (Dick, 2004), "a balance between delivering the right product quality within cost and on time. These three axes are not independent: generally, if a project takes longer, it costs more. Cost and schedule can be reduced by delivering lower quality. This is illustrated in Fig. 1 as the classic "management triangle"."



Figure 1: The Management Triangle. Source: (Dick, 2004)

4. ADVANTAGES OF APPLYING REQUIREMENTS MANAGEMENT

According to (Dick, 2004), "The benefits of effective requirements management include:

- Greater confidence that objectives are being met. Organizing and tracing requirements engenders greater reflection on the design process and makes the design rationale more explicit.
- Ability to manage change through impact analysis. Requirements tracing allows the potential impact of changes to be assessed more rapidly.
- Improved customer / supplier relations through better definition and understanding of contracts, a large part of which are requirements.
- Ability to track progress / status particularly in the formative stages of a project. When all that the project team is doing is writing documents, it is sometimes hard to measure progress. Effective requirements management puts measurable processes in place.
- Ability to save costs through cost / benefit analysis. Again, requirements tracing is a way of documenting the relationship between benefits (as expressed by the requirements) and cost (as expressed by the design)."

5. GATHERING AND MANAGING REQUIREMENTS

There are a lot of ways to gather the requirements for your project; but for an effective requirement management, according to (Dick, 2004), "In addition to document creation, editing, versioning, retrieval and publishing, requirements management needs the ability to manage the life and status of individual statements and to create, control and analyze traceability to statements in other documents." These capabilities are directly related with the tools that are used to gather the requirements of your project.

So, the simplest and less effective way is the manual one: writing your requirements on a paper and archiving all documents generated to manage these requirements; to consult the documents on any requirements changes, for searching if it will impact in any other requirement. This procedure does not support all specifications for an effective requirement management.

Another way is to write and manage your requirements in a word processing tool or spreadsheet (for example: Microsoft Word or Microsoft Excel). Compared with the first way, it improves somehow the way that you can manage your requirements, because it eases the search for a requirement; but, for impact verification you are supposed to know

which requirement is affected with the changes that you do in other requirement, and manage the traceability manually. So, it still is a limited way to do this kind of work.

The most effective way to manage your requirements is using tools developed for this specific function; for example, the Telelogic DOORS® 8.1, which is the tool used by us to develop this work because, according to recent prizes for this category, it was considered the best one. For example, “Yphise ranked DOORS #1 in its 2002 and 2004 software product assessments.”, as mentioned in (Telelogic, 2007).

According to (Dick, 2004), “-Telelogic DOORS®, the market and technology leader in Requirements Management, increases the quality of systems engineering, business-critical IT and software development projects by improving requirements communication and collaboration.

Telelogic DOORS® enhances quality by increasing the visibility of business objectives, customer needs, technical specifications, and regulations. With powerful capabilities for capturing, linking, analyzing, and managing changes to requirements and their traceability, this multi-platform system ensures conformance to requirements and compliance with regulations and standards.” Moreover, this environment allows user and group management, with read, modify, edit and administrative control access from project to requirement level. Another advantage of this tool is the capability of history storage, allowing to the Project Manager the possibility of checking the modifications done; and knowing who did the change (user), besides a lot of other resources.

6. ADVANTAGES OF USING REQUIREMENTS ENGINEERING

According to a survey did by (Meta Group, 2003), “-Approximately 60%-70% of project failures result from poor requirements gathering, analysis, and management.”

Another problem is when you need to fix an error found during project development: the farther the problem is detected in the project development lifecycle, the higher will be the costs to correct it. This occurs because a lot of decisions during the project advance may be done based on this wrong definition, so, the number of things that will need to be reworked will generate a cost larger than if this problem was solved before these decisions were taken. See the diagram in Fig. 2 that illustrates the Development Lifecycle versus Cost growth.

