BRIDGING THE GAP TO PAPERLESS

A RESISTANCE FORCE FIELD ANALYSIS OF PAPERLESS ALTERNATIVES BASED ON THE ONE IHC CONFIGURATION FOR IHC PIPING

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by

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Preface

This master thesis presents my graduation project for the master Marine Technology at the faculty of Mechanical, Maritime and Materials Engineering of the Delft University of Technology.

The project was conducted at Royal IHC. Where I developed an approach where both technological and people resistance towards paperless production is evaluated to determine the effort to bridge these gaps. From Royal IHC, I would like to thank my supervisor Jan Miedema, for his guidance, support and advice during the project. He gave me confidence at moments where this was needed. Also I wish to thank the colleagues of Royal IHC for making me feel welcome. Special thanks to Hans de Lang, who made it possible to work and conduct my case study at IHC Piping.

I want to acknowledge and show my gratitude for the support, patient and always fast feedback received from my supervisor of the TU Delft, Jeroen Pruyn.

Last but not least, I would like to thank my friends and family for their support and faith in me. Bart Eggen, thank you for dealing with all my all my stressful moments and for your love, patience, support and encouraging throughout the process.

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Delft, May 2018

Summary

As the title explains this research bridges the gap to paperless. As more shipbuilding companies move towards a digital shipyard, paperless production is enabled by the integrated information systems used to realize this digital transformation. Royal IHC is one shipbuilding company in transition implementing a new configuration of information technology systems. However, based on the developed configuration of these systems, effort is still needed to bridge the gap to paperless. Technological resistance or gaps are still presented and paperless solution must be explored. As well as addressing resistance from employees by changing to paperless. The objective of this research is to deliver a model to Royal IHC, whereby the effort to go paperless from technological and people perspective is determined by providing: (1) resistance from technological perspective; (2) solutions to realize paperless; and (3) resistance from employees to the paperless changes. The main research question that is answered is: *With what approach technological resistance and people resistance is evaluated whereby effort to bridge the gap to paperless based on the existing integrated information system is determined?* To this end, a case study is conducted for a paperless pipe shop. The functions of paper are observed as replacement or elimination of paper might become a hindrance due to the physical nature of paper. A delta session is used to find the differences between current and paperless state, where fits and gaps are assessed according elements: (1) paper; (2) process; (3) organization; and (4) people. Paperless alternatives, where the existing integrated information landscape is used as prerequisite and functions of paper are aggregated, are compared according the relatively impact and benefit. Final, a resistance force field analysis is used. Where resistance forces are caused by five sources of resistance including: (1) distorted perception; (2) failed creative response; (3) political deadlocks; (4) dulled motivation; and (5) action disconnect. Driving forces are prompt with six change management principles including: (1) diagnosis; (2) vision; (3) leadership; (4) communication of vision; (5) short-term results; and (6) institutionalize. In combination with methods: (1) education and communication; (2) participant and involvement; (3) facilitation and support; (4) negotiation and agreement; (5) manipulation and co-optation; (6) explicit and implicit coercion.

A case study at Royal IHC, provided the functions of paper in current pipe shop and effort and impact of alternatives to realize a paperless pipe shop. Resistance to not only the paperless change but the entire change were detected and an action plan to minimize resistance is provided to company. Using the resistance force field analysis also provided evaluation of change management currently used at company. The developed model provided the effort to go paperless and to minimize resistance from department. As the results of the case, only applicable for realizing the paperless pipe shop at Royal IHC, validate that effort is determined according model. The model is applicable for other cases and the resistance force field analysis can also be used for every change, not only paperless.

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Acronyms

CIM Computer Integrated Manufacturing. 7

ERP Enterprise Resource Planning. 1

MRP Manufacturing Resource Planning. 1

PLM Product Lifecycle Management. 1

1 Introduction

1.1 Research Background

The primary goal for product-oriented companies is to offer competitive products that provide solid financial returns to business. To achieve this, companies must have well-defined business processes for product development, engineering and product management. Today, software technology is almost embedded in every aspect of business. In the shipbuilding industry, projects are realized by co-operation of multiple processes carried out by multiple business units. Often these units use multiple and/or different enterprise applications. Even paper drawings are still used to facilitate the production of a ship. Due to this non-integrated approach, communication and information searching between units can result to non-uniformity and ambiguity. Consequences of separate computer systems that do not share or extensively reuse data are, for example loss of data quality when data is translated system-to-system or duplication of work [1]. This non integrated approach can lead to a time-consuming work flow and can raise the potential for error [1, 7, 8]. Enterprise applications as Enterprise Resource Planning (ERP) , Product Lifecycle Management (PLM) helps companies to meet their strategic goals and run their businesses more efficiently and effectively. Brown [9] published a report about the complementary roles of ERP and PLM which are summarized in the sections 1.1.1 and 1.1.2.

1.1.1 Enterprise Resource Planning

ERP came to prominence when companies were focusing on streamlining the flow of transactions and information across departmental boundaries. It provided a structure to help different areas of the business work more effectively together. Two central themes helped break down departmental barriers; (1) managing orders; and (2) financial control. ERP evolved from Manufacturing Resource Planning (MRP) systems that were designed to balance the flow of demand and supply for products. It united disconnected steps of order-related transactions and decision-making to improve the level of responsiveness to customer and market demand changes. By adopting centralized financial and cost accounting. While capturing transaction across multiple business areas, a level of financial control and visibility is provided. Which allows manufacturers to identify bottlenecks and improve process efficiency by highlighting key areas of opportunity. This also has improved speed, accuracy and level of control over the fiscal performance of the organization. Accomplishing integrated order and accounting, ERP required an integrated data model. This provides benefits including the ability to summarize, report from and mine the database in order to make better business decisions. Due to the transactional focus of ERP applications of the product development and engineering functions were not taken into account. In the left column of table 1.1 [9] focus and themes of ERP are presented.

1.1.2 Product Lifecycle Management

Product lifecycle management is the process of managing the entire lifecycle of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products. As stated above ERP had transactional focus, however, engineering and research and

development departments continued to develop their own solutions in parallel to ERP in order to continuously improve the way they brought new products to market; resulting in today's PLM system. PLM as a discipline emerged from tools such as Computer Aided Design (CAD) and Product Data Management (PDM), but can be viewed as the integration of these tools with methods, people and the processes through all stages of a product's life [55]. Brown mention that PLM addresses three themes; (1) managing product knowledge; (2) speed to market; (3) and collaboration.

Stated by Brown [9] "*Innovation-related processes still clearly benefit from streamlined processes flows,data sharing, visibility and central information. But the requirements to manage the product innovation processes rely much more on flexibility and the ability to manage large volumes of information and complex relationships. To make matters more challenging than ERP, the data does not lend itself to be stored in simple table structures but relies on complex geometric models in CAD and more free-flowing information found in documents. The power of PLM therefore, comes from the ability to effectively provide enough discipline and control on the product innovation environment to allow people to share information and follow best practices, while simultaneously providing a flexible, dynamic environment that does not hamper the creative process.*"

To manage the often complex information and relationships involved in product design PLM adopted a flexible data model, that supports complex relationships between processes, projects, products and product designs. However not only management but also better access to product data allows manufacturers to decrease product and process costs by making the right decision at the right time in the development cycle. In the right column of table 1.1 [9] focus and themes of PLM are presented.

ERP	**PLM**
Balancing Demand and Supply	Innovation
Managing Orders	Speed to Market
Cross-Departmental Transactions	More Profitable Products
Integrated Business Processes	Collaboration
Central, Relational Database	Product Knowledge
Operational Efficiency	Design Reuse
Financial and Cost Accounting	

Table 1.1: Focus and Themes ERP and PLM

1.1.3 Digital Shipbuilding

According Tim Nichols, director of marketing communications for the global aerospace,defense and marine industries at Siemens PLM Software, digitalization of shipbuilding is a top of mind issue for shipbuilders all over the world [39]. His conlusion is based on the received responses from the marine industry about shipbuilding technology and digitalization In another article [40] by Nichols, he elaborates more to digitalization and quotes:

"*throughout the greater part of this decade, manufacturers have been on a steady course to bring production from the outdated, out-of-sync plants of the past and into the data-rich, streamlined and efficient future of the smart factory. The key to that transformation is in the data: creating a synchronized thread of digital information that connects even the most disparate global supply chains into a cohesive digital enterprise. Doing so creates a "single version of the truth" for*

the entire ecosystem, stretching from conception to production to service throughout the product lifecycle."

Presentations presented by shipbuilding companies Feadship, located in the Netherlands, and Lürssen Weft, located in Germany, both declare to act on using as described by Nichols, a single source of the truth using PLM software integrated with ERP software. Another example of a digital shipyard is Newport News Shipbuilding [50]. This shipyard has taken a big step towards an integrated digital future. Approximately 15 percent of shipbuilders have stopped relying solely on 2D drawings and printed work packages to perform their daily tasks.

1.1.4 Royal IHC

Royal IHC, a Dutch shipbuilding company specialized in dredging, offshore and mining industry. Is also in transition to one integrated digital shipyard. IHC was not an integrated company as discussed in section 1.1 . This has led to a set of non-integrated processes and systems that do not cooperate in an appropriate way, as described in section 1.1. And because of the rapidly changing and very demanding environment in the offshore and dredging market the need for an organizational change to stay competitive was required. Therefore, IHC decided to start the One program to uniform all the processes and data within the company. One IHC delivers a business blueprint covering a whole new configuration of computer systems, data and processes to be implemented in the business as stated above. PDM and CAD, PLM applications, play an important role within the future product definition. These applications facilitate hand-in-hand from start to end the administration of the growing and maturing product information like systems and its requirements, system parts and library parts, locations and sub assemblies, release information, 3D model etc. Product information is retrieved from this product definition to manufacture and assemble parts and (sub)assemblies, based on shop orders which are administrated in ERP.

Due to this new integrated information system, paper currently used in production can be eliminated by using technology at production site. Conventionally, product definition information is processed at production engineering department resulting in printed drawings and accompanying details, coding, instructions and lists to facilitate the production to build the product. This is a time consuming process with a huge repetitive character, whilst subject to the paradox that the product definition details might change (concurrent engineering) forcing to print as late as possible despite not trying to slow down the production process. Using technology on site can contribute to many advantages. As information becomes out of sync once it is printed on paper, technology provides production to have access of the accurate data at all times. Also capturing production data with the use of technology provides real-time progress on site. As siemens states that the ability to capture, store and display real time manufacturing data is te primary of paperless manufacturing,. [51].

1.2 Problem Statement

Transformation to an entire paperless environment at production sites is not yet applied at many shipyards. Shipbuilding is still a labour-intense industry, where shipbuilders rely on their printed drawings and accompanying details, coding, instructions and lists to build the product. Moving from paper to digital requires change in technology but also change of people. For One IHC, bridging the gap to paperless with the developed configuration still needs effort. Technological resistance or gaps need to be analyzed to determine the effort required to go paperless. Where the existing integrated information system landscape is used as prerequisite. As well as an analysis of the people resistance that is faced by changing from paper to paperless. Lawrence [29]

states that often resistance to change is explained as simple as "people resist change", whereby no further looking of why they resist is included. However he believes that people do not resist technical change as such. And that most of the resistance which does occur is unnecessary. As result over the years change management is widely applied in order to preparing and supporting individuals, teams, and organizations in making such change. It helps to plan and implement change in organization in a way to minimize employee resistance and costs to the organization and maximize the effectiveness of change effort [16]. This research aims to find the possibilities of paperless production and the resistance against it from the employees. Whereby effort to realize paperless production and effort to minimize the resistance against it are determined.

1.3 Research Objective and Questions

Resulting from the problem statement the objective of this research is to deliver a model to Royal IHC, whereby the effort to go paperless from technological and people perspective is determined by providing: (1) resistance from technological perspective; (2) solutions to realize paperless; and (3) resistance from employees to the paperless changes.

To achieve the defined objective, the main research question that needs to be answered is:

With what approach technological resistance and people resistance is evaluated whereby effort to bridge the gap to paperless based on the existing integrated information system is determined? ?

To answer this question, first two separated studies are conducted whereby sub-questions are answered. Each sub question is briefly discussed. The first part focuses on the movement from paper to technology. And the second part focus on the people part. The first part answers the following sub question:

SQ 1. How is paperless production applied, and what are benefits and drawbacks of paperless?

To be able to analyze technological resistance, more knowledge of paperless is gained. As exploring paperless solution based on the existing configuration this sub-question is used to hold any reference to paperless applications, benefits and drawbacks.

The second study regards the people part. In this part change management is studied and why people resist to change. Where the following sub-questions are answered:

SQ 3. What causes people to resist to change?

This sub question provides the resistance factors which causes people to change.

SQ 2. How is change management applied in order to minimize resistance?

This sub question provides change models used to manage change in order to minimize the resistance to change.

If all precedent sub-questions are answered the last sub-question is answered:

SQ 4. In what way resistance from both technological and people perspective can be evaluated to find the effort needed to realize paperless?

Answering this question a model is developed to evaluate the paperless solutions and resistance to it. Where output is the effort to bridge the gap to paperless.

1.4 Research Approach and Structure

In order to answer the previously discussed sub-questions, the study is divided into 4 phases, see figure 1.1. In the first phase a literature review is conducted. Literature review by means of paperless, where applications, benefits and drawbacks of paperless are explored (SQ1). And a literature study reviewing resistance to change (SQ2) and the application of change management (SQ3). This two folded literature review is presented in chapter 2 of this report.

The information obtained during literature review is used as the main input for the development of a model in the second phase. By which technological and people resistance is evaluated and effort for paperless is output (SQ4). The phase is presented in chapter 3.

In the third phase an application of the model is provided by performing a case study at case company. The case is performed at IHC Piping where the integrated information system of One is going to be implemented and the model is used to determine the technological and people effort of a paperless pipe shop. This is presented in chapter 4 of this report.

In the last phase, conclusion based on the results of this research project are drawn. Additionally, recommendations are formulated. Conclusion and recommendation are presented in chapter 5.

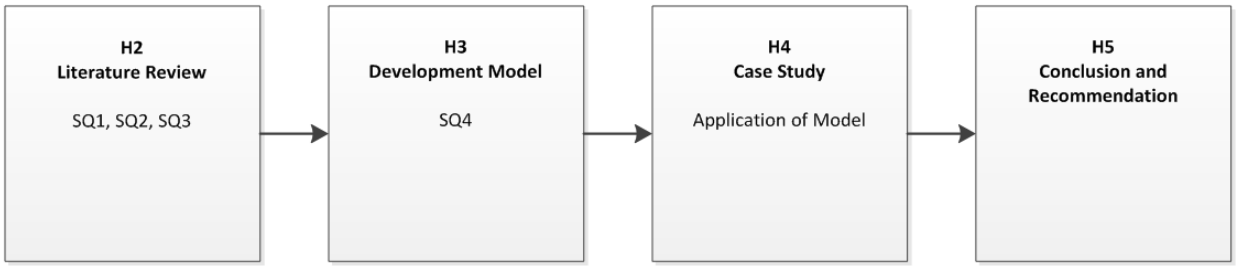

Figure 1.1: Thesis Approach and Structure

2 Literature Review

In the previous chapter the objective of this research is defined and research questions are formulated. The goal of this chapter is answering the first three sub-questions: how is paperless production applied, and what are benefits and drawbacks of paperless?; how is change management applied for successful change?;and what causes people to resist to change? The information gained in this literature study provides input of the development of the model where the effort to paperless on technological and people level is evaluated.

This chapter is divided into two separate studies. The first part, referred to as paper to digital, starts with the evolution of the paperless factory in section 2.1. Next, in section 2.2 value of paperless is discussed, where benefits and applications are described. Final in section 2.3 the function of paper is described as resistance to paperless. The second part, referred to as change management. Starts with an introduction to organizational change in section 2.4. Next, change models are described for successful change in section 2.5. Final in section 2.6 sources of resistance of change are discussed.

PART 1: PAPER TO DIGITAL

2.1 Evolution of the Paperless Factory

Many manufacturing companies have experienced strong competition for many years in an environment dominated by emerging technologies and a changing market place. To stay compatible, companies are forced to deliver their products and services at lower cost, with higher quality/reliability and lower product development cycle time.

Achieving these goals factory, automation and Computer Integrated Manufacturing (CIM) is used [12]. Factory automation, using technology by which a process or procedure is performed without human assistance. And CIM, where companies use computer to integrate manufacturing operations. By integrating computer systems, such as product development, process planning, production, and delivery and after sales, companies can deliver accurate information where and when it is needed, and in the format that is required. As discussed in sections 1.1.1 and 1.1.2, ERP and PLM contribute to this system integration approach. However, ERP nor PLM its nature is controlling day to day shop floor operations. Even though ERP vendors have been adding manufacturing capabilities to their product, in most cases specific software to control the shop floor is used.

The evolution of these electronic-based technologies made a significant contribution to the development of a paperless factory [12]. Traditionally, data communication among various functional areas of a factory has been through the exchange of blueprints, routing sheets, inventory lists, shop floor travelers and so forth. Shop travelers can be huge bundles of paper, checklists, drawings and data collection. As changes happen, data on paper becomes out of sync with computer.

Which can result in inaccurate information and disruption in working process and poor decisions to be made.

2.2 Value of Paperless

As Siemens [51] states " *"a common misperception" of paperless manufacturing is that it is simply "paper-on-glass," digital versions of paper documents or smart PDF files. However, the main value of paperless manufacturing comes from its ability to capture, store and display real-time manufacturing data.*"

Capture data is a method of collecting information and changing this information into a form that can be read and used by a computer. This can be done in two ways: (1) manually or (2) automatically. In manual data capture process, the data is entered manually by an operator using input devices like keyboard, touch screens or mouse. This method of data collection is labor intensive, time consuming and therefore businesses find it efficient to migrate to automated methods of data capture [21]. However, the manual method is not totally extinct and still finds application in business processes. Automated data capture uses computerized technology to capture data. This method has initial cost on account of the initial investment. However, investment in technology, is found to lower the operating costs significantly on account of low manpower requirement [21]. Proliferation of techniques and technology of automated methods of data capturing, provides particular type data or source of data for each suitable, as Dyduch describes some [13] describes above. By storing data complete visibility of current and historical information is obtained, which can be difficult to administer with a manual paper-based system.

According to Dyduch [13] true paperless operation solely rely on automated data capture, such as from scanners, touchscreens or automation layer. Information is displayed on devices like computers, large wall-mounted displays or mobile devices. But it also entails as described in section 2.1 above the direct connections between systems to avoid additional handling and reentry of data. Therefore, system integration with applications used at shop floor is needed to gain full benefit of the ability of capturing and storing the manufacturing data. Devices are needed to display data, see figure 2.1.

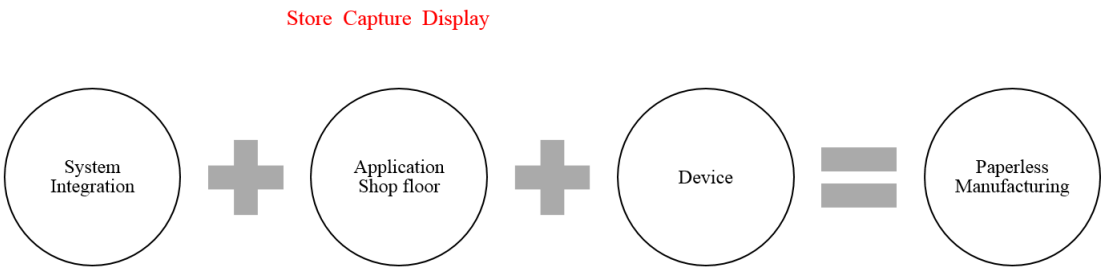

Figure 2.1: Paperless Manufacturing

Apriso [4] , provider of global manufacturing software solutions, asserts that manufacturers going paperless achieving elimination of non-value added time such as searching and walking around. Non-value added time, also called waste, in a production or manufacturing process is any time spent on a step in that process that adds nothing to the finished product. Rocketdyne Propulsion and Power, a unit of Boeing Co, also converted to paperless manufacturing to cut time. They managed to reduce manpower by 52% and cycle times by 25% on average, what resulted

in yearly saving of $ 4.2 million [3].

