

# The Road to Requirements Maturity

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## Abstract

*NDS' mission is to be a leading supplier of open end-to-end digital systems and solutions for the secure delivery of entertainment and information to televisions and IP devices.*

*This paper describes the processes and changes that NDS underwent, over the past three years, in order to achieve a culture of requirements management, and discusses the future of the process.*

*We will describe the establishment of the Requirements Management process, and focus on the leap, from the point of view of Return on Investment.*

*We will describe the side-benefits from achieving a working Requirements Management process and infrastructure:*

- 1. Lessons learned of the RM process*
- 2. Measuring the effectiveness of the RM process and presenting to Senior management*
- 3. Senior management setting new business goals.*

## 1. Introduction

### 1.1 Scope

NDS specializes in designing, developing and integrating software, across multiple platforms.

The organizational structure is built around the principle of SW product lines. Each product line designs, develops and tests core products, using different technologies for each product line. New development can be marketing-driven, customer-driven, or technology-driven.

The role of the Delivery organization, via the Project Managers, System Engineers and Integration & Test personnel, is to initiate projects, originate Business Requirements with the customers and translate them into system requirements by the system engineers. The project managers, in effect, “mix and match” the components produced by the product lines, in order to satisfy the needs of the company’s customers.

### 1.2 Motivation

Requirements are particular important to NDS for a number of business reasons:

- The main goal of all quality improvement processes in the company relate to improving customer satisfaction. Measuring compliance with requirements gives the customer-facing staff an idea as to whether the customer will be satisfied.
- NDS invests hugely in it’s workforce, whether this be developers, testers, project staff, or any other role. Clear, concise and complete requirements are necessary in order to assure efficient and effective use of their time.
- Requirements is the 1st link in the development chain, where each link expands on the previous links. “Bad” requirements are thus proliferated through multiple branches of the development process, leading to low quality software.

NDS sought to implement a Requirements Management process [1], far beyond “writing requirements documents”. The process would include a change in language, meetings, workflows, and in fact the whole company culture. The benefits of such a process would be to:

- Resell existing solutions to new customers, with minimum additional development
- Develop generic solutions for multiple customers
- Reduce development and delivery time
- Use the requirements as the backbone of the development, so that the design, coding and testing relate it easily.

### 1.3 Background

As stated above, Requirements is the 1st link in the software development chain, where each link expands on the previous links. When Requirements are elicited and managed correctly, they facilitate effective analysis, design, development and testing of the software. On the other hand, “Bad” requirements are proliferated through multiple branches of the development process, leading to low quality software.

Seventy-one percent of all software development projects result in complete failure (i.e. premature cancellation or shelfware upon completion) [2]. Poor

requirements management is generally considered one of the major causes for product failure [3], [4]. After all, if we do a poor job of understanding our customers' needs, if we do a poor job of deciding the right features to build, and if we do a poor job of writing down what we think we want out of a system, how can we possibly expect a successful project? [5]

Implementing a formal requirements management process, such as that defined in level 2 of CMM [1], enables an organization to find defects earlier in the development process, keep product definitions up to date, and communicate change to the development team.

## 1.4 Outline

Once the Requirements Management scope, motivation and overview have been presented above, the rest of the paper describes the Requirements Management process that was chosen, analyses experience gained from implementing both the process and underlying infrastructure, and describes the Requirements Management Roadmap.

Section 2 describes the company's culture, and how it affected the Requirements Management process. The original plan for Requirements Management process deployment, together with the actual deployment, are also included in this section. Section 3 describes the measurements taken, in order to evaluate the progress and penetration of the Requirements Management process. Experience days and an awards scheme are described. Section 4 analyses the success factors of the Requirements Management process, both from a direction of Requirements Management per se, and from the direction of the process and its deployment. Factors that impeded the deployment are also described. Section 5 describes the current work, and the roadmap for intensified deployment across the whole company. Section 7 summarizes both past and future work, in terms of the benefits that NDS has already reaped, and those that it expects to reap in the future. Finally, Appendix A shows the NDS Requirements Management Process diagram.