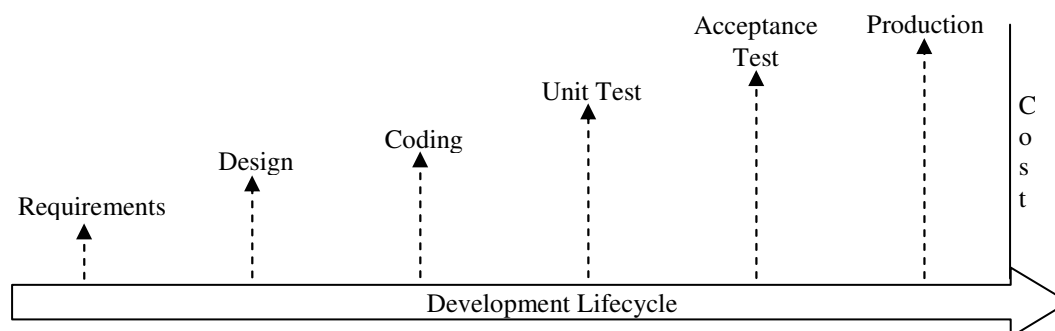


Figure 2: Development Lifecycle versus Cost Diagram. Based on (Austin, 2007).

Besides these facts, you have the customer satisfaction that need to be achieved in the case of a commercial product.

These are some examples of why is very important to spend as time as necessary in understanding the requirements at the beginning of the project, to reduce the costs and the need of reworks. For that, it is indispensable to learn how to write better requirements, to allow better understanding. For more information about this, you can consult (Alexander and Stevens, 2002), (Tavassoli, 2006), etc.

7. WRITING REQUIREMENTS FOR STANDARD PATTERNS

Sometimes, when writing your requirements, you were supposed to follow some pattern, to be approved by a certification authority or only to be in the corporation standard. The main difficult faced by people that work with this situation is to know how to organize the document in the pattern and what are the required sections to be used.

This is an advantage offered by the Telelogic DOORS® tool: a collection of templates with the most known standards used in the development process, as shown in Fig. 3. This option is available when creating a new document of requirements; and, when selected, it fills in the document automatically with all necessary sections found in the selected pattern. For the user, it remains only the task of completing the sections with the requirements.

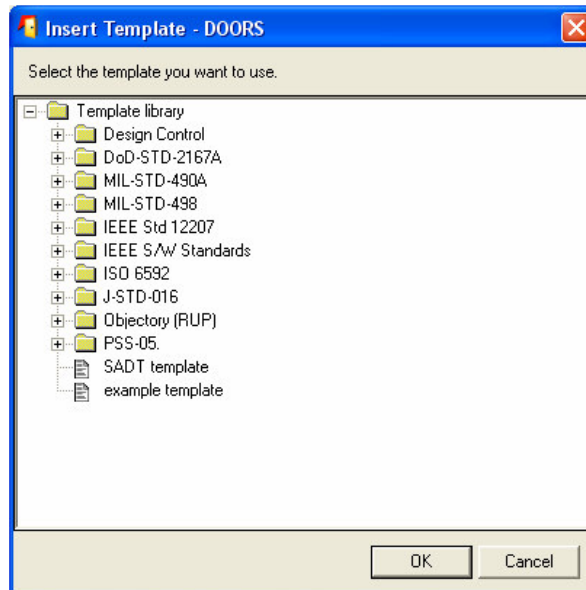


Figure 3: “Insert Template” window in Telelogic DOORS®.

8. A NEW PROCEDURE FOR EXPORTING REQUIREMENTS DOCUMENTS FROM DOORS®

When you are working with requirements, sometimes you need to generate a report by compiling all the requirements related to a specific product or process to send it for checking, approval or execution by the development/design team or by the customer, for example. Whatever the function or for who it will be sent, reports are always necessary. But, the big challenge encountered by the users is that, for each function, the report may have a specific format and may show different data. So, you need to do a lot of manual adjustments to set the pattern specified for the report, to copy only necessary requirements, to adjust layout, etc.; and do everything again when you need another report pattern.

The purpose of this work is to develop a solution for this problem, automating some steps of a report generation, making this procedure easier and faster for the user.

To do this, we will: 1) use some resources available in the Telelogic DOORS® tool to group the necessary requirements for the report; and 2) export the final result to a Microsoft Word document through a Microsoft Word Template file (.dot).

The steps presented below are executed when you already have the requirements document from which you will extract the data for the report.

Then, the first step is to create the Microsoft Word Template file with the desired layout. You can: 1) format header and footer for the pages; 2) set styles; 3) define default sections in the beginning of the document; 4) insert figures, that is, build the initial part of your report and define some general formats; etc. Then, you need to save this template in a known folder.