Deawoo Shipbuilding [22] developed a paperless collaboration system based on mobile framework in the field of ships and marine industry to provide easy access for production to the latest information of engineering. Site workers calls on engineering information and status using mobile applications. Four different prototypes were developed:

- Process status monitoring service (schedule, shop, material)
- Cable installation-support service (barcode scanning, detailed cable information)
- Engineering / production drawing viewer service
- CAD model viewer

The real-time paperless system using mobile framework for site employee is expected to improve productivity (business transactions, decision making, communication cost saving) of shipbuilding in ETO manufacturing environment.

Newport News Shipbuilding [50] has taken a big step toward an integrated digital future. As already stated in section 1.1.3, approximately 15 percent of shipbuilders have stopped relying solely on 2D drawings and printed work packages to perform their daily tasks. Instead, these shipbuilders use wireless connected touchscreen laptops to view 3D visual work instructions. They upgraded the wireless infrastructure in the yard and dry dock . And crews began to receive small touchscreen laptops and training on how to use them. A digital support team is located on-site for easy access, providing training and issuing. The program plans to increase the percentages of shipbuilders using the digital tools.

Concluded, the biggest benefit of using technology instead of paper comes from the ability to capture, store and display real-time manufacturing data. Where information on paper becomes out of sync with computer system, the use of technology provides the most accurate information at all times. Capture and store manufacturing data, provides the real-time production progress and continuously improvement and decision making can be made according accurate data. Also elimination of non-value added time can be eliminated as search, walk, or print to obtain the right document are eliminated. However, according to Grey [20], many companies in aerospace industry failed. He is convinced that new technologies must be delivered in a manner that optimizes the user experience and creates even greater value, rather than becoming a hindrance to the people working on the ground. Sellen and Harper [49] agree in such way that if a company is trying to replace paper with digital technology it must understand its organization and paper use in order to asses where and how such a move would be successful.

2.3 Function of Paper

The fact is that paper has been used over thousands of years as medium to record and present information. After the term "paperless office" is introduced, the expectation was that electronic technologies would make paper in the office a thing of the past. Yet, paper is surprisingly persistent and almost in every organization paper is still used. To find out why paper is so persistent. Sellen and Harper [49] conducted a study about the usage of paper by studying, work processes and workflows in various organizations. They concluded that paper has certain functionalities, affordances, which makes paper desirable, valuable and necessary.

Their study determined four affordances with respect to reading from paper as followed: (1) Navigation. By its physical nature, paper helps us easily and flexibly navigate through documents. Due tothe tactile nature of interaction with paper, many activities can be carried out with little to no visual attention. For example, when turning pages the thickness of the document is used as a physical cue for estimating its length and the remaining numbers of pages; (2) Annotation. An important affordance of paper document is that they can be easily annotated. Handwritten annotations on a printed document can be clearly distinguished from the document. Also, several persons can annotate the same copy of a document; (3) Interweaving.Outcome of the laboratory experiments is that reading in real work situations is more often entwined with writing than it takes place without some kind of concurrent writing. In the experiment the readers can write or read, but they cannot write and read at the same time as easily; (4) More than one document.Paper gives us the option to place more documents next to eachother. A lot of times more documents are used for information. Again the physical nature of paper comes forward becasue its possible to hold/lay out more documents at once/next to each other.

Another three affordances were found during this study: (5) Spatial organization. In addition to the affordance of the use of more than one document. The physical arrangement of documents also provides rich ways of expressing functions and priorities as well as relationships between them. For instance, creating a pile of documents is an informal strategy of organizing information on the desk. Sellen and Harper point out that the typical workplace of a knowledge worker contains different functional zones for documents of different priorities; (6) Mobile use of paper. Since paper is thin, flexible and lightweight, pen and paper can be easily taken along and used in a large variety of situations and physical places. At least this is true for short documents. If it comes to carrying heavy books or so, paper is not that mobile. Another benefit, pen and paper is always-on, since no battery back must be charged. Even in environments where only expensive specific computer hardware can be utilized (e.g. extreme temperatures, humidity, dust), pen and paper is working. Finally, paper is cheap. Hence, in most cases it is less problematic if a paper document gets damaged, lost or stolen than a more expensive computer device.

Paper is not only mobile at this "macro-level", where paper is carried to different physical places. Luff and Heath showed how important the micro-mobility of paper is [31]. By micro-mobility, they refer to the many small movements that we make with a paper document which is at hand. Since most paper documents are rather lightweight, we can easily reconfigure them during an interaction to best serve the current activity. For instance, the document is held at different angles to support comfortable reading depending on whether one is leaning back or leaning over the table. It is also hold differently depending on the activity (e.g. reading vs. writing) and depending on the communicative situation; and (7) Collaboration. Finally, paper has specific affordances that support collaboration and awareness of the activities of co-workers. First, using paper documents leaves implicit and explicit traces [33], which can be helpful for subsequent readers. For example, a textbook in a library, which has been used for some years, contains implicit traces of use. Nagged and stained pages indicate passages that have been read by many borrowers. Annotations or dog-ears made by previous readers are more explicit traces of use. Marshall [91] states that it is precisely for these traces that many students prefer buying second-hand textbooks instead of new ones. Paper also supports mutual awareness in co-located collaborative settings. At a single glance, even from a peripheral viewpoint, it is easy to see if a person works with little or many documents and if she is reading or writing. Mackay [32] clearly demonstrates how these features effectively support collaboration in air traffic control. Finally, there are subtle social aspects of how paper supports communication. Even though it is typically more effort to personally hand over a document to a coworker than sending an electronic mail, people frequently prefer the physical way. Studies show that physical hand-over of documents stimulates personal communication [32] and can even be a means for reconfirming

the social order by the specific way the document is handed over [41].

Affordances of Paper
Paper helps us flexibly navigate through documents
Paper allows the interweaving of reading and writing
Paper allows us to annotate documents easily
Paper facilitates the cross-referencing of more than one document at a time
Paper allows use to physically arrange documents
Paper is mobile
Paper supports collaboration and awareness of activity of co-workers

Table 2.1: Affordances of Paper

Sellen and Harper mention earlier researchers, whom set up experiments where the focus was on such things as how easy it is to read words on a screen versus reading words on paper, and how they missed the important issues, such as how and why people read documents. However people often attribute their reluctance to study on screen to inconvenience associated with the screen as a display medium [2]. Kretzschmar [28] studied the reading effort of three different media: a paper page, an e-reader and a tablet computer.The eye movement, brain activity and reading speed were studied in this matter. The participants also answered some questions to determine reading comprehension. The interesting thing was that all participants said that they preferred reading on paper, even though the study found no support for it being more effort-full to read on digital media. On the contrary, the older participants read both faster and with less effort on the tablet computer, due to the back lighting giving a better contrast, and because of this being better for older eyes. But why did all the participants still prefer to read on paper? The authors suggest that it is more about people's attitude towards the digital media than the actual reading experience: *The present findings thereby suggest that the scepticism towards digital reading media . . . may reflect a general cultural attitude towards reading in this manner rather than measurable cognitive effort during reading.* Ackerman and Lauterman [2] agree that the problem with screen reading is more psychological than technological. Their experiment with 80 undergraduate engineering student argues that medium preferences matter, since those who studied on their preferred medium showed both less overconfidence and got better test scores.

PART 2: CHANGE MANAGEMENT

2.4 Introduction to Organizational Change

Organizational change occurs when a company makes a transition from its current state to some desired future state. Managing organizational change is the process of planning and implementing change in organizations in such way as to minimize employee resistance and cost to the organization while simultaneously maximizing the effectiveness of the change effort[16]. According to Nadler and Tushman [58] organizational change can be considered in two dimensions: (1) the scope of the change and (2) the positioning of the change in relation to key external events.

Change that focus on individual components, with the goal of maintaining or regaining congruence, are incremental changes. These are changes looking for an improvement in the present

situation, but keeping the general working framework [58, 23, 18, 35]. Second type of change are revolutionary, transformational or revolutionary. These changes are radical transformation where the organization totally changes its essential framework [23, 18, 58].

Concerning the second dimension of change, a deviation between reactive changes and anticipatory changes is made [58]. Reactive changes are changes that clearly respond to an event or serie of events. Other changes are initiated, not in reponse to events but in anticipation of external events that may occur. These are anticipatory changes. Nadler and Tushman [58] also referring to the intensity, which relates to the severity of change and in particular, the degree of shock, trauma, or discontinuity created throughout the organization, of these changes. Radical changes are more intense than incremental changes, which can frequently be implemented without altering an organization's basic management processes. Reactive changes are more intense than anticipatory changes due to the necessity of packing substantial activity into a short period of time without the opportunity to prepare people or deal with trauma. Even though many research is based on a type of change, real changes are not a pure type but a mixture [10].

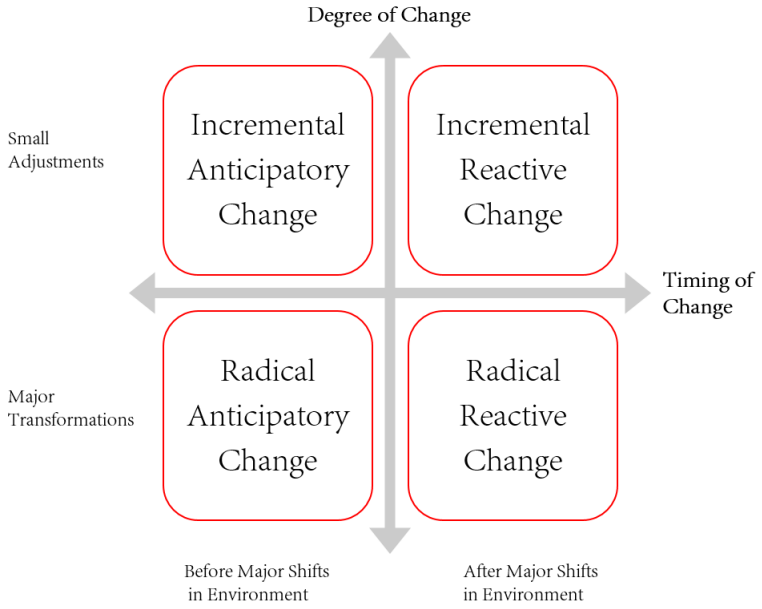

Figure 2.2: Types of Organizational Changes

2.5 Resistance to Change

Every change no matter how big or small, will face resistance. Change resistance can be defined as any phenomenon that hinders the process at its beginning or its development to keep the current situation, inertia [45]. Resistance has also been considered as a source of information being useful in learning how to develop a more successful change process [14, 17, 29, 42].
Rumelt [45] divided the main sources of inertia, which he called the five frictions, into five groups: (1)distorted perception (2)dulled motivation (3) failed creative response (4) political deadlocks (5) action disconnects.

2.5.1 Distorted Perception

Regarding the first group, change starts with the perception of its need, so a wrong initial perception is the first barrier to change. It includes: (a) Myopia or inability of the company to look in the future with clarity is one of those sources [5, 45]. It might be thought that

myopia is a perceptual distortion leading to the opposite of inertia, impulsiveness. However, if individual inertia is not intrinsic, but induced by the organization's context, then it will be expected. And the consequence of expected myopia is disbelief in the statements of others about the long-term and about the results of long-term investments [45]. (b) Hubris and Denial. A serious source of perceptual distortion is denial,the rejection of information that is contrary to what is desired or what is believed to be true [45, 5, 54].Rumelt explains hubris as superstitious learning: learning based on associating past success with factors that were coincidental with it but bear no causal relationship to the success. (c) Grooved Thinking. Groupthink, a term coined by social psychologist Irving Janis, occurs when a group makes faulty decisions because group pressures lead to a deterioration of "mental efficiency, reality testing, and moral judgment" [25]. Groups affected by groupthink ignore alternatives and tend to take irrational actions that dehumanize other groups. Another type of grooved thinking comes from the use of the "wrong" metaphor. Once a metaphor is accepted it provides a powerdul restriction on future thought [45].

Pardo del Val [10] added three other sources to this group of fiction. (d) Implicit assumptions. Starbuck [54] state that one reason groups of managers find change difficult is that many of the assumptions underlying their perceptions and behaviors are implicit ones. Explicit assumptions can be readily identified and discussed but implicit assumptions may never be seen by the people who make them, and these unseen assumptions may persist indefinitely. (e) Communication barriers. Departments develop a shared language that reflects similarities in members' interpretation, understanding, and response to information [57].This language or coding enhances communication within the department. However, organizational members unfamiliar with it may distort and misinterpret it and find communication with the departmental members difficult [34]. (e) Organizational Silence. Describes that there are powerful forces in many organizations that cause widespread withholding of information about potential problems or issues by employees[36]. This phenomenon limits the information flow with individuals who do not express their thoughts, meaning that decision are made without all the necessary information[36, 38].

Distorted Perception
Myopia
Hubris and Denial
Grooved Thinking
Implicit assumption
Communication barriers
Organizational silence

Table 2.2: Underlying Sources Distorted Perception

2.5.2 Dulled Motivation

Even if perception is accurate, organizations may resist change because the need is not felt with sufficient sharpness [45]. The lack of sufficient motivation may be rational, or it may reflect agency or psychological problems. This group includes: (a) Direct cost of change. It is likely that change temporarily increases the risk of organizational failure (mortality), disrupts operations, and involves a great deal of expensive effort. Even more importantly, change may imply the abandonment of costly sunk specific investments [45]; (b) Cannibalization costs. When a new product's success eats into the sales and profits of an older product, the older product is said to have been cannibalized [45]; (c) Cross subsidy comforts. The motivation to change is inhibited when a problem business is subsidized by rents from another business [45].

Pardo del Val [10] adds two other sources to this group of inertia.(d) Past Failures. Past Failures leave a pessimistic image for future changes[10]. (e) Different interest among employees and management or lack of motivation of employees who value change results less than managers value them [59].

Dulled Motivation
Direct cost of change
Cannibalization of costs
Cross subsidy comforts
Past Failures
Different interest

Table 2.3: Underlying Sources Dulled Motivation

2.5.3 Failed Creative Response

Three major sources of this group that diminish the creativeness in the search for appropriate changes strategies are: (a) speed and complexity. Analysis is blocked or frozen when things happen to fast [45]. (b) Reactive mindset. Change is inhibited when people stick to the view that their problems are natural and inevitable [45]. (c) Inadequate strategic vision or lack of clear commitment of top management to changes [45, 59].

Failed Creative Repsonse
Speed and complexity
Reactive mindset
Inadequate strategic vision

Table 2.4: Underlying Sources Failed Creative Response

2.5.4 Political Deadlocks

Political deadlocks lead to inertia by tying up time and energy in wrangling [45]. (a) Department politics. department politics or resistance from those that will suffer with the change implementation. [14, 45] (b) Incommensurable beliefs. The problem that arises when their are strong disagreement among groups about the nature of the problem or its solution [45] (c) Vested values. Unlike the cases of differing interest or beliefs, here individuals or entire departments are taken to have a strong emotional or value attachments to products, policies or the way of doing things [38**?** , 45]. Rumelt [45] also state that this source of inertia can easily be the greatest impediments to change. Pardo del Val [10] adds one more source to this friction: (d) Forgetfulness of the social dimension of change. [43, 29]

Political Deadlocks
Department Politics
Incommensurable beliefs
Vested values
Forgetfulness of social dimension

Table 2.5: Underlying Sources Political Deadlocks

2.5.5 Action Disconnects

The last source of friction concern those forces which prevent action. Sources of this friction are: (a) Leadership inaction; (b) Embedded Routines; (c) Collective Action Problems; (d) Capabilities Gaps. As these sources are explain themselves no further description of underlying source is given.

Action Disconnect
Leadership inaction
Embedded routines
Collective action problems
Capabilities gaps

Table 2.6: Underlying Sources Action Disconnect

2.6 Change Models

Back in 1940, Kurt Lewin [30] developed a three step change management model, see figure 2.3. He was widely considered as the founding fatfher of change management and this unfreeze-change-refreeze is regarded as the 'fundamental' or 'classic' approach to, or classic 'paradigm' for managing change [44, 53]. The first stage of change involves preparing the organization to accept that change is necessary. If any part of the core cognitive structure is to change in one than minor incremental ways, the system must first experience enough disequilibrium to force a coping process that goes beyond just reinforcing the assumptions that are already in place [47]. Lewin called the creating as such disequilibrium unfreezing, or creating a motivation to change. In the second stage movement occurs when the individuals engage in the change process. The third stage involves refreezing anchors new ways and behaviors into the daily routine and culture of the organization. Over the years more extensive, multiple step frameworks have evolved based on this model.

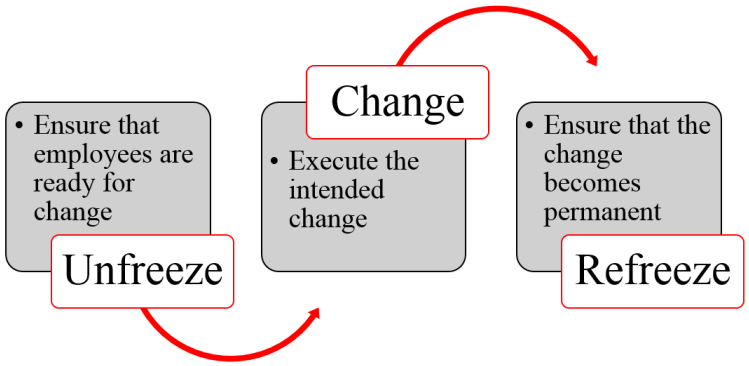

Figure 2.3: Lewin's change model [30]

Lewin [30] also developed the force field analysis. The idea behind force field analysis is that situations are maintained by an equilibrium between forces that drive change and others that resist change. For change to happen, the driving forces must be strengthened or the resisting forces weakened. Figure 2.4 illustrates a representation of force field analysis. The organization represented is currently at 'a' and wants to implement a change to move it to 'b'. Forces for change are presented within the organization and environment that make movement towards 'b' desirable. Forces against change representing forces in favor of maintaining the status quo. Movement from 'a' to 'b' requires that forces for the change exceed forces resisting the change. Movement can be achieved by (1) increasing the forces for the change, or (2) reducing the forces opposing the change.

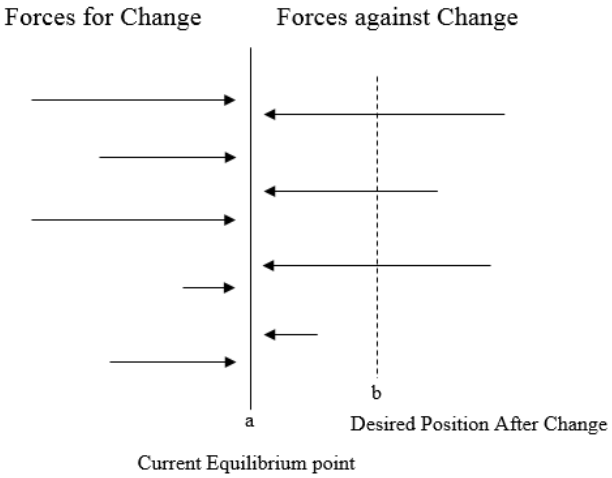

Figure 2.4: Force Field Analysis [56]

Quoted by Joe Thomas [56]: "*force field analysis is a concept adapted from the physical sciences. In physics, for example, the vectors and their relative strengths can be measured precisely. Measurement of the forces by a scientist allows for prediction of direction and speed of movement. Forces operating in an organization implementing strategic changes are not subject to such precise measurement, although identification of the salient forces operating in an organization should allow management to better assess the probable direction and speed of movement of the organization in implementing the new strategy.*"

Nadler and Tushman, [58] conducted a study focused on the factors that characterize the most successful attempts at frame bending - large-scale, long-term organizational reorientation, re-

ferring to radical reactive change in figure 2.2. In their research 10 principles are presented, they include: diagnosis; vision; energy; centrality; three themes; magic leader; beyond magic leader; planning and opportunism; many bullets and investment and returns. These principles are organized into four clusters including: initiating change; content of change; leading change and achieving change.