## 2. The Requirements Management Process

### 2.1 Attitudes within NDS Culture

At the outset of the Requirements Management process, NDS was already a process-oriented company, immersed in quality improvement. Processes were already part of the company culture, for example:

- QC and Testing
- Use Case Design and UML
- Configuration Management
- Defect Tracking

So what was so special about the Requirements management process?

All previous process and quality efforts had been focused and organized, affecting clearly identifiable groups of stakeholders. The goals and audience of these efforts were clearly defined and relatively small.

Requirements management had a more nebulous goal and audience. It was a process intended to encompass the entire company (then about 500 employees), starting from Sales and Marketing, through Project Management, to R&D and QC. Both engineers and readers were impacted by the requirements management process. The scope of the process was wider and broader than any that NDS had attempted in the past. In addition, this was a process that would foreseeably change the way in which a large percentage of the company worked.

### 2.2 Management

This software improvement process story actually does begin at the top. The group that promoted RM at NDS was the QA group. However, Requirements management became part of the culture at NDS, thanks to upper management focus and support. The VP of R&D was a central figure in the process. He appointed engineers and technical writers to specific tasks, instructed their managers to give people time to write requirements documents, raised the priority of the requirements documents, called people to learning sessions, raised the requirements process in managerial forums, used the consultants wisely, and did not let interim failures stop the process. His sense of ownership was felt throughout the process, even down to his running the bi-weekly Requirements Steering Committee meetings, taking the minutes, and mailing them out.

The Steering Committee is the senior management forum composed of VPs, Directors, Line managers, Chief Architect, and other highly experienced stakeholders.

The Steering Committee's role is: ownership, sponsorship, and managing (objectives, tracking, resource allocation) of the RM process improvement.

### 2.3 Grass Roots

"The only way a culture can change is if its participants change it. Whether it's the changing role of women in the real world or a management

reorganization in your company, change only works if those affected by it say it works and make it work. Top-down or not, corporate culture change isn't something that can be implemented with a memo." [6]

Without involvement and buy-in from the grass roots, no major cultural change is possible in a large company. The Requirements Process Group was set up for just this reason – to involve the grass-roots.

## 2.4 The Plan

Two outside consultants were brought in to support the NDS Requirements management efforts [7]: an organizational psychologist, and a requirements engineering expert.

The requirements engineering expert's contribution came in the form of attacking the problem from many different directions. She directed people to use known methodologies, a wide vision of the problem that always found areas for improvements in the process, methodologies, guidelines and tools. She was responsible for planning Requirements Measurements very early on in the process. The organizational psychologist's contribution was in the direction of change management, overcoming objection of the engineers, letting people think that they actually invented this wheel. He was also effective in persuading managers and engineers to join the process, and to do so in a good atmosphere.

A Requirements Management Steering Committee was set up. The committee was chaired by the VP of R&D, and it consisted of representatives of upper management and of the QA group.

The Steering Committee was responsible for:

- defining policy, objectives and direction
- prioritizing objectives and tasks
- planning and executing training
- allocating resources and supports
- tracking and monitoring
- overseeing deployment

The consultants first performed an assessment of NDS. Based on their findings, they devised the following three-phased plan:

1. Conduct pilots
2. Build infrastructure
3. Deploy requirements management efforts throughout the company

## 2.5 Process Implementation - Pilots

The following five pilots were run during the testing phase:

1. Verify functional requirements with respect to defined business applications

2. Evaluate requirements management tool, in particular with respect to requirements change impact
3. Requirements flowdown, including requirements traceability
4. Generic versus Specific specification, involving internal stakeholders
5. Requirements verification

The pilots phase was very important, in that it provided much input into the final requirements process. Requisite Pro was chosen as the best RM tool for the company's needs, and customizations to the tool were identified. Templates and forms developed for the pilots are in use till today. Some of the pilots developed into full-blown RM projects, while others did not.

## 2.6 Process Implementation - Infrastructure

The infrastructure needed to support the new processes was developed at the same time that the pilots ran, to support the needs of the pilots. When the pilot phase ended this infrastructure became part of the global NDS infrastructure (during the deployment phase.)