After that, you can open your requirements document at Telelogic DOORS® and organize data to match your needs for the specific report. When this process is repeated, whatever the period that it occurs, Telelogic DOORS® offers the resource of creating and saving “Views”. These “Views” save the way that you organized data for visualization; and, when selected, reorganize data in the same way, making possible to you generate different reports that contain different data from the same requirements document, only with two mouse clicks. To set a “View”, you can insert or remove columns, containing a document information (static data) or a script result (dynamic data).

Another resource available in Telelogic DOORS® is the possibility of customizing some data or executing some functions through scripts. The script language used is called DXL, and is based in the C language. So, it is easy to learn and apply this scripting when you already have at least a basic programming knowledge. For that, you may consult the DXL Reference Manual (Telelogic, 3 May 2004).

There are two ways to customize the data in Telelogic DOORS®. One is using a type of column, called “DXL Layout, shown in Fig. 4; and another is creating menu options that execute a script file associated.

A “Layout DXL” column type is a column that executes a script file associated with it every time that the page is refreshed, generating an output result to the user. It is useful to retain updated information between requirements that are interdependent, because, if one of them is modified, the information does not need to be manually corrected.

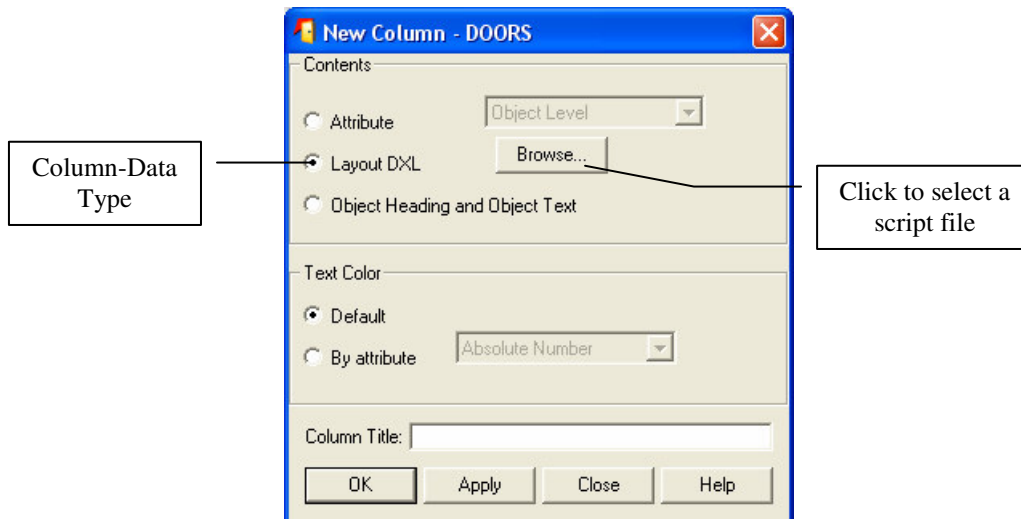


Figure 4: “New Column” window in Telelogic DOORS® with “Layout DXL” selected.

As said before, another way of customizing data is with script files that are executed independently of a column where a result should be shown. Figure 5 shows the “User” menu in Telelogic DOORS® where you can add your scripts; and, when you want to execute one of them, you just need to select the “User” menu and click on the script name.