Eisenstat, Spector and Beer [14], conducted a four year study of organizational change at six large corporations. They found that "the fallacy of programmatic change", the belief that attitudes changes lead to behavioral changes, which lead to organizational changes, is backwards. Behavior is shaped by organizational roles. The six steps they describe as critical path with focus on changing roles, responsibilities, relationships to solve specific business problems are: (1) mobilize commitment to change through joint diagnosis of business problems, (2) Develop a shared vision of how to organize and manage for competitiveness, (3)Foster consensus for the new vision, competence to enact it, and cohesion to move it along, (4) Spread revitalization to all departments without pushing it from the top, (5) Institutionalize revitalization through formal policies, systems, and structures, (6) Monitor and adjust strategies in response to problems in the revitalization process.

Beckhard [6] presents a model with focus on the management of transformational change effort in a significant system or complex organization. He includes as transformational change a major change of the way of doing work. Which also includes moving from low-technology to high-technology manufacturing systems, implementing computers and tele-communication and redesign the customer interface. The model consist of ten perequisites: (1) commited top leaders; (2) written description of the changes organization; (3) conditions that preclude maintenance of the status quo; (4) Likelihood of a critical mass of support; (5) A medium- to long-term perspective; (6) Awareness of resistance and the need to honor it; (7) Eductaion and training to overcome resistance and gain commitment; (8) Preserving with the change process and avoiding blame; (9) Facilitate the change process with necessary resources; (10) Maintaining open communication about process, mistakes and subsequent learning.

Harvard-Professor John P. Kotter has been observing the process of change for 30 years [26]. He believes that there are critival difference between change efforts that have been successful and change efforts that have failed. He developed an eight-step method where his first four steps focus on de-freezing the organization, the next three steps make the change happen, and the last step re-freezes the organization with a new culture. The eight steps in the Kotter's model are: (1) establish a sense of urgency, (2) form a powerful guiding coalition team, (3) create a clear vision expressed simply,(4) communicate the vision, (5) empower others to act on the vision, (6)plan for and creating short-term wins, (7) consolidate improvements and producing still more change and (8)institutionalize the new approaches.

Schaffer and Thompson [46] mention activity-centered versus result-driven change. They stated that at the heart of these activity centered programs, is a fundamentally flawed logic that confuses ends with means, processes with outcomes. This logic is based on the belief that once managers benchmark their company's performance against competition, assess their customers' expectations, and train their employees in seven-step problem solving, sales will increase, inventory will shrink, and quality will improve. four key benefits of a result-driven approach that activity-centered programs generally miss were found: (1)Companies introduce managerial and process innovations only as they are needed, (2)empirical testing reveals what works, (3)frequent reinforcement energizes the improvement process and (4) management creates a continuous learning process by building on the lessons of previous phases in designing the next phase of the program. Also management needs to recognize unexploited capability in the organization: (1)

ask each unit to set and achieve a few ambitious short-term performance goals, (2)periodically review progress, capture the essential learning, and reformulate strategy , (3) institutionalize the changes that work—and discard the rest and (4)create the context and identify the crucial business challenges.

2.6.1 Recurring Change Principles

Combining these change management approaches as some elements recur or meet the same principle. The following change management key-principles are described;(1) diagnosis; (2) vision; (3) leadership; (4) communication; (5) addressing resistance; (6) learning organization through short-term results; and (7) institutionalize.

Diagnosis

Nadler [58] state that less effective strategic changes suffers from a lack of diagnosis and the quick adoption of "solutions in search for problem". Therefore it is of high importance to spent time understanding the potential environmental challenges and forces [58]. state that effective reorganizations are characterized by solid diagnostic thinking. Whereby, environmental challenges and forces, critical success factors and organizational strengths and weaknesses are identified. Then a fully developed description of the desired future state which is more than a statement of objectives or goals. Kotter [26] describes by examining the market and competitive realities and identify and discuss crisis, potential crises or major opportunity a sense of urgency is derived. Eisenstat [14] who focused on task-aligned change across different units, explains that the starting point of any effective change effort is a clearly defined business problem. He suggest that helping developing a shared diagnosis mobilizes the initial commitment to begin the change process.

Create a clear vision

Managing change requires creating a vision for change and a set of matching strategy and goals [58, 26, 14]. Kotter [26] finds that many unsuccessful transformations attempt to provide direction through complicated plans and programs that not only fail to explain management's vision but actually blur it. He asserts that vision statements of effective change programs have four focusing traits: (1) They eliminate many or all possible misinterpretations of the vision; (2) they single out areas requiring change; (3) they set clear targets, and; (4) they are reasonably concise. He adds that effective vision statements use metaphors and analogies and are simple with no "technobabble". Such characteristics, Kotter asserts, help create a clear picture of what the organization aims to be after the change process. Nadler [58] finds that most visions of strategic changes touches in some way on six points which describes; (1) why the vision is needed or why change is required; (2) the discussion of the organization's stakeholders and what it seeks to provide for them; (3) core values and/or beliefs that drive the organization of the change; (4) what will characterize effective performance of the organization (and in some case individuals) once the change has been achieved; (5) how the organization will be structured or will work to achieve the vision; (6) of some specific elements of how people in the organization will operate and interact with each other. Beckhard [6] does not mention vision but includes in his prerequisites as second priority to produce a written statement about the future direction of the organization that makes clear its new objectives, values and policies.

Leadership

Leadership is needed to guide the change and help people to change [26, 14, 58, 6]. Beckhard discuss that one or more organization's top leaders must be committed champions of the change. He also discuss that a body of key managers and other important opinion-formers must be formed

to gain their commitment and disseminate it. Nadler address that an important component of success is an individual leader who serves as a focal point for change whose presence has some special "magic". He also states success depends on a broader base of support built within other individually as followers, helpers and co-owners of the change. Kotter [26] agrees on assemble a power guiding coalition team, who work together with enough energy and authority to lead the change.

Communication of vision

With a clear diagnosis, which creates a vision of the future and a strong leadership core to guide the change. The vision must still be communicated to the people. Effective communication builds urgency and support the organizational vision. Beckhard [6] promotes open communication to create a sense of trust during the change process. Kotter [26] agrees with this openness, adding actions speak louder than words. He states that nothing undermines the communication of a change vision more than behavior on the part of key players that seems inconsistent with the vision . Kotter also suggests methods of communicating the vision as a tool to involve and excite the organization's people. He explains that firms have failed in their communications by not communicating the vision on a day-to-day basis. By using as many available channels of communication as possible, such as routine discussions, routine performance reviews, meetings, and memos, managers can repeat the message of change continually to ensure it reaches across the entire organization . When this is done, Kotter explains, the change message has a better chance of being remembered, both intellectually and emotionally.

Adressing Inertia to change

Applying these first principles will not guarantee that the people within the organization will buy into and collaborate in a change program. Therefore adressing the inertia to change is of importance [26, 6, 58]. Kotter [26] states that acceptance from both managers and employees must be obtained before implementing any change program. The need of an accurate understanding of the organizational barriers that hinder the change implementation. These barriers must be identified and eliminated. In this way, organizational processes, structures, procedures and reward systems will need to be aligned with the new change. Also employee and managerial training and development must be determined. Beckhard [6] also priors in this model required education and resources for the change.

Creation of a learning organization through short-term results

Multiple examples in the literature direct managers to seek organizational change and improvement based on incremental results [58, 14, 6, 26, 46]. This meets what Schaffer [46] call "activity centered programs". These programs aim to produce organizational transformation through a fundamental change in managerial philosophy and/or in organizational culture. Improvements centered on short-term results, on the other hand, drive toward the heart of the change process: the system's outputs and outcomes. By focusing on outputs and outcomes rather than on activities during a transformation, managers can gain the benefit of immediate feedback on the change process itself. Such feedback can serve several purposes. Schaffer [46] states that by seeking short-term results, managers can quickly and accurately assess the impact of their actions, eliminate activities that do not contribute to the change process, and create a learning process that builds on each incremental success. This continuous feedback process thus affords a learning organization the flexibility needed to adapt throughout its transformation efforts.Kotter [26] adds a human resource approach to this rationale, reasoning that such incremental results provide employees with opportunities to briefly celebrate during the difficult change process, help the change program win essential support from additional employees and managers, and

show employees the benefits of their sacrifices.

Institutionalize the new approaches

Kotter's [26] final step of his model anchors change in the organization. He discusses that cultural change should emerge only in the latter part of a change process: previous efforts to root change into culture have failed because they first of all attempted to change culture and secondly attempted to do so at the outset of a transformational program. Once the managers endorsed the accomplishments of the change efforts, they must work with the guiding coalition and other managers on the following: (1)Identifying the norms and values that support the changes;(2) ensuring selection, promotion, and succession processes screen talent according to the new norms and values;(4)modifying reward programs to align with the new norms and values;(5) supplementing training and development activities to include the skills and competencies associated with the changes; and(6)modifying and eliminating organizational processes and procedures that do not support the changes.

2.6.2 Methods Overcoming Change

Kotter and Schlesinger [27] explain that many managers underestimate not only the variety of ways people can react to organizational change, but also the ways they can positively influence specific individuals and groups during a change. They present the following strategies to deal with resistance to change: (1) education and communication; (2) participant and involvement; (3) facilitation and support; (4) negotiation and agreement; (5) manipulation and co-optation; (6) explicit and implicit coercion. In table 2.7 the methods are presented with the drawbacks, advantages and commonly used situations provided by Kotter and Schlesinger [27].

Approach	**Commonly used in situation**	**Advantages**	**Drawbacks**
Education and communication	Resistance is based on a lack of information or inaccurate information and analysis	Once persuaded, people will often help with the implementation of the change	Can be very time consuming if lots of people are involved
Participation and involvement	Where the initiators do not have all the information they need to design the change, and where others have considerable power to resist	People who participate will be committed to implementing change, and any relevant information they have will be integrated into the change plan	Can be very time consuming if participants design an inappropriate change.
Facilitation and support	Where people are resisting because of adjustment problems	No other approach works as well with adjustment problems	Can be time consuming expensive and still fail
Negotiation and agreement	Where someone or some group will clearly lose out in a change, and where that group has considerable power to resist	Sometimes it is relatively easy way to avoid major resistance	Can also be expensive in many cases if alerts other to negotiate for compliance
Manipulation and co-optation	Where other tactics will not work or are too expensive	It can be relatively quick and inexpensive solution to resistance problems	Can lead to future problems if people feel manipulated
Explicit and implicit coercion	Where speed is essential, and the change initiators possess considerable power	It is speedy and can overcome any kind of resistance	Can be risky if it leaves people mad at the initiators

Table 2.7: Methods for dealing with resistance to change [27]

3 Bridging the Gap to Paperless

The defined objective of this research is to deliver a model to Royal IHC, whereby the effort to go paperless from technological and people perspective is determined by providing: (1) resistance from technological perspective; (2) solutions to realize paperless; and (3) resistance from employees to the paperless changes. To evaluate this effort, the changes between current and new paperless state need to be determined. These changes act as reference in the developed model. The model follows three key questions including: where is resistance expected?; what type of resistance is found?; and how to deal with this resistance?

The conceptual model is presented in figure 3.1. Based on findings in chapter 2, the "where" question is answered and three analysis are conducted they include: (1) paper; (2) technology; and (3) people. Output of the analyses, answers the "what" question, where the output of paper influences the technology analysis and people analysis. The output of the technology analysis influences people analysis. The "how" question provides technological effort and people effort. More elaboration on each element is given in the following sections.

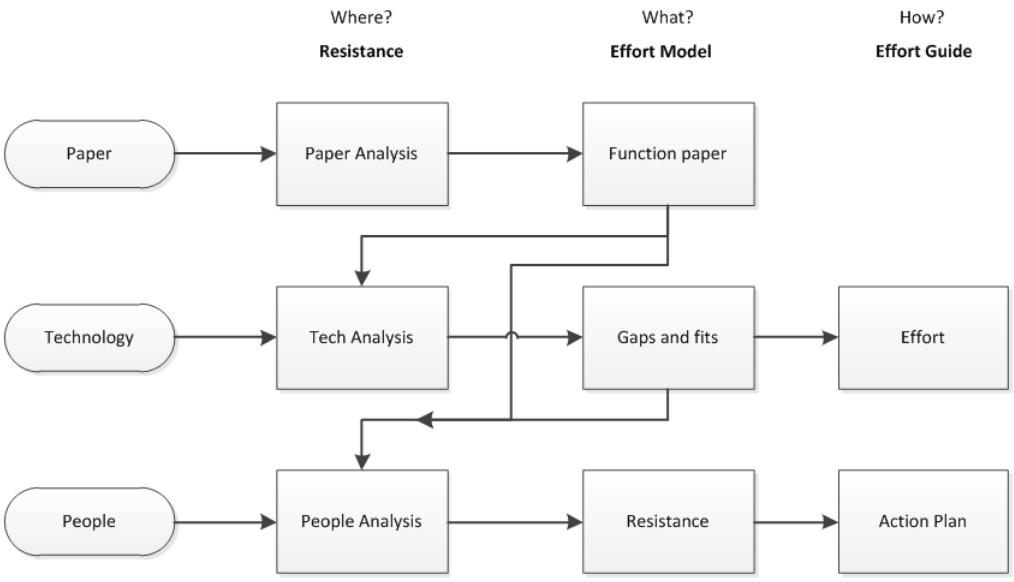

Figure 3.1: Conceptual Model

3.1 Paper

As reviewed literature [49, 20, 31, 33, 32, 41] showed, paper has certain functionalities which makes paper desirable valuable and necessary. Where, functionalities of paper are based on the physical nature of paper. In section 2.1.4 these functionalities are explained and based on

these functionalities paper analysis is conducted. Observation methods are used to analyze these affordances. Observation methods are useful to researches in a variety of ways. They provide researchers with ways to check non-verbal expressions of feelings, determine who interacts whit whom, grasp how participants communicate with each other, and check for how much time is spent on various activities [48]. In this research it is used to observe the functions of paper in the current state. In table 3.1 attention points during observing are presented for each functionality of paper.

Functionality	**Attention Points**
Navigation	Stakeholder navigates easily and flexible through documents whereby activities can be carried out with little or no attention
Annotation	(1) Stakeholder annotates on paper, (2) annotation used and/or made by several stakeholders on same document
Interweaving	Stakeholder writes and reads at same time
Cross-reference	Stakeholder uses more than one document at same time
Physical arrangement	Stakeholder creates functional zones for different priorities
Mobility	(1)Stakeholder takes paper easily to a variety of situations and physical places, (2) stakeholder easily reconfigure document during interaction to best serve the current activity
Collaboration and awareness	(1)Stakeholder use implicit or explicit traces from previous user of document, (2) use of paper provides mutual awareness by stakeholders, (3) use of paper stimulates personal communication and social order for stakeholders

Table 3.1: Observation Guide Paper Analysis

As functionalities are observed, resistance that might arise from replacement of paper are described. According the changes to the paperless state these resistances are redirected to the the technological analysis or people analysis. As some of the functionalities of paper might be replaced, made easier or even eliminated with paperless system, resistance of people might still occur as resistance due to, for example, embedded routines with paper are in order. On the contrary, if a paperless system disjoint the function of paper in some manner and this might become a hindrance for the activity, the resistance is redirected to the technological analysis.

3.2 Technology

The technology analysis is conducted according the company approach: delta session. The aim of the delta session is to identify the differences between the current way of working and the developed solutions. During this delta session, gaps and fits are listed. Gaps are processes that don't work for the department because the process does not comply with legal requirements or other regulations. Or the solution blocks a critical business process and local organization/processes can not be adjusted to make paperless work. Fits are explained by processes that will work for the department, although it may be different from current way of working. A fit can be created by adjusting the local organization and/or processes. The delta session is explained according four aspects including: (1) process, will the new process fit our business? Do we need to adapt our (non-system) processes?; (2) system, Do we need to change our systems (that will not be replaced by new systems) to work in the new situation?; (3) organization, is there impact on the

number of people? What organizational changes are required?; and (4) people, do our people have the right skills to work with the new processes?.

3.2.1 Delta Session Paperless

The delta session explained above will be conducted for the entire change by the company. Delta session in this research, analyzes the gaps and fits that arise due to the replacement of paper. Therefore the delta session in this model, will focus on the same aspects explained above only the aspect "system" is replaced by paper. Where paper in this case need to by replaced by the new system, and solutions or alternatives are explored. In table 3.2 the aspects of the delta session used in this model are presented.

Paper	What are possible alternatives to replace paper practices with new system?
Process	Will the new paperless process fit the business? Do we need to adapt our (non-system) processes?
Organization	Is there impact on the number of people? What organizational changes are required?
People	Do our people have the right skills to work with the new processes?

Table 3.2: Delta Session Aspects

Ensuing the paper aspect, alternatives are explored to realize paperless production. Since the use of an existing integrated information landscape is the prerequisite of this model, section .. is used as guidance and inspiration for finding alternatives. The process, organization and people aspects are contained as alternatives are explored. The alternatives, are relatively assessed according the impact and benefit of each alternative. An impact- effort matrix, designed for the purpose of deciding which of suggested solutions to implement, provides answers to the question of which solutions seem easiest to achieve with the most effects [19]. Illustration of the impact-benefit matrix is presented in figure 3.2. Impact and effort are discussed with experts from development of solution department and department where solution is implemented.

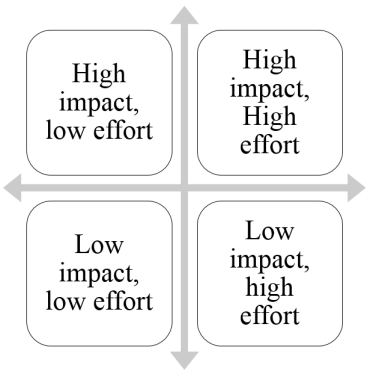

Figure 3.2: Impact- Effort Matrix

The changes required for realizing the paperless solution(s) are redirected to the people analysis.

3.3 People

In figure 3.3 an illustration of the principles of change management and the interconnection with the sources of resistance to change is presented. Among the reviewed literature [45, 5, 54, 25, 57, 34, 36, 38, 10, 59, 43, 29] resistance to change is derived from five main sources of resistance including: (1) failed creative response; (2) distorted perception; (3) political deadlocks; (4) dulled motivation; (5) and action disconnect. In section 2.5 these sources are explained according their underlying sources. Among the reviewed change models [58, 14, 6, 26, 46] seven recurring principles are found they include: (1) diagnosis; (2) vision; (3) leadership; (4) communication of vision; (5) addressing resistance; (6) short-term result; (7) and institutionalize. In section 2.6.1 these principles are described.