1. Requirements Management Process - NDS created a requirements process that covers the entire company and the entire development process, allocating tasks (Documents & Reviews) to the appropriate people, and defining interfaces with other activities (Design & Testing)
2. Requirements Workshop - the Requirements Management process has been taught, every 3 months, to groups of 25 people involved in the requirements process.
3. Requirements Management Tool - the tool chosen for requirements management was Rational's RequisitePro.
4. The RequisitePro Users Group - a group meeting regularly in order to share the challenges and lessons of Requisite Pro.
5. Intranet Site - a site was set up linked to the QA site, as a central repository for all information related to the Requirements Management effort.

## 2.7 Process Implementation – The Process Group

A few months after the Requirements Steering Committee started its work, an inventory was done on the current state of requirements. The Steering Committee, whose role was management focus of the RM process, came to the conclusion that a Requirements Process Group was needed. The role of

the process group was to review, in depth, process, tools and methodology issues that seemed to be shared by multiple projects or groups, and to get the experience and the expertise in our process.

This was, in fact, the “doers”, the grass-roots team that the Requirements process needed. The group consisted of people who have major responsibility for requirements throughout the SW development life cycle: development managers, system architects, project managers, system engineers, and technical writers.

The Process Group was responsible for:

- defining methodologies and process
- building templates and examples
- liaising with pilot projects
- disseminating knowledge
- members acted as change agents

## 2.8 Process Implementation - Deployment

The Requirements Management process developed by NDS reflects the company’s 2-phase development process – project and component.

The RM process defines:

- all the many participants: contributors, reviewers and readers
- the interface between Requirements management and other processes (testing, system design that breaks the system requirements into component specs)
- the progress timeline
- the reviews.

The process showed us how to use the requirements – who the reviewers are, the readers, the people who will write documents that are based on the requirements. And last, but not least, it showed us the complexity of deploying the process in all the company. The process is shown in Appendix A.

The organizational structure of the company was used in order to achieve penetration throughout the company

## 2.9 Training

The requirements workshop, consisting of a lecture and hands-on exercise, became a pre-requisite for all those involved in crafting requirements documents. In addition to the general workshop, there was a session specifically for technical writers, and a few sessions aimed at managers.

A presentation about Requirements Management concepts was prepared and presented at each department’s monthly meeting.

All new projects are coached through each

requirements phase.

## 3. Measuring the Requirements Management Process

The spread of the new requirements process throughout the company was tracked and measured. The Requirements Management process is intended to improve quality, therefore both quantitative and qualitative measurements are shown. The quantitative measurements are expressed as metrics. The qualitative measurements are expressed both as metrics (e.g. the number of projects being reused is a reflection on their quality), and with respect to the experience days and requirements awards.

### 3.1 Metrics

At the beginning of 2000, 20 projects were evaluated with regards to compliance with the requirements management process. The results are listed below:

- 40% of the documentation required by the new process was written
- 60% of the stakeholders played the role they were expected to
- 45% of the reviews were held according to the process expectations
- 65% of the target population had attended the Requirement Workshop
- 20% of the requirements were ported to Requisite Pro
- ReqPro was used by eight projects (40 employees) to track requirements, create traceability matrices, and to generate reports that span the Business Requirements down to the Test Cases performed in the lab.

At the end of 2002, a further evaluation was performed. This time, due to the large amount of data, only projects that had been updated in 2002 were reviewed. The results are listed below:

- 51 projects (including system and component projects) were actively using ReqPro
- At least 65% of the active customer projects were following the process at the system level.
- More than 100 component specifications were written during 2002.
- 7 projects had been reused (by 33 other projects)
- Just over 10% of the requirements in ReqPro had been traced
- Over 250 participants have attended the Requirements Workshop to date
- Approximately 25% of all documents released during the year were directly related to the

requirements process

As can be seen, there has been a marked improvement over time. In 2000, just 8 projects were following the Requirements Management process, along with Requisite Pro, whereas in 2002 51 projects were following the process along with Requisite Pro. This is an increase in the number of projects using the process of nearly 550%, over less than 3 years. At the end of 2002, 33 projects were reusing 7 projects that manage their requirements in Requisite Pro according to the Requirements Management process. This means that, on average, each project following the Requirements Management process in full, saved the development effort of 5 other projects.