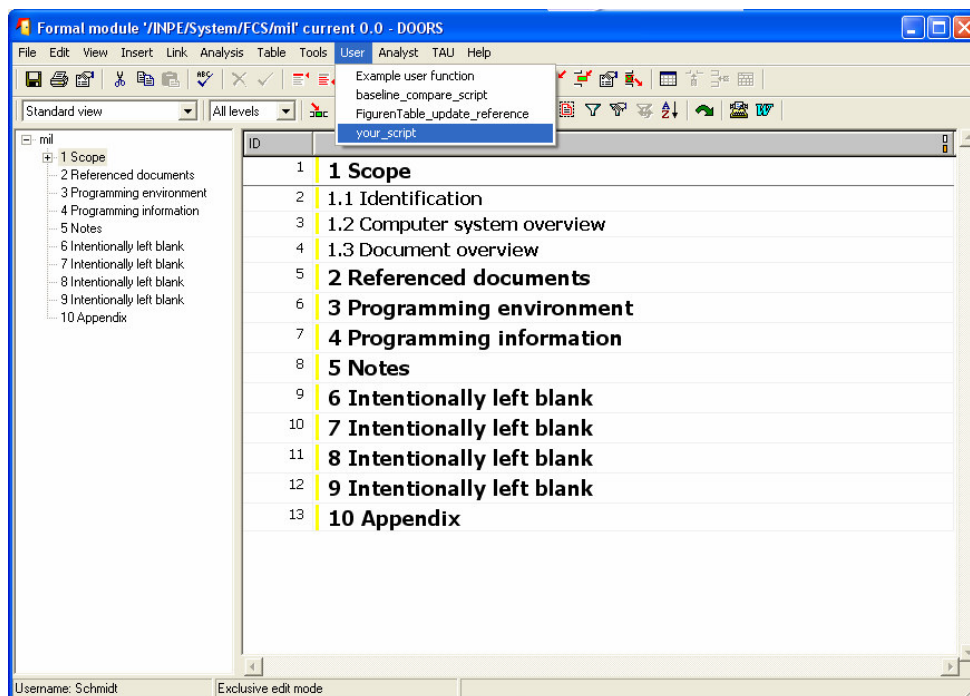


Figure 5: “User” menu in Telelogic DOORS®, showing available scripts.

After organizing and customizing the data according to the format necessary for the report, we need to export it to some program where we can do the final adjustments on the report layout before printing it or sending it to someone. Another important thing is the report to be in an accessible file format for the part that will receive it. Figure 6 shows various export options available in Telelogic DOORS®. For this work, we exported data to a Microsoft Word document based on the Microsoft Word Template created initially. To do it, we used the function available in the menu File, Export, Microsoft Office, Word option or on the “Export to Microsoft Word” button, both shown at Fig. 6. These options open a window called “Export To Word”, with two options tabs, as shown at Fig. 7. At this window, we setup the preferred configuration for export process. We used to uncheck the “Include Empty Attributes” in General tab, shown at Fig. 7(a), to avoid blank spaces on the report where the attribute of requirement is blanked. In Advanced tab, shown at Fig. 7(b), we uncheck the “Use normal template” option and fill in the “Template name” field with the path to a Microsoft Word Template file, saved before.

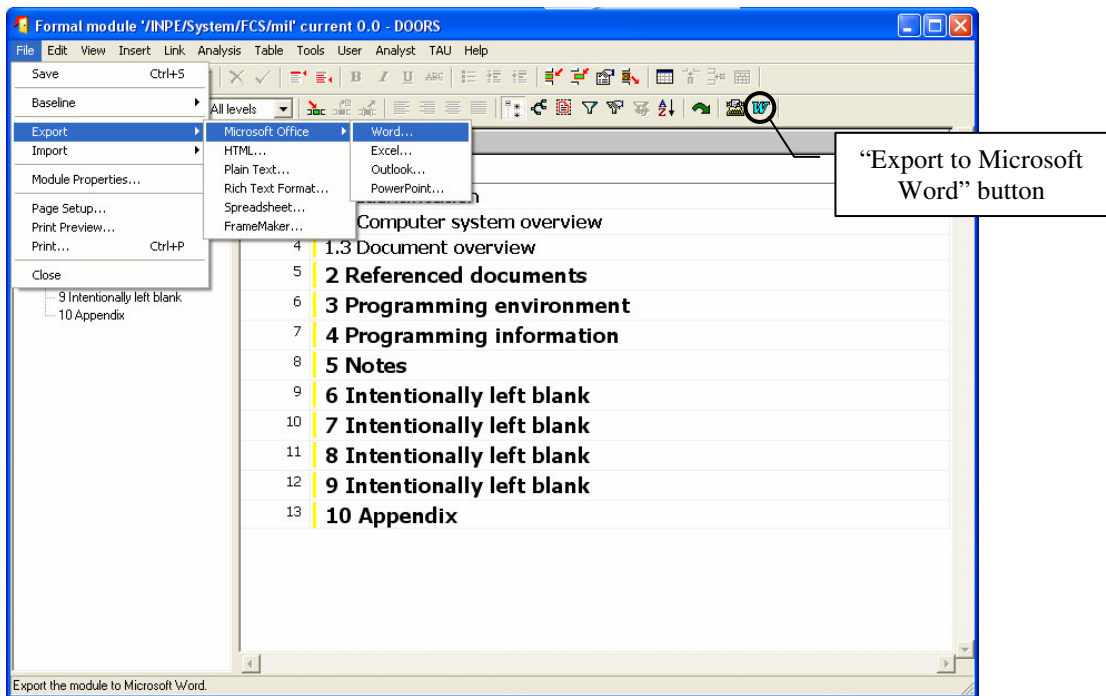


Figure 6: Exporting data to Microsoft Word from Telelogic DOORS®.