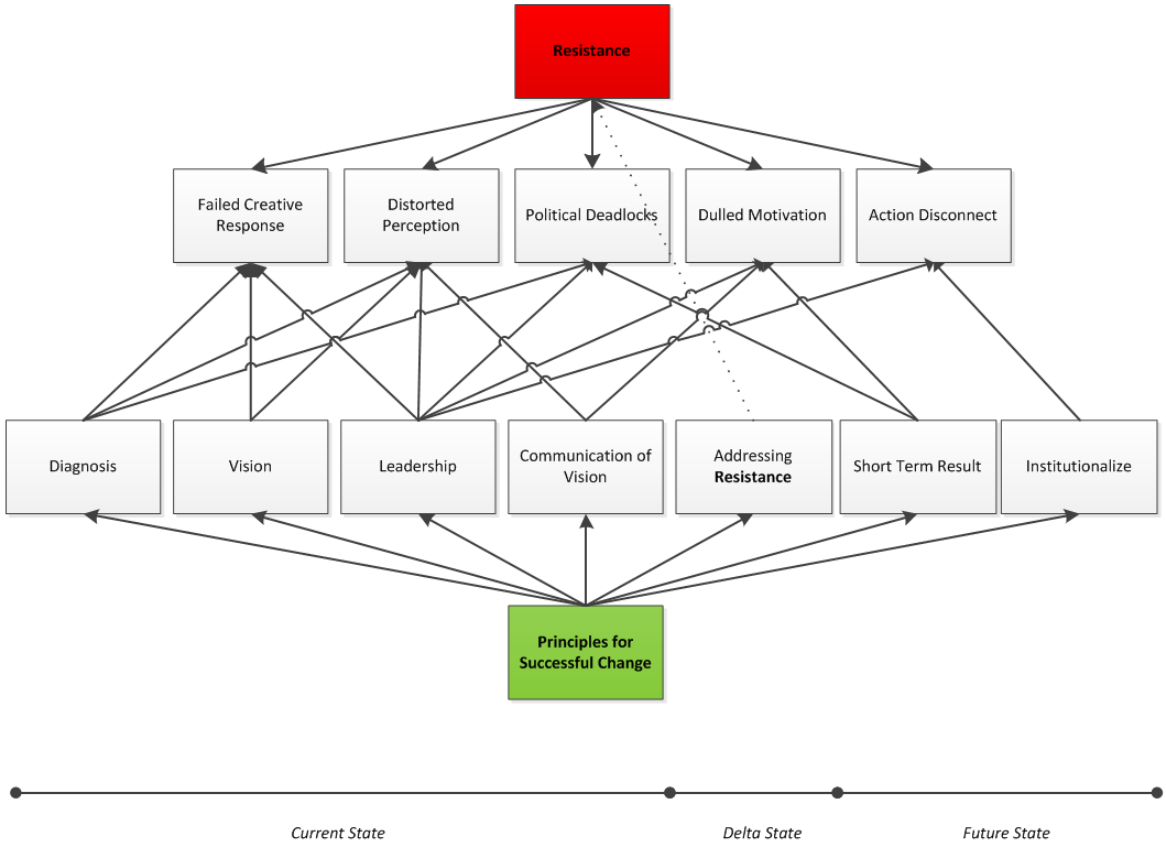

Figure 3.3: Interconnection Resistance with Principles

The model presented in figure 3.3, presents that resistance, referring to the red block in the figure, are influenced by drivers of change, referring to the green block in figure, which are in this model the principles of change management. The drivers of change are situated into the different stages in Lewin's change model [30], described in section 2.6. Different denominations to the stages are given where; (1) refreeze stage is current state; (2) change stage is delta state; (3) and freeze stage is future state. The principles, diagnosis, vision, leadership and communication of vision are situated in the current state. Where, awareness, excitement and commitment is generated among the stakeholders about the change. The impact of these principles can influence the impact of resistance from all sources. In the delta stage, resistance towards the change is addressed. For this research resistance to change is used to find effort to change. Therefore, this principle does not influence resistance but connects with the sources of resistance. The principles concerning short term result and institutionalize are situated in the future state, and

influences the resistance sources of dulled motivation and action disconnects. In the following section relation of the underlying sources of resistance with principles and the methods described in section 2.2.6 is given to minimize the main source of resistance. The method education and communication is in this model incorporate with the principle communication of vision.

3.3.1 Overcoming Resistance to Change

Described in section 2.5 each main source of resistance is induced by underlying sources of resistance. Overcoming the main source failed creative response is illustrated in figure 3.4. Note that in this figure as well as in the forthcoming figures 3.5, 3.6, 3.7 and 3.8 in this section the arrows are options to deal with resistance, as in some cases multiple options are explained. This does not mean that every arrow needs to be followed, however in some cases it does yet this is dependent on the situation. The length of the arrows have no meaning in the figures and also note that no stage line is presented.

The underlying sources of failed creative response are presented in table 2.4. This resistance is assumed to be exposed while diagnosis and vision are already made and change is already happening or change is not happening at all. Resistance due to underlying sources speed and complexity and inadequate vision are influenced by diagnosis and vision of the change. Inadequate vision and reactive mindset are influenced by leadership. To overcome this resistance, diagnosis and vision need to be re-assessed with all required information of key stakeholders involved in the process. During this process key management need to be convinced and committed to the change.

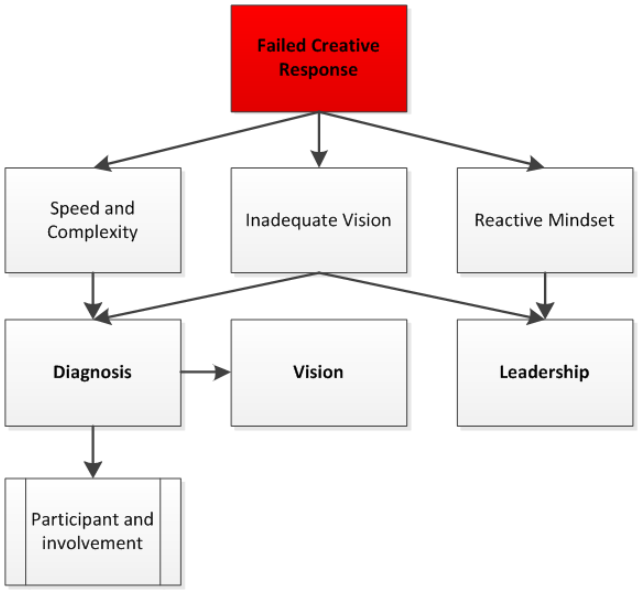

Figure 3.4: Overcoming Failed Creative Response

Figure 3.5 illustrates overcoming the main source resistance distorted perception. In table 2.2 the underlying sources of distorted perception are presented. Myopia, is caused by the vision of the change. If vision is not clear and does not picture the future, diagnosis and vision need to be re-assessed. This is also the case if resistance is caused by implicit assumption. Eventually the vision need to be communicated. If vision of company is clear and do pictures the future after change, communication of the vision needs more attention. Group think is also caused by wrong communication of the vision, assuming diagnosis and vision are well performed and designed. The remaining underlying sources, hubris and denial, organizational silence and communication

barriers are all influenced by leadership.

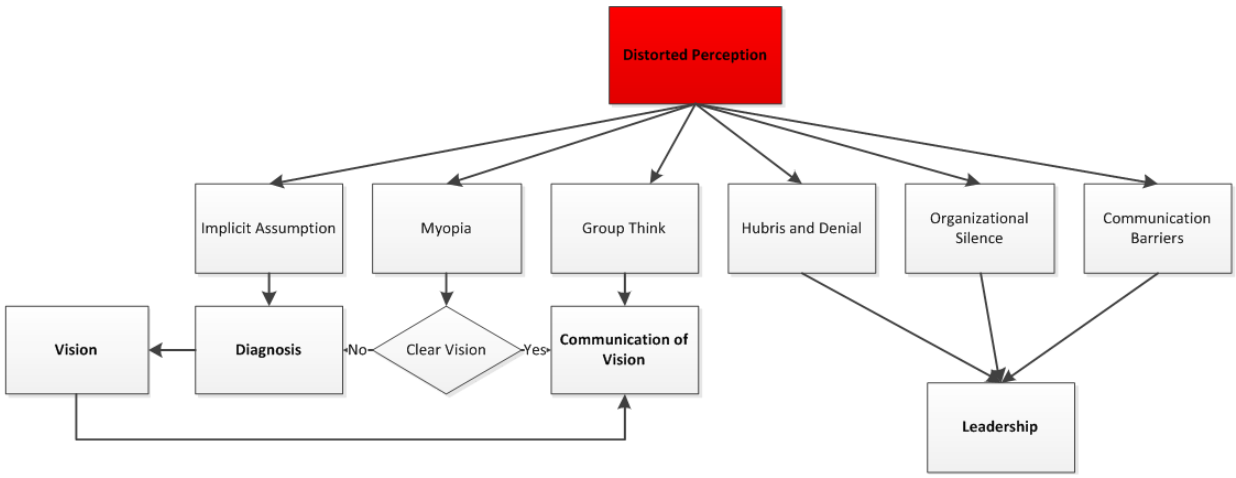

Figure 3.5: Overcoming Distorted Perception

Figure 3.6 illustrates overcoming the main source resistance political deadlocks. In table 2.5 the underlying sources of political deadlocks are presented. Assumed is that the vision is understand by department, however they do not agree with vision, as they might suffer from it, and therefore they do not agree with the diagnosis. If participant and involvement during diagnosis is possible, this helps overcoming this resistance and/or creating a shared diagnosis and therefore vision. If not, leadership is important and methods as negotiation and agreement, manipulation and co-optation or explicit and implicit coercion are optional. Facilitation and support is needed to not forget the social dimension.

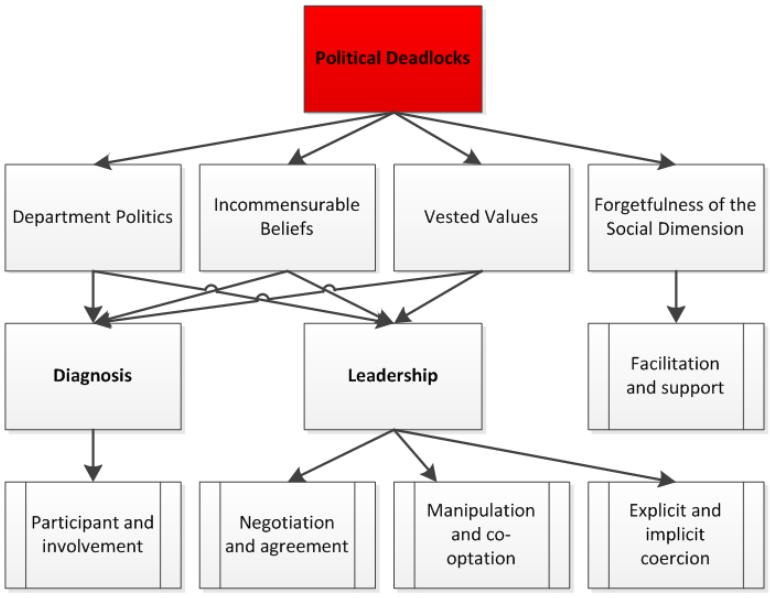

Figure 3.6: Overcoming Political Deadlocks

Figure 3.7 illustrates overcoming the main source dulled motivation. The underlying sources of dulled motivation are presented in table 2.3. Since resistance comes from not being motivated because they do not feel the need for change. Impact of the communication of vision is important for all underlying sources. As change is assumed to be implemented for the better cause of the

company, urgency to change needs to created by communication of its vision. As well as through leadership. If impact resistance is still high, methods as negotiation and agreement, manipulation and co-optation or explicit and implicit coercion are optional.

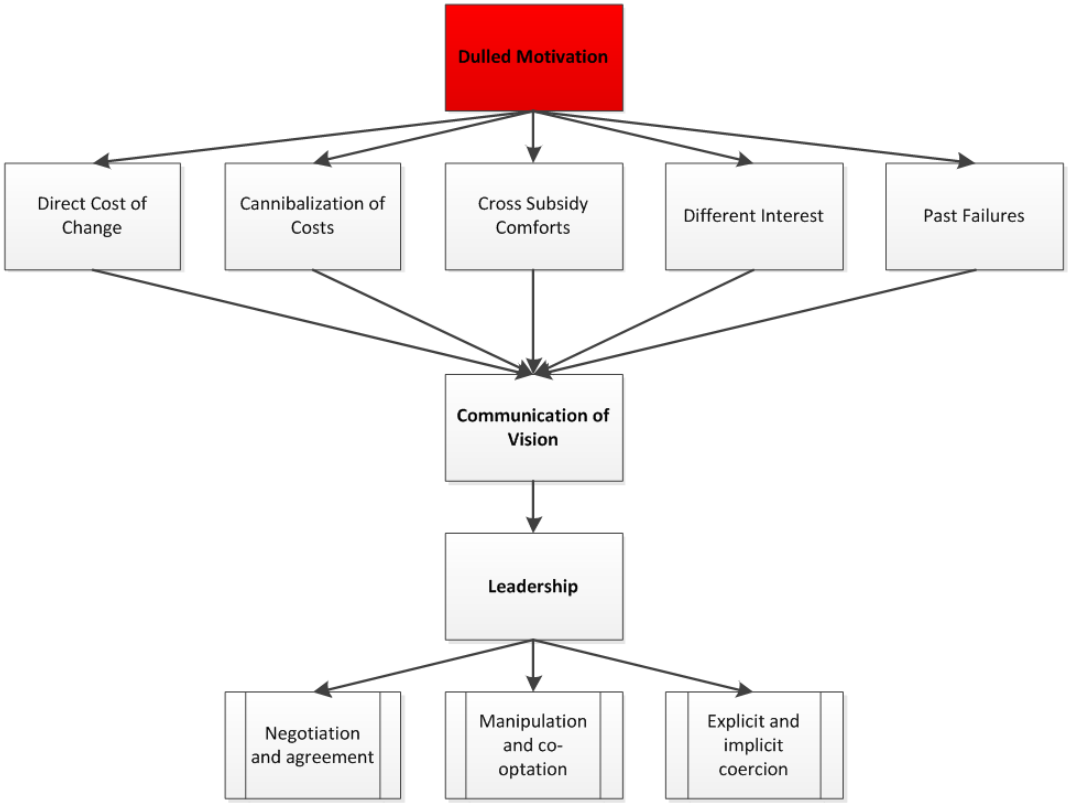

Figure 3.7: Overcoming Dulled Motivation

Figure 3.8 illustrated overcoming the main source action disconnect. The underlying sources of action disconnect are presented in table 2.6. These sources are described as the forces which prevent action. Whereby leadership inaction and collective problems and embedded routines are influenced by leadership. Embedded routines and capabilities gaps requires facilitation and support.

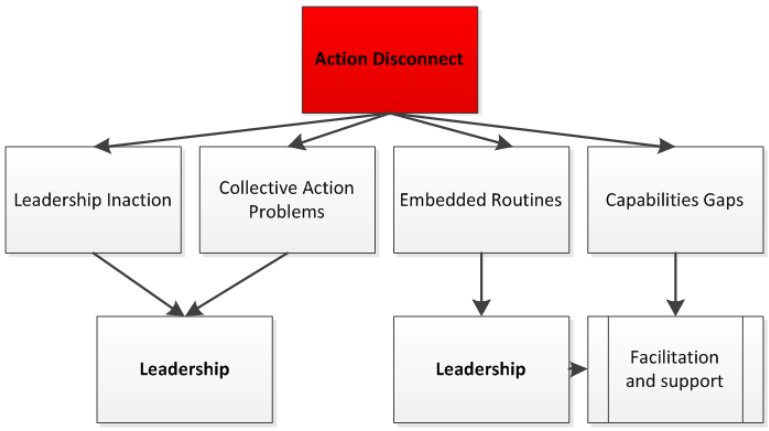

Figure 3.8: Overcoming Action Disconnect

The principles regarding short-term result and institutionalize are not explained in the above figures. Short-term results however have influence on department politics and dulled motivation as resistance from those sources are exposed during implementation of the change. Principle institutionalize influences the resistance from main source action disconnect.

3.3.2 Resistance Force Field Analysis

The force field analysis technique, explained in section 2.2.2 is used to perform the people analysis. Whereby, the forces against change are categorized in the sources of resistance and helping forces are the drivers of change.

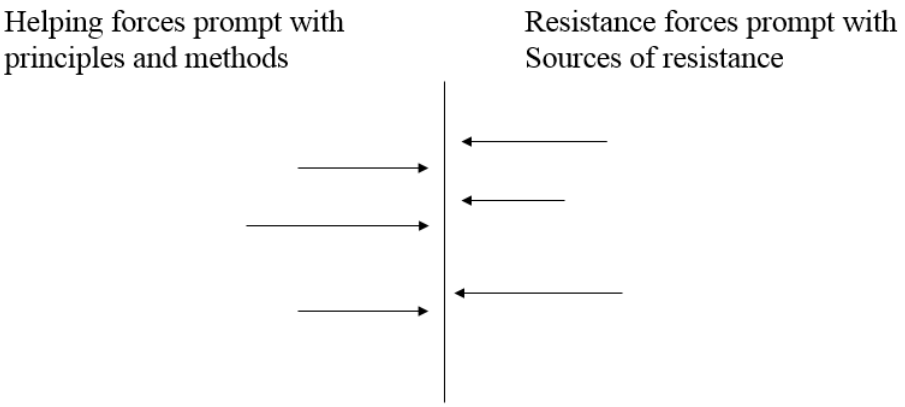

Figure 3.9: Resistance Force Field Analysis

The first step contains listing the resistance forces. Forces are detected by observation and semi-structured interviews. Forces are listed category wise, where the sources of resistance are the categories. Impact of the resistance forces are explained by the recurrence of the resistance among the employees. Helping forces in this model are the principles of change management. The impact of these principles are derived according the resistance forces found as-is. Impact of helping forces need to be increased As described in section 3.3.1
Methods are used to increase these forces but also creation of new helping forces according methods are used to decrease or eliminate the resistance forces.

4 Case Study

In this chapter an application of the model provided in the previous chapter is presented. It includes the case of a paperless pipe shop for Royal IHC. IHC Piping (Piping), is one of the business unit within Royal IHC. They supply all piping systems for shipbuilding, yacht building and a variety of mission equipment. This year the implementation of the new systems takes place for Piping.
First, the current and future state are presented. Second, the alternatives of paperless are described. Final, the resistance force field analysis is used to create an action plan to bridge the gap to paperless.

4.1 IHC Piping

A ship contains kilometers of pipes of various sizes, connections and functionality. IHC Piping (Piping) supply all piping systems for shipbuilding, yacht building and a variety of mission equipment. In shop, pipe spools are fabricated. Pipe spools are the pre-fabricated components of piping systems. They include the pipes, flanges and fittings. Pipe spools connect long pipes with flanges at the tips so that they can be bolted to another pipe with matching flange. In figure 4.1 various spools are presented.

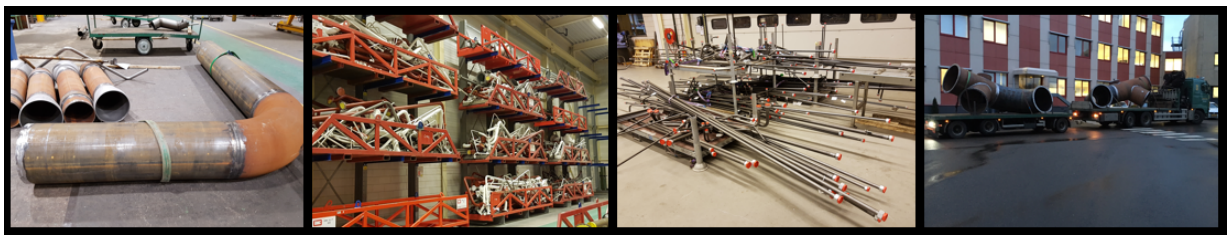

Figure 4.1: Various spools fabricated by IHC Piping

Machines in Shop	**Capacity**
CNC pipe bending machines	up to Ø220mm
innovative CNC pipe fit/welding robots	up to Ø200mm
CNC flame pipe cutting machine	up to Ø1200mm
Non-welding flaring machine	up to Ø60mm

Table 4.1: Machines in Shop

The shop consist of two areas of production. The main area where the vessel piping is fabricated and a smaller and cleaner area for hydraulic piping. To fabricate the spools, several operations are conducted. Every spool starts with pipe material which is cut into the required length of the spool. If spool requires bending, the next operation is bending. Thereafter, if the spools requires extra materials, these materials are fit to the pipe. And final, the materials are welded

to the pipe. In some cases, it is not possible to fit all material before welding. Therefore it occurs that after welding the spools requires fitting again. At the cut and bend workstations, the operators control the machines. At the fit and weld stations the operators perform the operations themselves. In table 4.1 the machines in shop are presented. Note, that there are two pipe fit/welding robots located at cut station in the main area. In figure 4.2, also presented in Appendix A.2, the production process is presented.