### 3.2 Experience Days

Since the start of the requirements process, two Requirements Experience Exchanges have taken place. Each session was a half day long, at which 8 leading teams presented to each other their experience with the process and tools and outlined how to proceed and improve them. At each experience exchange session, a different 8 teams presented.

The experience exchanges had several goals:

- Encouragement
- Improved self-assurance of the process users
- Practical know-how exchange: What works and what doesn't
- Networking amongst users

The experience exchanges were very informative, and well attended, by many more staff than those directly involved with the projects themselves. The exchanges showed how requirements management was used in diverse parts of the company.

It was noted that adhering to the process involved some overhead, but that the investment was worth while, and does save time in the end. The attendees were urged to use the process, and not push it away because the beginning is time-consuming.

A few examples of presentations are:

- Component Specs and Integration of the Requirements Process into a Product Development Line
- ReqPro use for Requirements Management
- Functional Requirements and "slurping" guidelines
- Requirements Process in Synamedia. A joint process between NDS-Israel and NDS-UK.

### 3.3 Rewards

Although a rewards scheme had been devised at the outset of the process, implementing the scheme took time. At the beginning of 2003, the first prizes

were awarded.

Three categories of awards were defined, each with a set of criteria:

1. Best use of ReqPro
  - 1.1. Requirements organized intelligently
  - 1.2. Attributes used intelligently
  - 1.3. Traceability coverage
  - 1.4. Reuse (by other projects/products)
  - 1.5. Quality (clarity, testability, maintainability, appropriate level of abstraction, accuracy, readability, appropriateness to purpose, etc.)
2. Best compliance with the Requirements process
  - 2.1. Appropriateness of artifacts vis-à-vis the process diagram
  - 2.2. Depth (business req → func req → sys spec → sys atp → comp spec → comp atp)
  - 2.3. Reviews follow requirements methodology
3. Best requirements document
  - 3.1. Quality (clarity, testability, maintainability, appropriate level of abstraction, accuracy, readability, appropriateness to purpose)
  - 3.2. Rated usefulness by the document users
  - 3.3. Style (shall, should, etc.) and format

20 customer projects and R&D products, involving more than 50 employees, were nominated for awards. The awards committee consisted of the VP of R&D, the VP responsible for project delivery, and the QA Director. The awards committee were unable to agree on just 3 winning teams, and finally awarded prizes to 4 teams.

## 4. Analysing the Requirements Management Process

A change in management at NDS was a perfect opportunity to review the positive and negative results of the Requirements Management process.

### 4.1 What have we learned about Requirements Management?

The NDS management learned about how to implement cultural change at a company-wide level.

NDS learned that the quality of requirement is not just a technical writer issue, but is connected to the entire requirements management process.

Early meetings with customers should be attended not only by marketing personnel, but also by research and development engineers who can assess feasibility, and who can then immediately begin working on development.

### 4.2 The Positive Aspects of the Requirements Management Process

1. The main benefit, that must be seen as 'strategic', is the overall culture and mindset change that resulted from the development and deployment of the process.
2. People in both development and delivery are far more receptive to process orientation, and this should have impact far beyond 'requirements'.
3. We developed a process and not a methodology.
4. We based the process on the infrastructure built up over time
5. Strong support of the Senior management and synergy amongst both
6. The structure of Steering Committee and Process Team was good fit for the process
7. Stability & longevity of the key players in the committee over the years
8. There was lots of action not just talking, and therefore there are real results.
9. There is a formal, well defined and practical process.
10. The process was well supported by the training classes and the 'experience exchange' events
11. The participants were willing to 'go till the end' with the process experimentation and application
12. The process is now instilled in all the rank & file across the company
13. All new projects today are trying to follow the process
14. The change process had impact far beyond the immediate Requirements domain
15. Today's understanding of the people distinguishes well between Requirements (the what) and Design (the how).