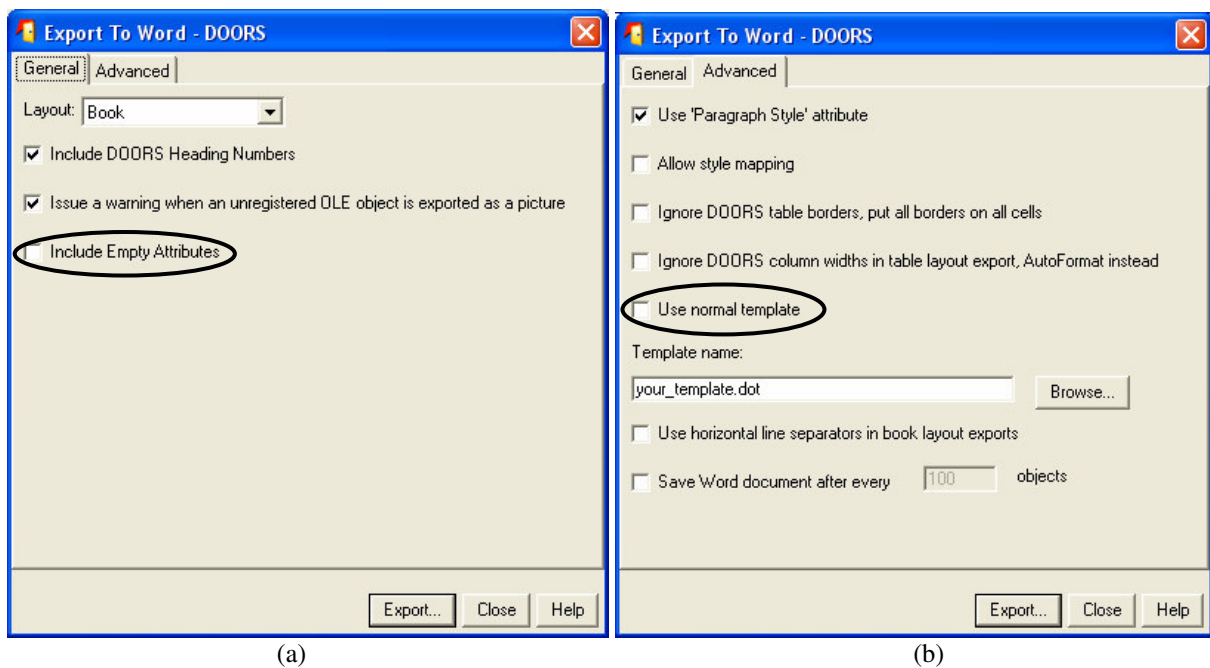


Figure 7: "Export To Word" window in Telelogic DOORS®. (a)General and (b)Advanced tabs options.

Figure 8 shows the result of this procedure, that is a customized report in Microsoft Word document format. It is very good, because this file can be shared with any other user that have a word processor compatible with .doc format. It shows that using Telelogic DOORS® will not block you of sharing requirements information with people that do not have this software.