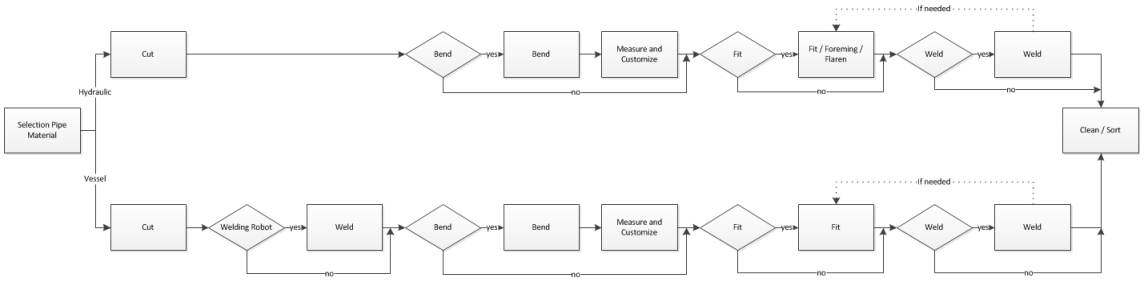

Figure 4.2: Production Process Spool

Preceded to the fabrication of pipe spools, Central Production Engineering (CPE) delivers all production information to Piping. Once the arrangement plans of a ship are defined by Basic Engineering, pipe routing is determined, drawn and released per section by Detailed Engineering. These released pipes can be found in the piping structure data base (PSDB). CPE picks up data from PSDB and checks the manufacturability of the spool. They plan the spools and generate the production information as materials and operations. Machine files and sketches are made to release to production.

Once the planning and production information of the spools are determined, the planning of the shop takes place. The work preparator of the shop retrieves the spools released to production from Extended, current main software used by Piping. The work preparator selects a batch of spools according planning to produce in shop. Extended subdivides the spools in jobs based on the material ID (diameter, hydraulic or vessel) and project. For each job a job package is available and printed. In figure 4.3 this information flow is presented, also presented in appendix A.1.

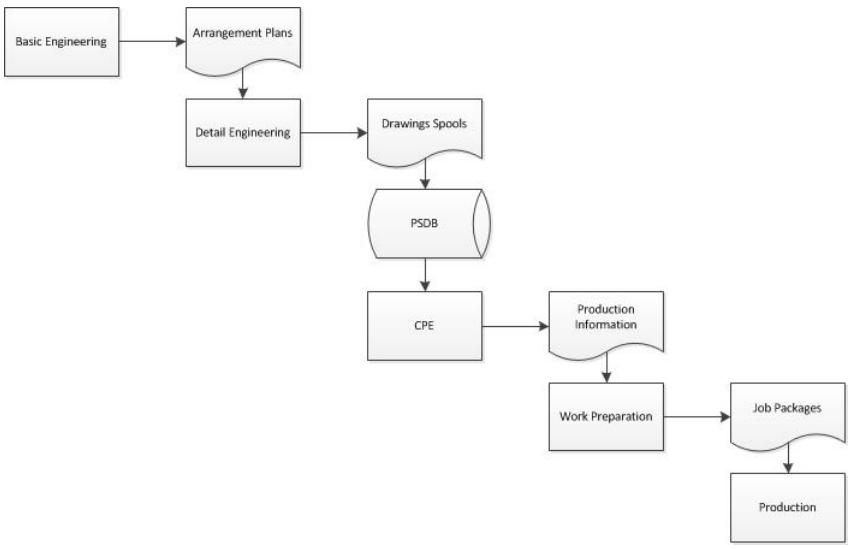

Figure 4.3: Information Flow Pipe Spools

4.1.1 Shop Floor

Jobs are used to minimize outlay, cost of setting up the bending machines. As described above every job consist of spools with the same diameter, material and project. One job package consist of the following documents: (1) saw list; (2) welding list; (3) bending list; (4) material note; (5) assembly list; (6) sketches (original, vietnam); and (7) isobuilder worksheet. In appendix A.3, an example of a job package is presented. Each operator uses the documentation required for their operation. Hence, at every workstation the packages gets smaller. Time registration is also handled per job, manually.

Once the job packages are printed they move to shop floor. The shop floor manager, foreman, receives these jobs and continues planning. He sort all jobs on the most desired sequence through shop. He distinguish if the job requires the small or large bending machine and if bending and cutting are in order. If all jobs are sorted the foreman assigns "production" to the jobs in Extended.

At this point production begins. At the first station, pipes are cut. The operator receives the job packages from foreman and select the saw file required for this job. Before he starts his operation he checks the rest lengths for each pipe in order to select pipe material most efficient. Also, there are two welding robots available at this station. The welding list in job package provide welding information for these robots.

The second station regards bending the pipes. Three bending machines are available; (1) smaller diameters bending machine; (2) bigger diameters bending machine; (3) old manually bending machine. The operators pick up the job packages and pipes at the cut station. They select the machine settings for the job and perform their operation.
After bending, the pipes are measured and if needed customized for fitting at the "check" station. This is seen as an activity of a fitter.

The third stations regards fitting the pipes with the extra material, like flanges. The extra material gathered from the warehouse is available at pick-up point. Operators can pick up the material and pipes themselves. However, sometimes the foreman specifically assigns jobs to a fitter and provide him with the pipes and materials. The job package at this point only consist of the sketches.

The last station regards welding of the pipe spools. The foreman assigns pipes to welder. No information from job packages is needed for this activity. Once the spools are produced, they are cleaned, sorted and placed in cradles depending on the post-treatment of the spools. This operator also signs off the pipes in EXTENDED. The operations at the hydraulic shop are basically the same. Naturally, the shop is much cleaner and smaller.

Warehouse

Warehouse receives a material note per job from foreman, once the job started production. He picks materials according the material note from warehouse. The picked materials per job are put into a crate. After the job is finished at check station, the residual documents are acquired by warehouse and also placed in accompanying crate. The crate is now ready for pick up.

Time Registration

Each operator manually keeps up with the time spend on a job. At every station a list is present were they write the start and end time of each job. At the end of the day all time-lists are collected by the foreman and manually captured in excel sheet. This can be a time-consuming

process. The foreman must calculate how many hours the operator has worked per project and if the total is 8. Because the operators notate start and end time of job, the foreman must calculate the amount of time. He sometimes uses a table presenting minutes in hours. For example, a operator starts at 7:15 and ends at 11:45, results in 4 hours and 30 minutes. He checks with table, 30 min is equal to 0.5 hours. And confirms 4.5 hours.

4.1.2 Stakeholders

The entire organization of Piping is affected by the One program. However for this research which focus on the paperless addition of One, the affected stakeholders are the operators and foremen in shop and the work preparator, who are all still depending on paper practices. Also the piping manager is seen stakeholder due to his eventually responsible of the performance in shop.

Stakeholders Paperless
Manager Piping
Work Preparator
Foremen
Operators in Shop

Table 4.2: Stakeholders Paperless

4.1.3 Elimination Paper - Real Time Data

The amount of paper used in shop is tremendous. Provided with enough orders and shops capacity around 125 spools a day. Results, for example with an average of 25 spools per job, in:

$$125(spools) * 3(sketch/isobuider) + 5(jobs) * 5(other) = 400(pages)perday$$

Which makes 2000 pages per week, yet, time-lists for each operator for each day not included. Also real time data is not used in shop. Once the job packages are printed, the data becomes out of sync with computer data. Also no operational data is captured and stored and time registration is manually captured. Due to these paper practices the following drawbacks of current situations are found:

- No accurate operational data, planning shop based on experience
- Time wasted on printing documents, documents delivery, walking around, manually capture time registration,
- Warehouse often not up to date
- Possibility of out of sync production data / status of spool / delivery units

4.2 One Solution - Future State Analysis

As earlier stated IHC started the One IHC program in order to uniform all the processes and data within the company. The functional area, which is a discipline within Royal IHC with specific competences and skills to execute certain processes, important for this case is Make. This area contains the steps to make the products. Which are briefly, creating shop orders for each spool and executed these shop orders, see appendix B.5. One describes the following concise steps for the functional area Make: (1) prepare; (2) get the stuff; (3)turn 'm into parts; (4) check

it out; (5) make it work; (6) and tell 'm that you are done. In

4.2.1 IT Landscape

The heart of the application landscape of One are IFS and Teamcenter. IFS, ERP software, is used for all transactional actions, which includes, work preparation, production, assembly, commissioning, procurement, logistics and all financials including time registration.

Teamcenter, PDM software from Siemens PLM software, is central application for engineering. It contains all details of IHC products. Data exchange between applications is triggered by the application itself or via workflows. Teamcenter communicates one way with IFS. see appendix **??** for entire landscape see appendix B.6.

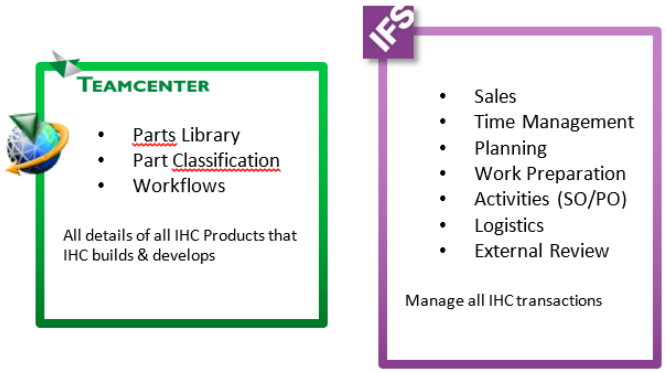

Figure 4.4: Heart of Application Landscape One

3R solution, is new specific Piping software introduced in pipe shop. 3R software is used for automatic planning across shop floor and efficient sawing of the pipe material. As this case focuses on finding the effort to bridge the gap to paperless at shop floor, the entire flow of Make for Piping is not explained. But starts for this case when shop order of spool is released to production and structure and production data of spool are already defined by CPE (Make Engineering for One).

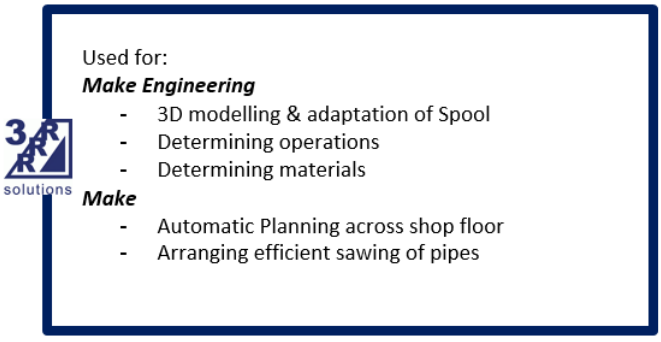

Figure 4.5: Specific Piping Application

4.2.2 New Paperless Processes at Shop Floor

Instead of retrieving the spools released for production from Extended the work preparator, operational planner in One terms, uses the applications of 3R, Ramp package manager. Ramp

receives all relevant material, drawing and fabrication data from Roni IsoBuilder, another application used in an earlier stage defining the production data.

In Ramp Manager all spools released for production are displayed. In the Rampmaster file a time value, contingent on the material, is assigned to each work step. In this way the various stations know the appropriate maximum use of capacity and bottlenecks at individual stations in fabrication can be detected and avoided early. The operational planner selects the spools for production for a period of time, batch, and a check of the capacity of shop is automatically processed.

Subsequently, the created planned batch is presented in the Ramp Monitor, where the operational planner releases the spools for production. Automatically a check for material is done by creating a batch. If material is not in stock, the spools can not be released for production. Simultaneously, the status of the shop order of the spool in IFS is set to released.

Current	**One**
Use of Extended	Use of 3R, Ramp manager
Create batch	Create batch assigned to period of time and automated check of capacity* and planning of spools is done by 3R
Jobs creation based on material ID and project, printed job packages	Jobs based on only material ID send to Pipecut
*capacity check is currently done before work preparation, CPE communicates with Piping manager and releases spools based on the average throughput time of spool	

Table 4.3: Changes Work Preparation

Another application of 3R, Pipecut, is used at the cut station. In Pipecut the released spools are available. In the application the cutter loads material and Pipecut automatically nest the pipes. He selects the spool and start his operation in Pipecut. To actually start his operation he must select the saw file, load material and start operation in software of the machine, as before. If the pipe is cut the cutter confirms in Pipecut and declares what to do with rest length of the pipe.

Once the pipe is cut a sticker with unique barcodes for every activity of the spools is sticked to the pipe. At all other workstations an application of IFS is used; Workbench. Each operator scans their activity and will be provided with the production information of spool. In the workbench operator start and stop their activity.

Current	**One**
Use of job packages	Use of 3R, Pipecut and IFS, workbench
Time registration on paper	Use scan and IFS for time registration for each spool

Table 4.4: Changes Shop

The entire job package can be eliminated as software is introduced in shop to log their activity and where manufacturing data of spool is available in workbench. As the core values of paperless,

capture, store and display manufacturing data. One provided a system which collect operation data by manually start and stop the activities in application of each spool in shop. This data is stored and used for transactional reasons in IFS which provides real-time and accurate data on labor and production costs. Also real-time status of the spool is provided per spool and activity in IFS. The use of the IFS lobby functionality enhances real-time visibility of the shop.

> *The IFS Lobby functionality is named so because it approximates the lobby of a high-end hotel, with a front desk, concierge, information and ways to get to other parts of the building from a central location. This is the place you start out, a place to meet and find all the information you need for your visit, or for your work day in IFS Applications.* [24]

For shop floor the data provides accurate time value of each workstation and therefore the capacity of shop, used to automatically plan shop.

Computerized Processes
Capacity check (3R)
Planning through shop (3R)
Material check (3R) Rest length management (3R)
Time registration (IFS)

Table 4.5: New Computerized processes

4.3 Bridging the Gap

This section presents the application of the model provided in the previous chapter. In section 4.3.1 the paper analysis is presented and the functions of paper are described. In section 4.3.2 the technology analysis, gaps and fits and effort are presented. Final in section **??** the force field analysis is presented and an action plan provided.

4.3.1 Paper

Two type of paper practices are presented in the current state of Piping. These include, the job packages provided with manufacturing information used by the operators in shop and the manual time registration. In table 4.6 the information and stakeholders of the paper practices are presented.

Paper Practice	**Information**	**Stakeholders**
Job packages are printed to provide manufacturing information to shop floor	• saw list • welding list • bending list • material note • assembly list • sketches • isobuilder worksheet	• work preparator prints and delivers to foreman • Foreman delivers to operators • Operators use use paper
Time registration	Time registration per job per operator	• Operators note their time • Foreman manually captures data

Table 4.6: Paper Practices Piping

To find the affordances, observation according table 3.1 is conducted in shop to find the actions with paper. In appendix C.1, the results of this observational study is presented.

From these actions the following affordances were found; (1) Annotation: Almost every stakeholder occasionally makes notes on paper. Sometimes to make a quick calculation, sometimes to adjust some information and the cut and warehouse operator use annotation to scrap the pipe length or material from the saw list or material note. (2) Mobility: At the check station and fit stations the operators held their sketch next to the pipe. the ability of the paper to held at different angles helps them comfortable reading and compare the skecth with pipe. Also in this environment, meaning big steel material and welding operations, it is less problematic if a paper gets damaged. (3) Collaboration and awareness: physically hand-over of the documents between office, foreman and operators refers to the collaboration and awareness between all stakeholders.

As research indicated that this stimulates the personal communication. Also from foreman his perspective it is assumed that this practise gives him a sense of controlling the shop by through these paper documents. (4) Spatial organization: is detected at cut station, the operator creates two piles of finished paperwork. One for the cut operations and one for the robotic welding operations.

Affordances	**Stakeholders**
Annotation	cut, bend, check, fit, warehouse
Mobile	check, fit
Collaboration/Awareness	foreman, operators, office
Spatial Organization	cut

Table 4.7: Stakeholders Affordances

Reducing/Elimination Paper

Although more affordances are found, yet one affordance, the mobility of sketch, is observed as actual functionality of paper that might hinder the way of working replacing it in digital form.

The spatial organization is withdrawn by the paperless system. As no saw list and welding list are presented with the new system. Annotation can be replaced by any notebook for the operators and the awareness and collaboration functionality can affect the collaboration between office and shop, and between foreman and operators. This is however not seen as a hindering on the job yet there are many other ways to create awareness and collaborate in a good manner.

Even though these affordances can be replaced, keep in mind that these operators have been working entwined with paper and therefore these functionalities can impact the resistance on a paperless solution. Yet, the mobility of the paper sketch can impact resistance on the actual job.

4.3.2 Technology

In this section the paper delta session is conducted. first the changes in technology and processes are described. Thereafter, deltas are described and solutions are presented.

Change in Software

Extended, the main software used by Piping is replaced by IFS. For work preparation for shop, Extended is replaced by 3R, automatic planning of shop is a new feature. 3R is also used for nesting and saw functionalities. Also IFS is introduced to all operators in shop except for the cut operator. In table 4.8 an overview of change in software per stakeholder is given.

Stakeholder	Current Software	New Software
Piping office (Manager)	Extended	IFS
Work preparator	Extended	3R
Cut operator	-	3R
Warehouse operator	Extended	IFS
Sort operator	Extended	IFS
Bend/Check/Fit/Weld operator	-	IFS

Table 4.8: Stakeholder Changes in Software

Change in Hardware

To provide the manufacturing information, devices are needed for the operators in shop. Also two type of scanners are introduced in shop. Operational scanners to scan the operation barcode sticked on spool. And logistic scanners equipped with feedback screen with functionalitie in IFS.

Change in Process

For this case, process is described as the actions taken by stakeholder to perform their job. For each stakeholder the changes in process are described. Comparing current processes with future processes described in the current and future state sections, a list current and future steps are presented in the following tables 4.9, 4.10, 4.11, 4.12.

Stakeholder	Current Process	Future Process
Work preparator		
	• Create batch for production (Extended) • Create jobs (Extended) • Print job packages (Printer) • Deliver job packages to shop	• Create batch for production (3R) • Check capacity shop (3R) • Check materials (3R) • Release to production (3R)

Table 4.9: Change in Process - Work preparator

Stakeholder	Current Process	Future Process
Cut Operator	• Receive job packages • Note begin time of job • Check rest lengths pipes • Load matching machine file (machine software) • Load pipe material (machine software) • Start operation (machine software) • Note end time of job	• Select pipe material (3R) • Perform live nest (3R) • Start operation (3R) • Load machine file (machine software) • Load pipe material (machine software) • Start operation (machine software) • Confirm saw operation (3R)

Table 4.10: Change in Process - Cut Operator

Stakeholder	Current Process	Future Process
Bend/check/fit/weld operator	• Receive job package • Note begin time of job • Pick up pipe(s) • Bend / measure and customize / fit / weld • Note end time of job	• Pick up pipe(s) • Scan activity barcode on pipe (scan) • Start operation (IFS) • Bend /measure and customize/ fit /weld • Confirm operation (IFS)

Table 4.11: Change in Process - Bend/check/fit/weld operator

Stakeholder	Current Process	Future Process
Warehouse operator	• Receive material note • Pick up material • Sort material per job • Sign off picked materials (Extended)	• Print picklist (from IFS) • Pick up material (scan?) • Sign off material (IFS)

Table 4.12: Change in Process - Warehouse operator

Deltas and Alternatives

Deltas according paper aspect
For a paperless pipe shop and a working One Solution, devices are needed for presenting the manufacturing information of the spools to the operators. And to capture and store operation times and progress per spool by start and stop the operation in 3R and IFS. This is an important feature because one of the main benefit for Piping of this system approach is the automatic planning of the shop, as described in section 4.2.2. This requires, operators to start and stop each spool for accurate data whereby optimal planning is attained. So the first new delta describes the introduction of electronic devices in shop. Discussion about the choice of devices is still open. Four alternatives are determined they include, fixed workstation, mobile device, shared devices and personal devices. Investment of devices depends on several aspects,

Also scanners are introduced. The operational scanners is used as filtering method of the operation of spool in IFS. At this point One delivers scanners connected through USB connection with device. Notwithstanding, Piping thinks these scanners, with emphasis on the wiring, will not last long in shop. An alternative is to use wireless scanners. Logistic scanners are introduced however, the solution of One at this point, prints the pick list in order to pick the materials. In this way no real-time data is used and warehouse operators operate in the same way as they do now. In order to provide true paperless the logistic scanners must be used. So materials are signed off real-time.