### 4.3 Aspects of the Requirements Management Process for Improvement

1. The process was voluntary, hinging on managers' good will. This led to the process taking too long to entrench and deploy.
2. The process did not penetrate widely and deeply enough in R&D
3. The fact that the target audience was only loosely defined made it more difficult
4. The concrete goals were either not well defined or not accomplished
5. There were inadequate measurements (metrics, indicators)
6. Lack of clarity of the role of the process versus the tool (Requisite Pro)
7. A long learning process for the leading team
8. We did not realize a priori how difficult the deployment will be (and thus did not harness

- enough ammunition to support it)
9. The process was not managed like a 'project'
10. No effective linkage to the Sales & Marketing teams/processes
11. Failed to include NDS from other parts of the world

## 5. The Requirements Management "Takeoff"

### 5.1 New goals

Three years into the requirements process, at the beginning of 2003, a change in personnel brought some new ideas to the table. While many parts of the company were very much involved in the process, and working in accordance with it, other parts of the company were lagging behind. In addition, with the new staff came an attempt to redefine the goals of requirements management.

The Steering Committee were looking for a new way to measure the level of deployment across the company. The Requirements Management Maturity Model [8] was just what they were looking for.

Level 0 – Chaos, No requirements

Level 1 – Written requirements

- Can be backed up and restored
- Maintained, updated

Level 2 – Organized

- Quality (reviewed)
- Format
- Accessibility, Security, Version Control

Level 3 – Structured

- Types of requirements
- Attributes (e.g. priority, release phase, stability)

Level 4 – Traced

- Track relationships (traceability, coverage, etc.)

Level 5 – Integrated

- Integrating Requirements Management with the rest of the software development methodology
- Change management

After reviewing the maturity levels, and discussing what other issues were important to the company, new goals were defined by the Steering Committee:

- Reuse
- Coverage
- Requirements Maturity level 2

NDS' objective now is to match customer requirements with what the customer receives, with maximum re-use. During the establishment of the Requirements Management process, the company was mainly investing. Now that the Requirements

Management process infrastructure is in place, we can finally reap the fruits and enjoy the benefits – the ROI via reuse, and customer satisfaction via coverage.

## 5.2 Requirements Management Roadmap

A temporary sub-committee was formed, consisting of at least one representative of all the major stakeholders in the company. The sub-committee was tasked with defining a roadmap for reaching the goals defined by the Steering Committee. The roadmap, which has just been approved by the Steering Committee, as this paper is being written, consists of the following milestones and principles:

- Department managers define the level of requirements maturity for each of the products and/or projects in their department.
- The steering committee defines the list of “must have” artifacts from the requirements process.
- Department managers prepare a plan for reaching the desired level of requirements maturity in their products and/or projects.
- The steering committee approves the department managers’ plans
- Department managers update the steering committee, monthly, on the progress of the deployment.

## 6. Conclusions

Over the last 3 years, NDS has invested heavily in the Requirements Management Process and infrastructure. The establishment phase of the process is winding down, and NDS, as a company, is already reaping the benefits. Senior Management is now focusing on full-scale deployment, over the breadth and depth of the company.

In addition to the benefits of the Requirements Management process, NDS has been able to benefit and improve it’s processes, in other ways:

- Lessons learned of the 3-year process, by the Steering Committee
- Measuring the requirements management process, and presenting to Senior management
- Setting new business goals to guide the requirements process and other quality improvement processes in the company
- Setting up the infrastructure to enable the company to reach these goals
- Road-mapping the future of the requirements management process

Usually, establishment of a process is mainly

investment. At NDS we are now past this stage, and entering a stage from which the company can only benefit. Senior management can now ask for reuse and coverage, because the infrastructure is there, to help. We are at the point where the Requirements Management process can really start to show ROI.

## 7. References

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8. Appendix A

# NDS Requirements Process Diagram