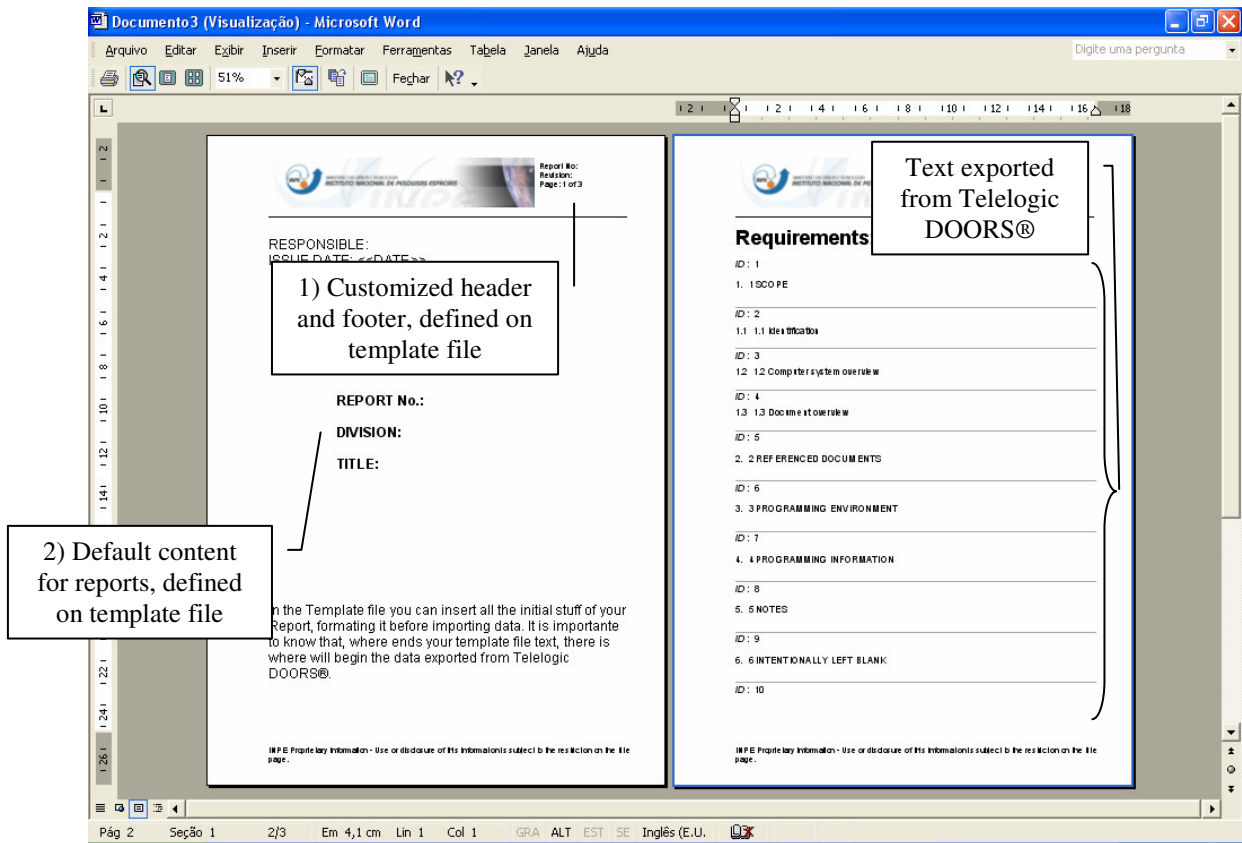


Figure 8: Final result of procedure. Template file contains: 1) header and footer defined; 2) and the text until “Requirements:”, including it. After that, there are the data exported from Telelogic DOORS® requirements document shown at Fig. 6.

9. A NEW PROCEDURE FOR IMPORTING REQUIREMENTS DOCUMENTS TO DOORS®

But, what will you do if you already have all requirements documents done in another format, like Microsoft Word? Shall you make all of them again? How much time will you spend to do this? Is it advantageous?

No. You do not need to do your documents again. If they are in Microsoft Word file, you need only to format it in the right way, setting text styles according to the level of requirement, save as rich text file, and then, import it into Telelogic DOORS®. Figure 9 shows the import options available on File menu.

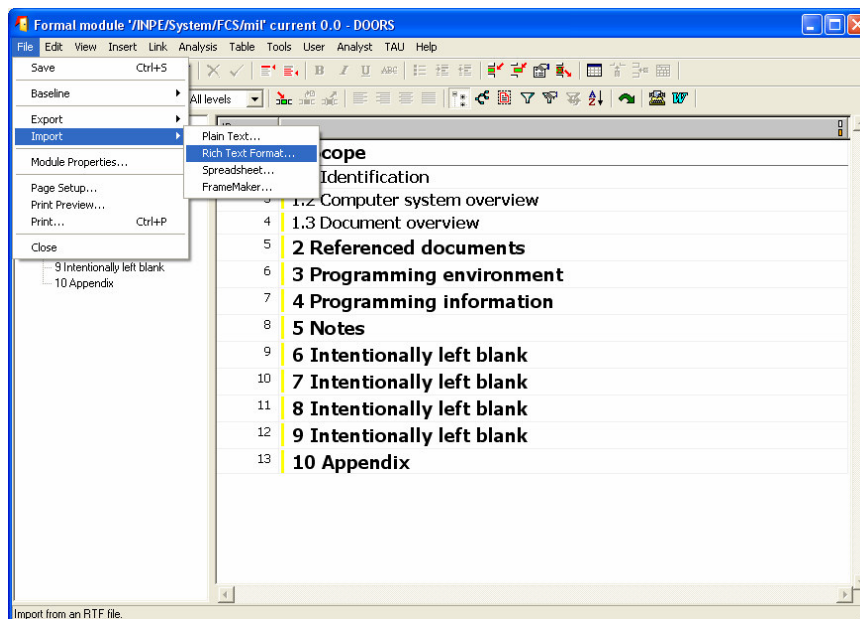


Figure 9: Option Import Rich Text Format, available on the File menu at Telelogic DOORS®.