Referring to capture data, this scanner only filters the operation of the spool. It does not automatically start or stop the operation in system. For true paperless operation, scanners with functionalities of start and stop operation in IFS is an option.

The last action delta concerns the sketch for the fitter. As described in section 4.3.1, the mobility of the sketch can cause hindering in operation. The alternative is to print the sketch for fitters.

Deltas according process aspect
In the current way of working each operator receives job packages. These job packages show each operator which spools they need to produce. The sequence of the pipes is determined by these job packages. The bender knows which pipes to pick up at the cut stations. The fitter picks up crate with materials provided with residual job package. And thereby knows which pipes to pick up.

In the new way of working pipes do not move as job through shop. The sequence is determined in RAMP and in PIPECUT the most efficient sequence for the batch is presented. To persist this sequence it is of importance that the pipes are physically sorted in this sequences for upcoming workstations, as operators are no longer provided with a document. In this way the operators always pick up the next in sequence pipe to operate on.

As spools move individually through shop, Piping states that for warehouse operators and fitters performing their operation per spool, this will results in a very inefficient way of working .

In warehouse, materials are currently picked according the material lists per job. As no jobs are created with the new system, the warehouse operators uses in the new system consolidated pick lists. As explained, he currently sorts the materials per job in crate so fitters are provided with all materials for job. In order to continue the same principle, the consolidated pick list must be used to provide at once materials per "job" to fitters. In this way, warehouse sorts materials per consolidated pick list and fitters do not have to move to pick up material for every single spool.

This results in a delta of who and where in the process the consolidated pick lists is created.

Deltas according organization
Organizational changes are not required to realize a paperless pipe shop.

Deltas according people
As new software and technology is introduced in shop. The operators need to learn working with these changes.

Delta	Description
1	New: usage of electronic devices in shop
2	New: usage of scanners in shop
3	New: usage of software in shop
4	Action: determine logistic of spools and material
5	Action: determine scan in warehouse (picklist function)
6	Action: determine sketch for fitter

Table 4.13: Deltas

Delta	Alternatives
1(a)	Mobile device
1(b)	Workstation
1(c)	Personal device
1(d)	Shared device
2(a)	Wireless scanner
2(b)	USB connected
2(c)	functional scanner
4	Batch of spools after check with consolidated pick list
5(a)	Printed picklist
5(b)	Picklist scanner
6(a)	Printed skecth
6(b)	Digital sketch

Table 4.14: Deltas alternatives

4.3.3 Technological Impact and Effort of Solutions and Alternatives

Based on the work areas and stakeholders in shop, benefits are explained. According expert of Make, see appendix **??** the effort needed is determined.

Work preparation

Currently, work preparation is done at the main office at Piping. Which is located above the shop, new software is used. But no gap is related to this change.

Cut

For cut operations a new device is needed. During operation the cut operator remains at same spot to control the machine consoles. The operator does not need mobility for its device to perform his job, therefore it is suggested that the best alternative for this operator is a personal

fixed workstation next to these consoles. In this way, he can perform his actions in 3R simultaneously with machine consoles. All other alternatives are not related to this operator.

Bend/Fit/Weld

The bender, same as cutter, remains at the same spot to control the machine console during operation. Before operation he moves to cut station to pick up pipe. This operator also requires a personal device. Choosing a workstation next to the console with USB connected scanner, requires movement of the spool at all times next to the workstation, to scan barcode. The use of a laptop with usb connected scanner is another option. While locating the laptop on trolley the operator can mobile the scanner next to the pipe. However, durability of a laptop in shop is expected to be less than a stable work station due to the work environment. Also charging of the laptop becomes operators responsibility. Wireless scanners are also optional. Wireless scanners connected with Bluetooth are possible in this solution. Although this will not require more effort in modification, investigation into which wireless scanners is needed.

Usage of tablets can combine mobility and scan by using camera as scan function. However, usage of IFS on tablet is not validated by One so this requires also high effort. However One is currently developing a function in portal, ref APPENDIX. Which requires shop floor logging with communication to IFS. This development enables using mobile devices as tablets or smart phones to start and stop operations. Shop floor logging at this point is not included into IFS logistic scanners. To build functionalities demands very high effort.

For fitter (which also includes check station) and welder, the same paperless options as descibed for bender are in order. However, the fitter use sketch where mobility of sketch can result in resistance in operation. Using a printed sketch will not influence paperless manufacturing benefits. And effort for this alternative is seen as scare, as printing the sketch from IFS is possible.

Warehouse

A fixed workstation is already located in warehouse. Consolidated pick lists are retrieved from IFS. Logistic scanners are presented in One solution only, at this point the functionality of material picking according pick list is still in progress. So little effort required. Therefore logistic scanner and workstation is the best solution for warehousing.

4.3.4 Benefit-Effort

Alternative	Benefit	Effort
mobile + portal	high	low
laptop + USB scan	low	medium
mobile IFS including scan	high	high
workstation + wireless scan	medium	medium

Table 4.15: Benefit-Effort mobile scan

4.3.5 Resistance Force Field Analysis

Hindering Forces

Distorted Perception
The first source of resistance comes from a wrong initial perception of the change. Which is detected in several ways. To begin, One works according the scrum method. The main activity of scrum is the sprint, a time box iteration which last four weeks. During this sprint a prioritized list of tasks, which need to be completed during sprint, called sprint backlog, is worked on by the scrum team. At the end of a sprint the team demonstrates the functionality added during the sprint in a sprint review. The goal of this meeting is to get feedback from the product owner and any users or other stakeholders who have been invited to the review. A product owner serves as the customer proxy and is responsible for representing the interests of the stakeholders and ensuring that the product backlog, which is a complete list of the functionality that remains to be added to the product, remains prioritized.

During development of the One solution for Piping, several stakeholders of Piping are invited to the reviews. In this way as explained above feedback from Piping is provided. However, there is a time range to the development of the solution. If the backlog is increasingly growing the product owner needs to prioritize this list of tasks. Meaning, if there is not enough time to deal with all the tasks, some tasks are moved to the delta state. However, this list is prioritized by the product owner. The product owners view is compiled with how to manage Piping in the uniform solution of the entire organization. Tasks that he thinks are manageable during delta session are prioritized last and possible shifting to delta state. Nonetheless, stakeholders of Piping are experts on the piping practises and encounters all possible crisis, threats and so forth, based on a comparison of current and what is presented at reviews. Also, during these review as described, single topics of the solution are presented. For stakeholders of Piping this creates an unrealistic scenario, see appendix C.3

Also during review, One is obligated to work in test environment of the systems. Meaning only selected data is presented in system and instead of the real practices of many spools the examples includes a small amount of spools. Also IT problems due to this environment, server and others can occur. This creates mistrust about if the system can handle the real situation.

This dynamic between One and Piping causes, in this stage, resistance from sources of myopia, hubris and denial, implicit assumptions and communication barriers. Due to the impression of Piping that One has not enough knowledge of the working environment of Piping and in their eyes many issues, important to piping, are neglected or skipped to the next phase. Causes Piping to resist. However their perception of the entire change is not complete as well as how this process is going to proceed.

Communication at this point, about the change at shop floor is feeble. Although a pilot of 3R software is presented to foreman and cut operator, the remaining operators are only aware that something is going to change, however clueless of what/how/when. Foreman of shop mentions that he has no trust of system to handle shop. This due to the pilot meeting, which could only handle seven pipes.

Group think among the operators is expected. Several times, operators use exactly the same phrases or words to express certain things. A wrong perception of one operator can affect a large group of operators to agree on this point without even thinking of the alternatives.

In table 4.16 all hindering forces due to distorted perception are presented.

	Hindering Forces	Category	Impact
1	Piping feels there is not enough knowledge of the Piping work environment at One	Myopia	High
2	Foreman has no trust the system can handle shop	Myopia	High
3	Piping feels often nothing is done with feedback that is given	Hubris/denial	Medium/High
4	Most operators in shop do not know what is going to change	Distorted perception, *group think	Medium
5	One acts more on organizational level than piping level. Also they are bound to the chosen software	Implicit assumptions, hubris and denial	Medium
6	*In shop, group think is expected	Group think	Medium/High
7	In shop, communication can occur	Communication barriers	Low/Medium

Table 4.16: Hindering Forces - Distorted Perception

Dulled Motivation
The second type of hindering forces discusses the lack of sufficient motivation. In this case several hindering forces are found. The first contains the replacement of Piping's current software. This software is specifically designed for Piping needs. Comparative to IFS, which is designed to be implemented into the entire organization and not specifically for Piping, a continuously comparison between in Piping's eyes 'ideal' Extended and IFS is expected. This is mentioned by several stakeholders therefore impact of force is high, see appendix C.3.

Another source of dulled motivation is described as direct cost of change. A busy period for Piping is approaching and the fear of disruption of their operations by changing to another system during this period is mentioned several times. The great deal of expensive effort to change is not really detected since no real investigation of costs of One change towards Piping is done. However, if Piping is responsible for expensive effort to change this can create dulled motivation about the change.
Different interest among employees and management or lack of motivation of employees who value change results less than managers value them, is also a source of dulled motivation. Currently, this is detected in several ways. Shop operators will value the change results less than the manager of Piping. The mindset of some key stakeholders in shop, due to their long experience in shop and changes that they are passed through, is that most changes in their work environment did not particularly improved their way of working. Also, these operators are focused on cut/fit/bend/weld a pipe spool. They are not aware or do not even mind about the organization results, they just work on the work they are provided with. And in their eyes they know how to work best in their work environment. The traditional, conservative, "me-too"approach, as Morrow describes it [37]. In his article he mention that a long-time manufacturing executive

client describes this as a command-and-control environment, with clear reporting lines and functional silos. Others have characterized it as a “You don’t understand” and “It won’t work here” attitude. Also different interest about the paperless alternatives are detected. As manager of piping describes devices can influence work behaviour and act as trigger to distract operators in work. This reaction is can also been seen as implicit assumption by piping towards his operators.

Coming back to the several changes the operators has passed through, another source that can be expressed in resistance due to dulled motivation are past failures. Several operators mention the "scanning failure" from some years ago. Scanning was introduced in shop for automatic time registration and it failed to succeed. In appendix D, reactions of operators are described. A quote repeated by several operators is "With the investment made for the scanners, we could go on vacation!". From a different perspective this also meets the force of the great deal of expensive effort which is made to change. Nonetheless, this reaction only formed itself after the scanners failed.

Also, a feeling of distrust from operators to office is detected. Quoted by one of the operators "Big brother is watching you". This mistrust is possible to be expressed in dulled motivation. However, this force is more related to political deadlocks.

In table 4.17 all hindering forces due to dulled motivation are presented.

	Hindering Forces	**Category**	**Impact**
8	Current software, Extended special made for Piping	Direct cost of change	High
9	Fear of disruption operations	Direct cost of change	High
10	Change great deal of expensive effort	Direct cost of change	Low
11	Different interest between One and Piping	Different interest	High
12	Value of change less to operators in shop	Different Interest	High
13	Scanning failed in past	Past Failure	Medium

Table 4.17: Hindering Forces - Dulled Motivation

Failed Creative Response
The third resistance to discuss comes from a failed creative response. Currently, Piping feels the mature One solution of Piping is not mature enough for Piping. Piping feels that certain important aspects are not taken into account which they did notice to One, as described in forces due to distorted perception. One delivers this solution to Piping and expects these uncertainties of Piping are manageable during the delta state. However, in this stage no prediction can be made if this source of failed creative response will act as resistance to the change as in system failures. However, if they do the reactive mindset about the issues Piping describes and complexity and

speed of the change can result in resistance.

	Hindering Forces	Category	Impact
14	Reactive mindset of One about certain aspect of Piping	Reactive mindset	
	...		
15	Due to time and complexity, One not able to coop all Piping needs	Speed/ complexity	...

Table 4.18: Hindering Forces - Failed Creative Response

Political Deadlocks
The fourth source of resistance comes from political deadlocks. As discussed, these forces reveal itself during delta state. However, this situation lies between current and delta state. Therefore, these forces are more conjectured than the others. However, possible hindering forces are detected. As Kotter and Schlesinger state political behavior sometimes emerge before and during organizational change efforts when what is in best interest of total organization is not in the best interest of one individual or group. People focus on their own best interest and not on those of the total organization. Although, there are many improvements for Piping with the new system, the comparison with current system, as described in dulled motivation, can cause Piping to think they will lose something of value from old to new system.

Same as for operators in shop. The use of electronic devices is more likely seen as "suffer", whereby more actions need to be performed for same operation. Incommensurable beliefs is already detected due to some of the disagreements between Piping and One. These however, reflect on small parts of the change and not the entire change.

	Hindering Forces	Category	Impact
18	Piping	Department politics	Low
19	Shop	Department politics	Low
19	Piping - One	Incommensurable beliefs	Medium
20	Shop	vested values	Low

Table 4.19: Hindering Forces - Political Deadlocks

Action Disconnect
Action disconnect resistance forces as is include the deltas as described in section 4.3.2. Other resistance forces that might result in resistance are embedded routines and leadership inaction. Embedded routine due the long experience with working without paperless technology in field can result in resistance. These forces are discussed however, impact will result while change is in order. The capability gaps however are impacted high as at this point gaps are still presented.

	Hindering Forces	**Category**	**Impact**
20	Operators in field for long time	Embedded routines	..
21	Leadership inaction	Leadership inaction	..
22	new software	Capability gaps	high
23	new hardware	capability gap	high

Table 4.20: Hindering Forces - Action Disconnect

Helping Forces

As discussed in section 3.3.2. Helping forces are convergent with the six recurring change management principles. Diagnosis and vision are the first two principles. However, these principles are performed on several levels as this change contains multiple changes across various departments.

The first and highest level is organization level. Diagnosis of the problem is conducted and vision of how to change is determined. The next diagnosis is the translation of vision into actionable strategies. Resulting in vision: the model of the entire organization. These Diagnosis and vision are conducted at organizational level and One level. A new diagnosis of how to fit Piping in the organizational model is the next diagnosis on One level. Which result in the vision for Piping; One Piping solution. Currently this vision is reached.

This however needs again diagnosis of how to fit Piping solution in Piping. Resulting in vision of Piping; fit solution. Then again diagnosis of how to plan implementation, result in vision of implementation. These last two diagnosis and vision are conducted at Piping level.

In figure 4.6 the diagnosis and vision levels are presented. Currently the green blocks are conducted and the red blocks still to come.

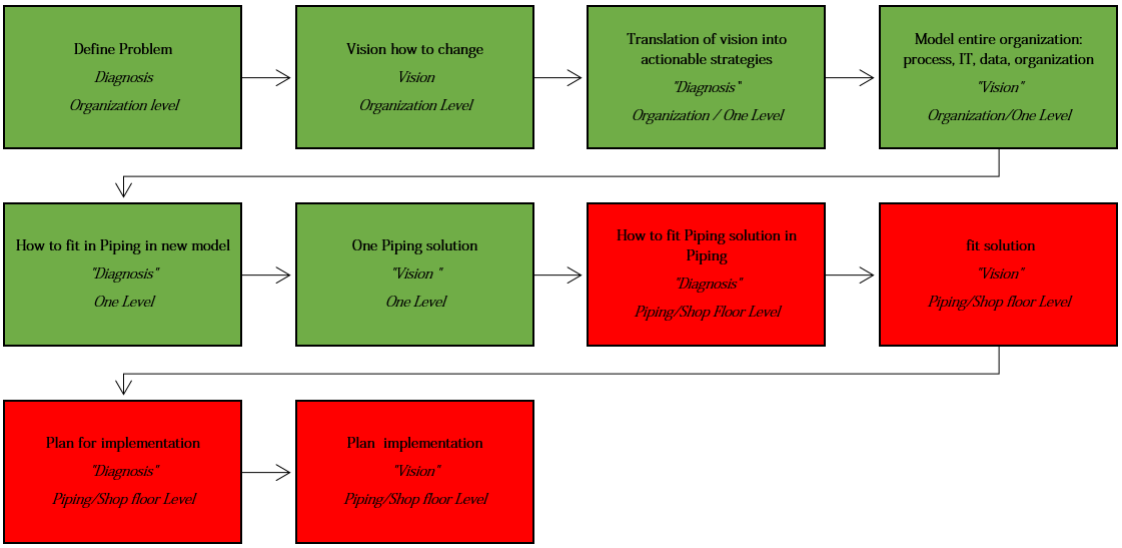

Figure 4.6: Diagnosis Vision on Multiple Levels

Currently, IHC is already in transition to future state. Therefore, helping forces from organizational level have all high impact. IHC accepted that change was necessary and the business model they used was not a proper model to face the future. So at that time board of directors along with the supervisory board decided to change making IHC a more uniformly operating company. Analysis of market and organization answers why change must happen and goals and expected results are stated. See appendix B

For this case at this stage, the forces from One level and Piping have impact on the change, so these forces are described. They include the four blocks in the middle in figure 4.6. Leadership and communication of vision are also included as they are also helping forces.

Diagnosis of how to fit Piping in IHC new model is conducted by One where, One solution of Piping is outcome. Therefore the impact of the forces are at this point high. However, distorted

perception of the change at Piping is presented, as described, as resistance forces. This is explained due to the impact of other two helping forces

At this point no "real" leader is presented. One department can be seen as the leaders in change as they are committed to change and are communicating change to department. Which is for this case scrum team of Make. However, their role is not to lead change, their role is to develop a solution for Piping.

During development of One solution for Piping a designated expert of Piping communicated on behave of Piping with product owner Make. But during the process of development the expert of Piping switched to department One. Nevertheless, expert still remained expert of Piping as his knowledge of Piping did not disappear but, communication between Piping and One became less.

Thus communication of vision is done according expert and reviews, as explained at hindering forces. However, at this stage it only includes some stakeholders of Piping and limited communication due to development phase as described in distorted perception forces.

	Helping Forces	**Category**	**Impact**
1	How to fit Piping in IHC new model	Diagnosis	High
2	One solution of Piping	Vision	High
3	Leadership	Leadership	Low
4	Communication of vision	Communication	Medium

Table 4.21: Helping Forces - Organizational Level

Impact of helping forces at Piping level are at this point low as described as did not occur yet.

	Helping Forces	**Category**	**Impact**
5	How to fit One Solution in Piping	Diagnosis	Low
6	Fit solution for Piping	Vision	Low
7	Management of Piping committed to change	Leadership	Low
8	Roll-out team guidance	Leadership	Low
9	Communication vision	communication	Low

Table 4.22: Helping Forces - Organizational Level

Decrease or Eliminate hindering forces

To encounter the resistance forces the impact of the helping forces are increased and trussed with methods using the resistance model. As described Piping enters the delta stage where education and communication of One solution need to be reinforced. Especially, since One solution is leading, misinterpretations about the solution need to be demoted and acceptance of the solution is gained by stakeholders understanding the solution. A shift from education to participation

is in order for diagnosis gaps between One solution and Piping. A shared diagnosis is the first step of commitment to change from stakeholders. Issues from Piping need to be discussed but this requires full understanding of the solution as otherwise, issues that might be different in solution One then current Piping are expected to cause resistance. Along creating a shared diagnosis, commitment of stakeholders is gained and first step to a coalition team at Piping is formed.

Note, these vision and diagnosis communication and participation is between Roll-out team and key stakeholders of Piping which are needed to design and implement the change, not all employees have to be involved in this process as this can slow down process. A vision of Piping is created due to diagnosis, and if not all employees are involved the vision need to be educated and communicated to all employees.

This approach concerns reducing or elimination of resistance forces 1, 3, 14 and 15. But for this case it also encounters resistance forces 8, 9, 10, 11 and 18. However, if resistance is still in order after communication and participation of/in vision of piping. Then, dulled motivation and political deadlocks are nature of resistance and other methods are used, depending on situation.

This effort to overcome resistance is based on the entire change of Piping. Concentrating on the paperless part, the resistance forces at shop level are discussed.

Paperless deltas as discussed in section 4.3.2 arise in diagnosis. To reduce or eliminate resistance from political deadlocks, participation and involvement in diagnosis by key stakeholders of shop about deltas can be used. The same course of action as described above will reduce or eliminate resistance forces 2, 4, 5, 6, 9, 10, 12, 19 and 20. Again if there is still resistance, the other methods are used for forces regarding dulled motivation and political deadlocks.
Resistance of action disconnect, requires good leadership and facilitation and support. As new software and devices are introduced, operators need training to work with new system. Leadership to provide support to operators is also needed as fear can be in place by replacement of paper with technology. An action plan is provided in figure 4.7

4.3.6 Action Plan

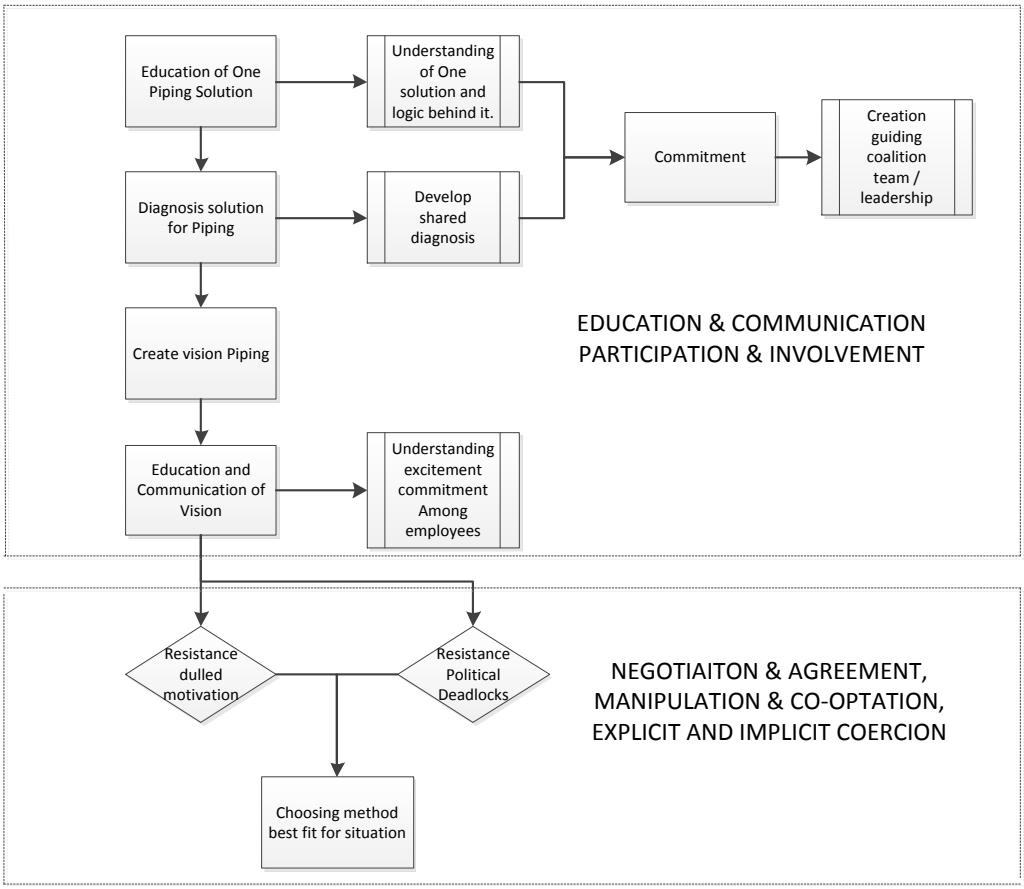

Figure 4.7: Action Plan

5 Conclusion, Discussion and Recommendation

The defined objective of this research is to deliver a model to Royal IHC, whereby the effort to go paperless from technological and people perspective is determined by providing: (1) resistance from technological perspective; (2) solutions to realize paperless; and (3) resistance from employees to the paperless changes. In this final chapter, an answer is provided to the corresponding main research question.

In section 5.1, the main conclusion of this research is presented. Thereafter, conclusion of each of the sub-research questions is provided. In section 5.3 a discussion of the results is presented. Lastly, in section 5.4 recommendations are provided for future work.

5.1 Main Conclusion

The main research question of this research is: With what approach technological resistance and people resistance is evaluated whereby effort to bridge the gap to paperless based on the existing integrated information system is determined? To this end, a case study is conducted whereby elements paper, technology and people are assessed according the three questions: (1)where is resistance expected?;(2) what type of resistance is found?; (3) and how to deal with this resistance? , see figure 3.1.

First the functions of paper are observed. As replacement or elimination of paper might become a hindrance due to the physical nature of paper, the function of paper provides if paper can be replaced and influences the technology choice to go paperless. Second, a delta session is used to find the differences between current and paperless state. Fits and gaps are assessed according elements: (1) paper; (2) process; (3) organization; and (4) people. Paperless solutions are explored where the existing integrated information landscape is used as prerequisite and functions of paper are aggregated. The alternatives are compared according the relatively impact and benefit.

Final, a resistance force field analysis is used to detect the people resistance to the paperless change. Where resistance forces are caused by five sources of resistance including: (1) distorted perception; (2) failed creative response; (3) political deadlocks; (4) dulled motivation; and (5) action disconnect. Driving forces are prompt with six change management principles including: (1) diagnosis; (2) vision; (3) leadership; (4) communication of vision; (5) short-term results; and (6) institutionalize. In combination with methods: (1) education and communication; (2) participant and involvement; (3) facilitation and support; (4) negotiation and agreement; (5) manipulation and co-optation; (6) explicit and implicit coercion.

Results of the case provided Royal IHC with paperless solutions and alternatives based on their existing information system landscape and the effort to it. The resistance force field analysis

provided an action plan to minimize the resistance of people.

5.2 Answering sub questions

This section provides the conclusion of the sub-research questions. From these conclusion the main conclusion is derived.

SQ 1. How is paperless production applied, and what are benefits and drawbacks of paperless?

The biggest benefit of using technology instead of paper comes from the ability to capture, store and display real-time manufacturing data. Where information on paper becomes out of sync with computer system, the use of technology provides the most accurate information at all times. Capture and store manufacturing data, provides the real-time production progress and continuously improvement and decision making can be made according accurate data. Also elimination of non-value added time can be eliminated as search, walk, or print to obtain the right document are eliminated. Touchscreens, mobile applications, computers, wall-mounted display scanners are some of the technologies used to go paperless.

However, replacement or elimination of paper might become a hindrance due to the physical nature of paper. And according the reviewed literature [49, 20, 31, 33, 32, 41] functionalities of paper are: (1) navigation; (2) annotation; (3) interweaving; (4) cross-reference; (5); physical arrangement; (6) mobility; and (7) collaboration and awareness.

SQ 2. What causes people to resist to change?

Among the reviewed literature [45, 5, 54, 25, 57, 34, 36, 38, 10, 59, 43, 29] resistance to change is derived from five main sources of resistance including: (1) failed creative response; (2) distorted perception; (3) political deadlocks; (4) dulled motivation; (5) and action disconnect.

SQ 3. How is change management applied in order to minimize resistance?

Multiple change models discuss successful change is derived according certain principles. Among the reviewed change models [58, 14, 6, 26, 46] seven recurring principles are found they include: (1) diagnosis; (2) vision; (3) leadership; (4) communication of vision; (5) addressing resistance; (6) short-term result; (7) and institutionalize. Additional, Kotter and Schlesinger [27] presenting six methods to overcome resistance to change they include: (1) education and communication; (2) participant and involvement; (3) facilitation and support; (4) negotiation and agreement; (5) manipulation and co-optation; (6) explicit and implicit coercion

SQ 4. In what way resistance from both technological and people perspective can be evaluated to find the effort needed to realize paperless?

Technology

Evaluating technological resistance is determined according the functions of paper and the deltas between current state and paperless state. An paper analysis based on the functionalities found in the reviewed literature is the first step to find technological resistance. Output of this analysis can influences the choice of paperless solutions but also evaluation of resistance from people. Differences between current and paperless is done according a delta session, which the company uses to find the differences, explained in section 3.2. The aspects, system is replaced with paper. As the "system" used in current state is paper and is . solutions to the eliminate the deltas

provides the effort still needed. Findings from the first sub-questions are used as direction during this analysis

People
Interconnection between the findings in the second and third sub-questions is made, presented in figures 3.3, 3.8, 3.4, 3.5, 3.6, and 3.7. The resistance force field analysis, explained in section 3.3.2 is used to evaluate the resistance and determine the effort needed to overcome the resistance, based on the interconnections.

5.3 Discussion and Recommendation

First to discuss is that the development of the approach is based on limited change management literature, the resistance force field analysis model is restricted to those models and literature that are reviewed during this project. Although, the change management review uses extensively used change models, change management used especially for technological change, could provide better management towards paperless change. Nevertheless, as the reviewed models already showed, change is managed mostly according same principles only minor differences, denominations or sequences in use of these principles are presented in different model.

The sources of resistance described by Rumelt are used in this model as these could be analyzed by comparing current situation to the change and observations during communication about change. However, resistance is also dependent on the emotional state of people. As Ellis and Harper [15], are convinced that an individual's emotions and behaviours depend upon the way they structure their thoughts. they identify a number of irrational ideas that individuals hold. As individual behaviour is another field of study this is not included. however, this could be interest to extend the resistance force field analysis with to provide better insight of how people will react.

Application of the model uses participant methods as data collection. Several researchers have noted the limitations involved with using observations as a tool for data collection. For example, Billie and Kathleen DeWalt [11] state that male and female researchers have access to different information, as they have access to different people, settings, and bodies of knowledge. Schensul, Schensul and Lecompote [52] mention that the how researcher is accepted in the community is dependent on several aspects as one's appearance, ethnicity, age, gender, and class. This indicates that different users of model on same case could be provided with different outcome of model.

As in this research several observation methods are used without in-depth knowledge of which is most preferable to be used. This could be improved by using model and validation of the results or more in-depth studies to participant studies. Nevertheless, the model provides insight and guidance to manage the resistance to change. And believed is that people resistance, can only be detected if the resistance is really showed in situation. As the case provided resistances that are presented and resistance that might arise, the interconnection model can be used at any time during change as evaluation of what causes resistance and guidance to deal with the resistance. As some resistance is more prediction than accurate, using methods up-front, could be a waste of time.

Appendices

A IHC Piping

A.1 Information Flow of Pipe Spool

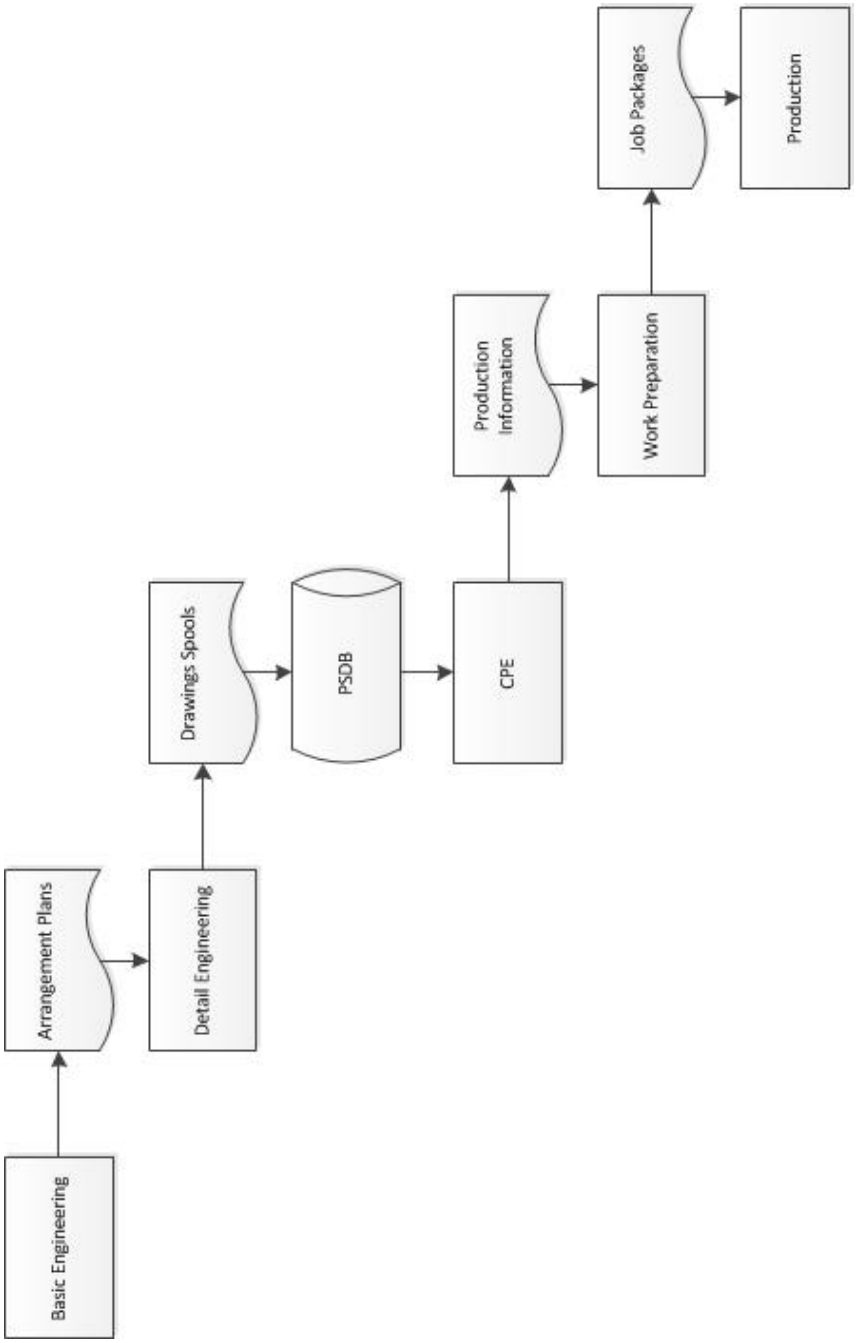

Figure A.1: Information Flow of Pipe Spools

A.2 Production Process

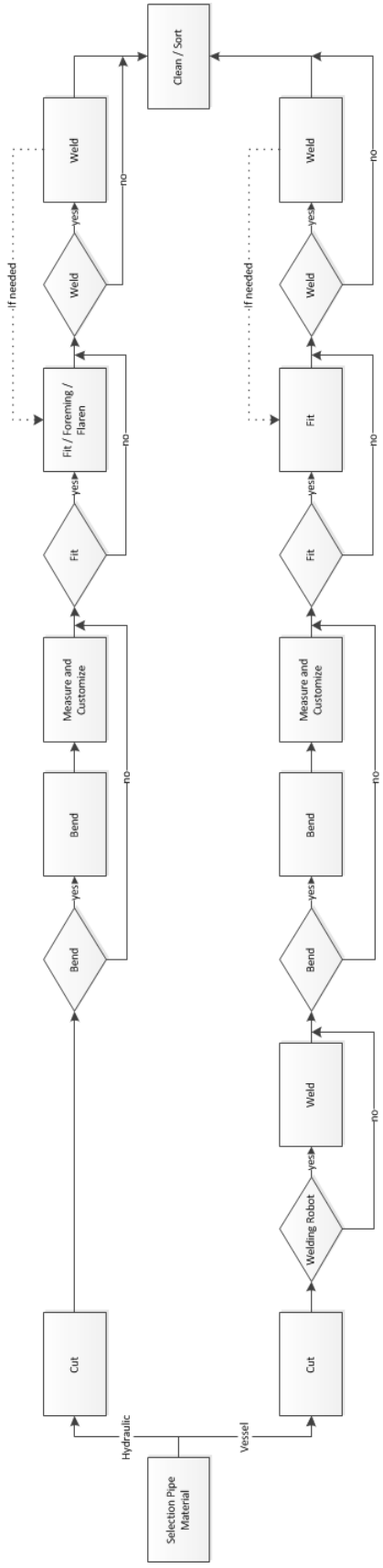

Figure A.2: Production Process

A.3 Job Package

IHC MERWEDE

IHC Holland B.V.

WEEK	YEAR	CLASS	RUNNR	JOB
28	2017	H	16733	7

SAWLIST - 3016353 - Pipe 042x03,0 SMLS. Hydr. E235 NBK Pipelengths: 3 Sketches: 4

Checked	Line	Spool-ID	Project	Sketch		Seq	SawLength (mm)	Next Process
Pipe: 001	Length: 6000 mm		Used: 5179 mm		Rest: 821 mm			
☐	0001	P211058	002881	30045-002		00	2960 mm	Bending
☐	0002	P211057	002881	30045-001		00	2219 mm	Bending
Pipe: 002	Length: 6000 mm		Used: 3762 mm		Rest: 2238 mm			
☐	0003	P211038	002881	30005-002		00	3762 mm	Bending
Pipe: 003	Length: 6000 mm		Used: 3803 mm		Rest: 2197 mm			
☐	0004	P211037	002881	30005-001		00	3803 mm	Bending

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Figure A.3: Sawlist

IHC MERWEDE

IHC Holland B.V.

WEEK	YEAR
28	2017

CLASS	RUNNR	JOB
H	16733	7

WELDINGLIST - 3016353 - Pipe 042x03,0 SMLS. Hydr. E235 NBK Flanges: 0 Sketches: 4

Checked	Line	Spool-ID	Project	Sketch	Seq	SawLength	X3	Z3	Left Flange	Right Flange	Next Process
☐	0001	P211058	2881	30045-002	0	2960 mm	2960 mm	00 °	0	0	Bending
☐	0002	P211057	2881	30045-001	0	2219 mm	2219 mm	00 °	0	0	Bending
☐	0003	P211038	2881	30005-002	0	3762 mm	3762 mm	00 °	0	0	Bending
☐	0004	P211037	2881	30005-001	0	3803 mm	3803 mm	00 °	0	0	Bending

07-07-17 16:43 uur 2/6

Figure A.4: Weldinglist

IHC MERWEDE

IHC Holland B.V.