Figure 10 shows the text style that you need to select for each requirement level on your requirements document. And the result of the import procedure is shown at Fig. 11. Notice that the hierarchy level of the requirements are automatically generated, based on the rich text file format.

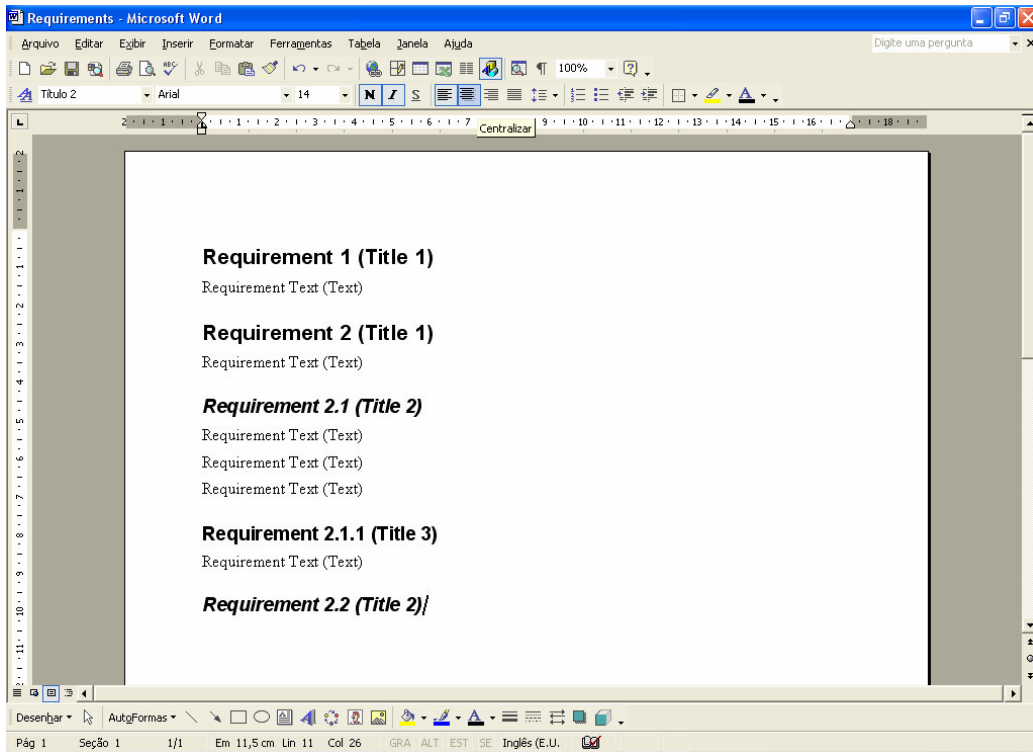


Figure 10: Rich Text file, formatted correctly on Microsoft Word to import into Telelogic DOORS®.

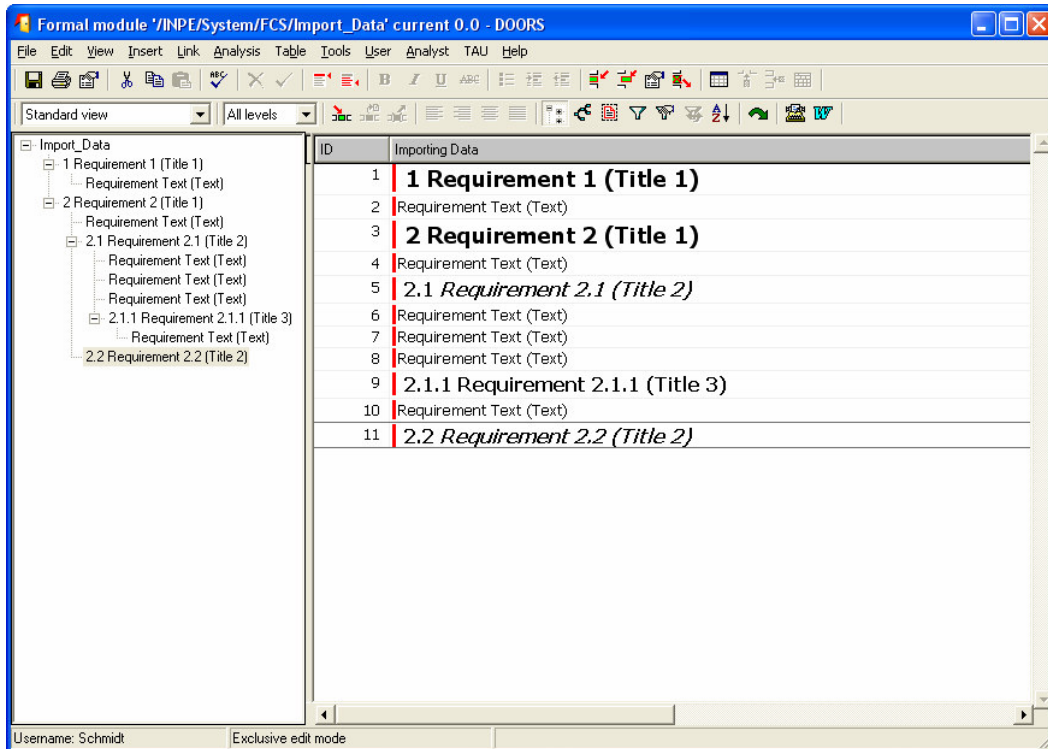


Figure 11: Result after import the Rich Text file shown at Fig. 10 into Telelogic DOORS®.

This shows how easy is to migrate your data to Telelogic DOORS® and start a better control of your requirements. You will not spend much time to do it and will have a big advantage, improving your requirements management; and, consequently, improving your process, product and/or service, achieving the expected quality and getting the customer satisfaction.

10. CONCLUSIONS

In this work we presented a new procedure for generating requirements reports automatically in a Requirements Engineering Environment. This included: 1) knowing better the requirements management tool DOORS® from Telelogic; 2) creating new procedures to import and to export requirements documents from/to Telelogic DOORS® tool, using its programming capability, through DXL language; and 3) summarizing their uses in a process for customizing reports.

We showed the importance of a good requirements management in any developing area, and the need for an adequate tool to do this. We also showed that the process for migrating documents from another format to Telelogic DOORS® tool is not difficult, and could be done in simple steps without spending so much time; and vice-versa.

Finally, we concluded that with a well done requirements management, we can get a better quality product/service, with low cost and more customer satisfaction.

11. ACKNOWLEDGMENTS

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12. REFERENCES

- Alexander, I.F., Stevens, R., 2002, "Writing Better Requirements", Ed. Addison-Wesley, Harlow, England, 162 p.
- Austin, C., 24 April 2007, "Writing Effective Requirements", OnDemand Presentation, Telelogic AB, Malmö, Sweden. 07 May 2007 <http://www.telelogic.com/company/events/webinars/ondemand_player/index.cfm?id=4950>
- Dick, J., 05 November 2004, "What is Requirements Management?", Version 1, White Paper, Telelogic AB, Malmö, Sweden.
- Easterbrook, S.M., 2004, "What is Requirements Engineering?", Draft book chapter, <<http://www.cs.toronto.edu/~sme/papers/2004/FoRE-chapter01-v7.pdf>>
- Hull, M.E.C., Jackson, K., Dick, A.J.J., 2002, "Requirements Engineering", Ed. Springer, London, England, 216 p.
- Meta Group, 2003, in Austin, C., 24 April 2007, "Writing Effective Requirements", OnDemand Presentation, Telelogic AB, Malmö, Sweden. 07 May 2007, <http://www.telelogic.com/company/events/webinars/ondemand_player/index.cfm?id=4950>
- Tavassoli, Domenic, 2 August 2006, "Ten Best Practices for Writing Better Requirements", Version 1, White Paper, Telelogic AB, Malmö, Sweden.
- Telelogic, 3 May 2004, "DXL Reference Manual" - Telelogic DOORS®/ERS. Telelogic AB, Malmö, Sweden.
- Telelogic, 2007, Telelogic DOORS Ranked #1 Requirements Management Solution by Yphise. 7 May 2007 <<http://www.telelogic.com>>

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