WEEK	YEAR
28	2017

CLASS	RUNNR	JOB
H	16733	7

BENDINGLIST - 3016353 - Pipe 042x03,0 SMLS. Hydr. E235 NBK | **Sketches: 4**

Checked	Spool-ID	Project	Sketch	Seq	Simulation Result	File Name	Next Process
☐	P211058	002881	30045-002	00	bendable	7_30045-002_0.TOB	Assemble
			(1) F: +580 / R: 0° / B: 93°		(2) F: -240 / R: 90° / B: 93°	(3) F: -245 / R: 90° / B:93°	(4) F: +1487 / R: 0° / B:0°
☐	P211057	002881	30045-001	00	bendable	7_30045-001_0.TOB	Assemble
			(1) F: +142 / R: 0° / B: 29.8°		(2) F: +328 / R: 180° / B: 29.8°	(3) F: +1661 / R: 0° / B:0°	
☐	P211038	002881	30005-002	00	bendable	7_30005-002_0.TOB	Assemble
			(1) F: +952 / R: 0° / B: 93°		(2) F: +715 / R: 180° / B: 93°	(3) F: +1823 / R: 0° / B:0°	
☐	P211037	002881	30005-001	00	bendable	7_30005-001_0.TOB	Assemble
			(1) F: +263 / R: 0° / B: 47.2°		(2) F: +348 / R: 180° / B: 47.2°	(3) F: +3053 / R: 0° / B:0°	

07-07-17 16:43 uur 3/6

Figure A.5: Bendinglist

IHC MERWEDE **IHC Holland B.V.**

WEEK	YEAR
28	2017

CLASS	RUNNR	JOB
H	16733	7

MATERIAL NOTE

Project	Article Nr.	Description		Quantity	Written Off	Weld. Robot	To Pick	Location	Balance
2881	3036090	Half Coupling Thickw 1/2 inch BSP L=30 CS		3	0	0	3	F08C06	34 / 300
2881	3036115	Half Coupling Thickw 3/4 inch BSP L=30 CS		1	0	0	1	F06B01	52 / 45
2881	3036140	Half Coupling Thickw 1 inch BSP L=30 CS		2	0	0	2	F06B05	29 / 50
2881	3091650	FL lock plate SAE 3000 S=2 20AP1		8	0	0	8	K02A03	98 / 0
2881	3502500	Flare flange F37-320-CSX		5	0	0	5	K01C04	46 / 0
2881	3502501	Flare flange F37-320T-CSX		3	0	0	3	K01D04	22 / 0
2881	3505000	Insert flat IN20-42x3.0TFCS		3	0	0	3	K01B11	46 / 0
2881	3506000	Insert Seal IN20-42x3.0TFVCS		5	0	0	5	K01A11	92 / 0
			TOTALS	**30**	**0**	**0**	**30**		

Figure A.6: Material Note

IHC MERWEDE **IHC Holland B.V.**

WEEK	YEAR
28	2017

CLASS	RUNNR	JOB
H	16733	7

ASSEMBLY LIST - 3016353 - Pipe 042x03,0 SMLS. Hydr. E235 NBK

Spool-ID	Project	Sketch	Revision
P211058	2881	30045-002	0
0 JOB 1682 - 7 1			
	1 x	3036090	Half Coupling Thickw 1/2 inch BSP L=30 CS
	1 x	3036115	Half Coupling Thickw 3/4 inch BSP L=30 CS
	2 x	3036140	Half Coupling Thickw 1 inch BSP L=30 CS
	2 x	3091650	FL lock plate SAE 3000 S=2 20AP1
	2 x	3502500	Flare flange F37-320-CSX
	2 x	3506000	Insert Seal IN20-42x3.0TFVCS
P211057	2881	30045-001	0
0 JOB 1682 - 7 1			
	2 x	3091650	FL lock plate SAE 3000 S=2 20AP1
	1 x	3502500	Flare flange F37-320-CSX
	1 x	3502501	Flare flange F37-320T-CSX
	1 x	3505000	Insert flat IN20-42x3.0TFCS
	1 x	3506000	Insert Seal IN20-42x3.0TFVCS
P211038	2881	30005-002	0
0 JOB 1682 - 7 1			
	2 x	3036090	Half Coupling Thickw 1/2 inch BSP L=30 CS
	2 x	3091650	FL lock plate SAE 3000 S=2 20AP1
	1 x	3502500	Flare flange F37-320-CSX
	1 x	3502501	Flare flange F37-320T-CSX
	1 x	3505000	Insert flat IN20-42x3.0TFCS
	1 x	3506000	Insert Seal IN20-42x3.0TFVCS
P211037	2881	30005-001	0
0 JOB 1682 - 7 1			
	2 x	3091650	FL lock plate SAE 3000 S=2 20AP1
	1 x	3502500	Flare flange F37-320-CSX
	1 x	3502501	Flare flange F37-320T-CSX

Figure A.7: Assembly List - 1/2

IHC MERWEDE

IHC Holland B.V.

WEEK	YEAR
28	2017

CLASS	RUNNR	JOB
H	16733	7

ASSEMBLY LIST - 3016353 - Pipe 042x03,0 SMLS. Hydr. E235 NBK

Spool-ID	Project		Sketch	Revision
		1 x	3505000	Insert flat IN20-42x3.0TFCS
		1 x	3506000	Insert Seal IN20-42x3.0TFVCS

07-07-17 16:43 uur 6/6

Figure A.8: Assemly list - 2/2

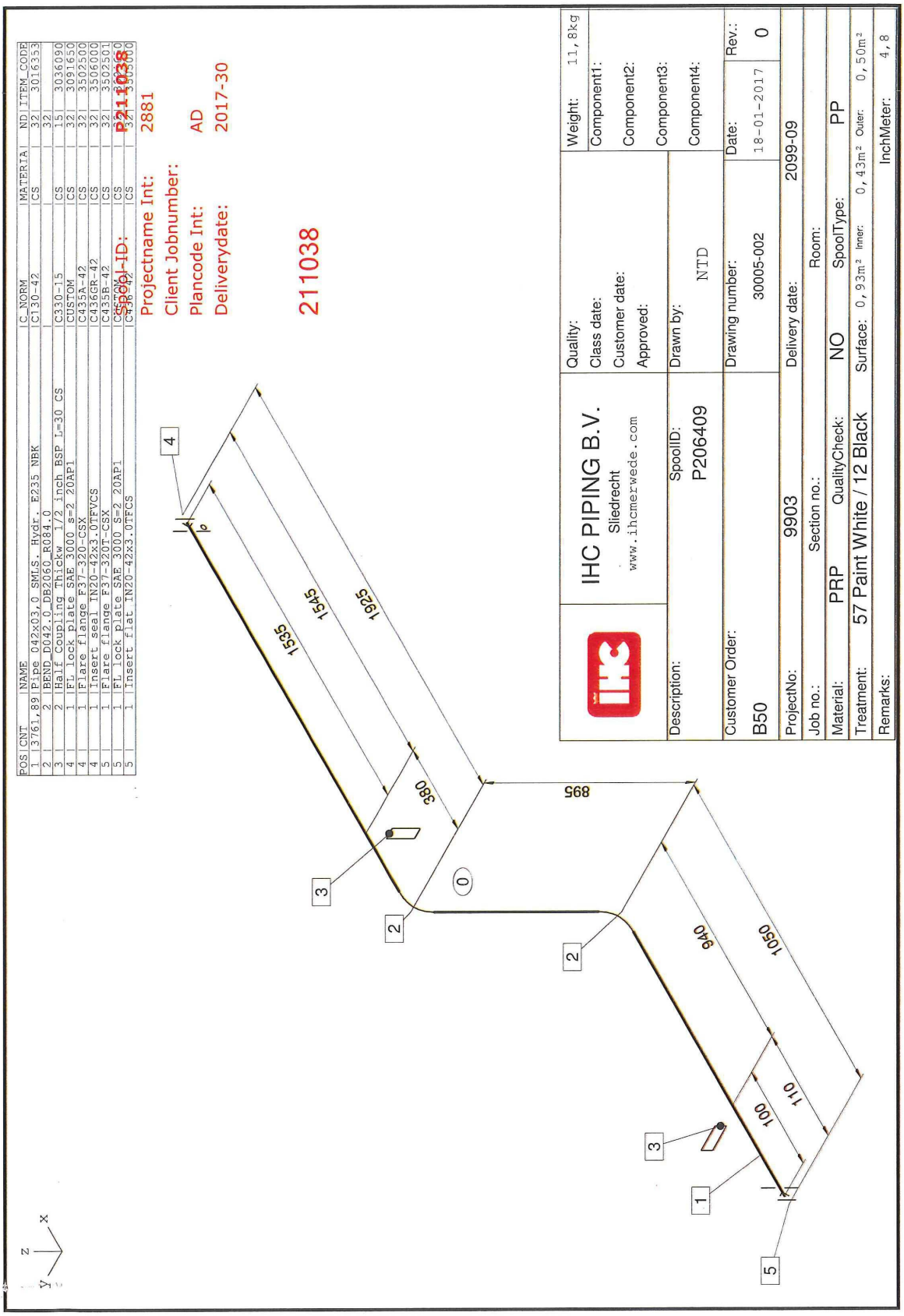

Figure A.9: Original Sketch

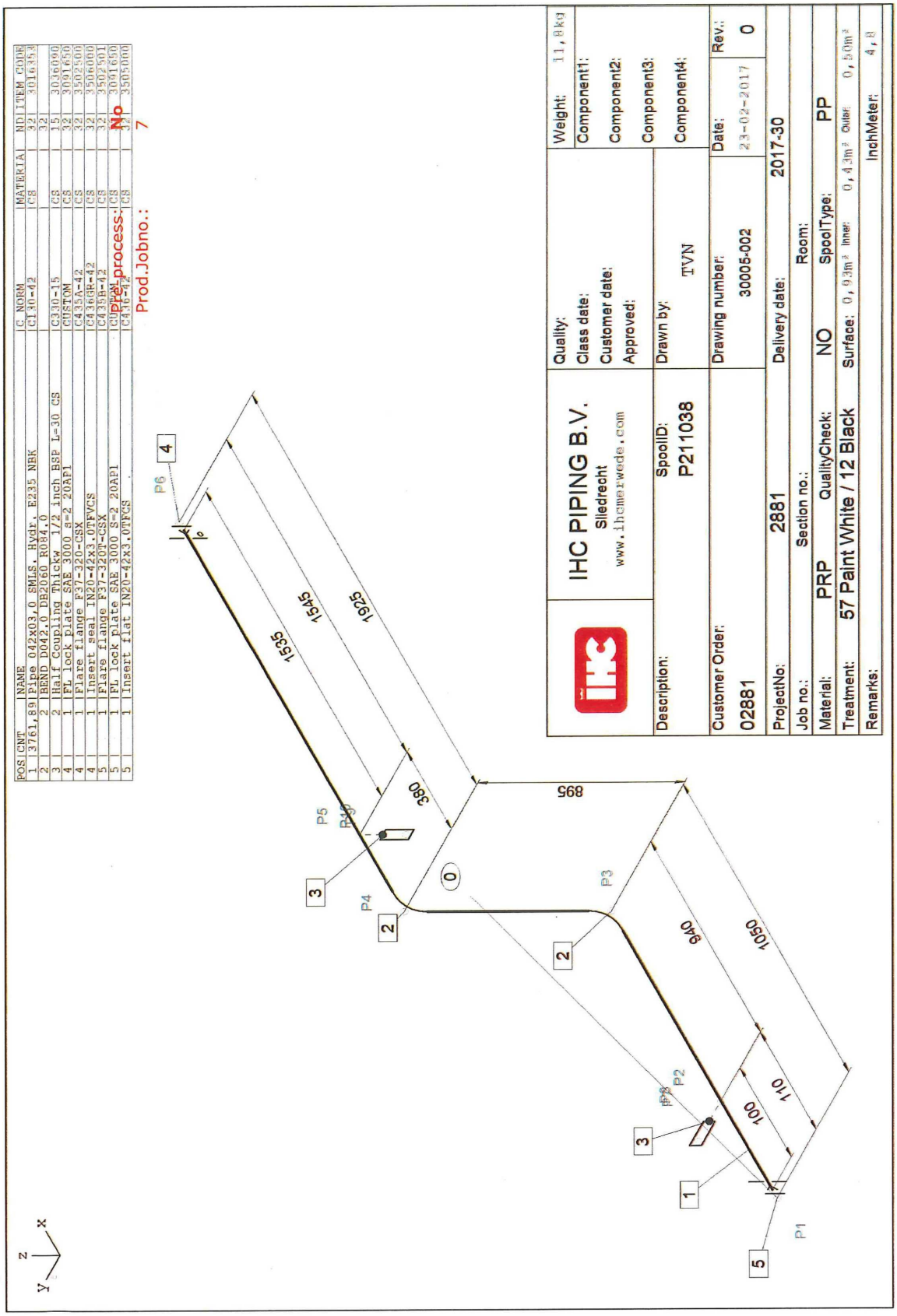

Figure A.10: Sketch Vietnam

IsoBuilder Worksheet

Isoname: 30005-002_0_P211038 **CustomerOrder:** 2881 **3R SpoolNo:** 0
SpoolID: P211038 **JobNo:** **Total weight:** 11,85kg
IntProjectNo: 2881 **Description:**

Material	C_NORM	ND	Dimension	Points	Info1	Info2	Item_Code
Pipe 042x03,0 SMLS. Hydr. E235 NBK	C130-42	32	3761,9x 42,0x 3,0	P1 - P6	S		3016353
Flare flange F37-320-CSX	C435A-42	32		P6		4/10	3502500
Insert seal IN20-42x3.0TFVCS	C436GR-42	32		P6		4/10	3506000
FL lock plate SAE 3000 s=2 20AP1	CUSTOM	32		P6		4/10	3091650
Flare flange F37-320T-CSX	C435B-42	32		P1		4/10	3502501
Insert flat IN20-42x3.0TFCS	C436-42	32		P1		4/10	3505000
FL lock plate SAE 3000 S=2 20AP1	CUSTOM	32		P1		4/10	3091650
Half Coupling Thickw 1/2 inch BSP L=30 CS	C330-15	15	L:30,0	P7			3036090
Half Coupling Thickw 1/2 inch BSP L=30 CS	C330-15	15	L:30,0	P9			3036090
BEND_D042.0_DB2060_R084.0		32	90,0°	P3			
BEND_D042.0_DB2060_R084.0		32	90,0°	P4			

Spool-ID: **P211038**
Prod.Jobno.: 7

23-2-2017 1.8.3.0 1/2

Figure A.11: Isobuilder Worksheet

Isoname: 30005-002_0_P211038 **CustomerOrder:** 2881 **3R SpoolNo:** 0
SpoolID: P211038 **JobNo:** **Total weight:** 11,85kg
IntProjectNo: 2881 **Description:**

CNC-Data

Machine: DB2060_R_70856
Outer Diameter: 42,00mm **Radius:** 84,00mm
Points: P1 - P6 **Cutting:** 3761,9mm
Remark:

Flange1: (X) [P1] **Flange2:** (X) [P6]
Flange Rotation:

Feed	Rot	Bend	OBend	Elong.
951,87	0,00	90,00	3,00	P1-P3: 0,0
714,60	180,00	90,00	3,00	P3-P4: 0,0
1822,73	0,00	0,00	0,00	P4-P6: 0,0

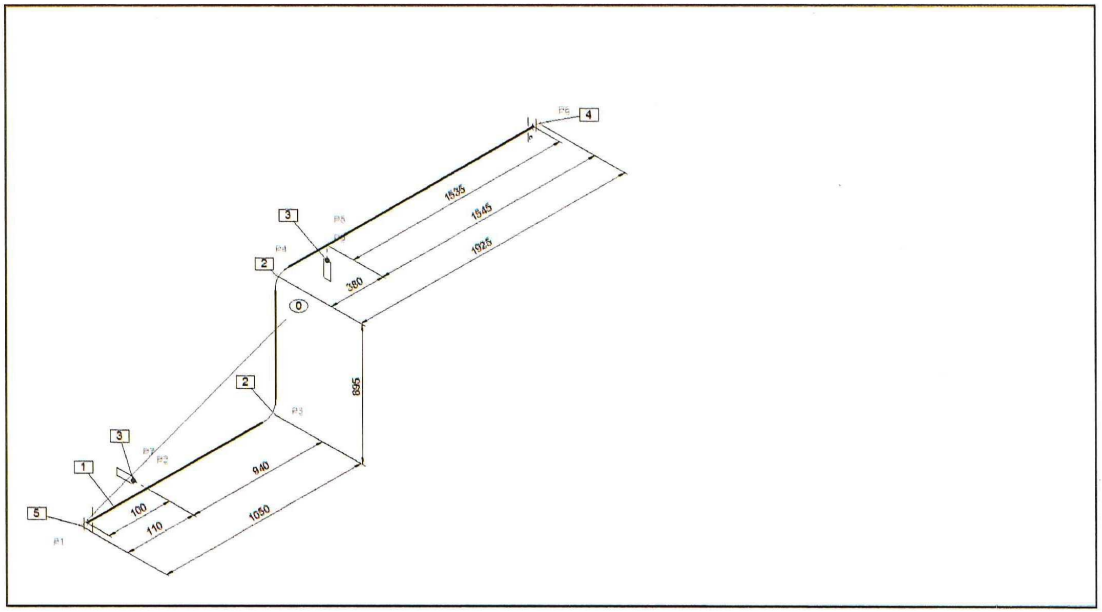

Figure A.12: CNC-Data

B General Introduction One IHC

IHC is a very old company. It is reputed to go back more than 400 years. But for sure the last decades it has been run in a fairly decentralized way. All its business units have their own profit and loss responsibility.

They worked in a fairly independent way. Interaction with one another as normal suppliers and normal customers do. They did not work as an integrated way, despite the fact that the products of IHC are often very integrated.

Example: If we build a ship, we need the participation of perhaps 15 business units of IHC. All working towards this one integrated product. But the companies involved in that effort work pretty much independent. Over history these companies have developed their own processes, their own ICT systems, they have their own data conventions and coding systems and product structuring conventions etc. So whenever one company of IHC needed the services of another company of IHC they did interact as normally between supplies and customer.

One IHC is there to end this approach. Because around 2010, the board of directors decided that this is not the proper model to face the future and the competition. So that moment in time the board of directord along with the supervisory board decided that they have to change the company, making it more a uniformly operating company where all the units that work together to supply that integrated product would work in a more seamless manner.

Ubald Nienhuis - Manager, One IHC

B.1 Why One?

Markets

The offshore and dredging market is a rapidly changing and very demanding environment. The conditions are constantly changing. The market's dynamic character is mainly directed by the oil price, which is currently the major determinant for the market's demand. The lowering of oil prices results in a decreasing of this demand and, at the same time, a higher need for more sharply priced products. Another factor that causes the present market dynamics is the severe competition in the offshore and dredging industry. At the moment a lot of potential customers, including the larger dredging corporations, are occasionally taking the services of our competitors rather than IHC services. IHC is not always providing the right price and delivery time at the right quality. With these circumstances given, it is of an urgent importance for IHC to adapt and become a leaner and meaner fighter in the world market.

Integration

IHC was not an integrated company for historical reasons. This has led to a set of non-integrated processes and systems that do not cooperate in an appropriate way. For One IHC it is an important starting point that this is not an acceptable way of working. And indeed One IHC is aimed to alleviate this problem. At the same time, we faced reorganizations over the last few years. We have modified out strategy somewhat. And we have revitalized the organizational structure to go along with that. We are putting more emphasis on sales and we are putting more emphasis on services. The operational expenditure of our customers is becoming more and more important to us, rather than their capital expenditure. And we are putting more emphasis on mission equipment at the expense of the platform itself, the ship.

IHC 2020

Al of that must reflect in the organization. We have has organizational changes. We to go through some personnel reduction programs and all that has impacted the organization. All the parts and units of the organization are part of One IHC. So that is the context which One IHC must operate and become successful. Last but not least we have had the IHC 202 venture. Within this venture leadership, culture, efficiency, internationalization and a number of other areas have received attention in order to make IHC a better performing company.

B.2 Goals and Expected Results

Synergy

One IHC must lead to a vastly improved synergy which reduces the amount of routine work and increases the amount of time available for value added time available for value added activities and increased creativity. This will counteract the historical situation where IHC units were fairly independent. IHC needs much more synergy.

Flexibility

The marker requires more flexibility and shorter product lead times. Improving this flexibility is another goal of the of the One IHC program. However, only implementing the program will not be enough. Flexibility also requires our personnel to be more flexible, to improve their skills and to more mobile and ready to work for other units.

Cost

Reducing costs is the most important factor in order to improve IHC's market position/ It goes without saying that cutting that costs will reduce the selling prices for services and products of IHC. In order to achieve this, we need to be more efficient and source some of our activities in more internationally competitive regions. In the future One IHC will help in enlarging the efficiency of the company and reducing the costs without affecting the quality of our products and services.

Time

Flexibility can only by achieved when product lead time is reduced. Or in other words, reduce the delivery time from the moment we receive an order. One IHC will provide faster delivery from our supplies, no waiting times in our manufacturing and assembly operations and instantaneous availability of information

Future

The mentioned goals on this slide will, with the help of the One IHC program, make sure that in the future operations can continue and that a sizeable amount of employment is preserved within company.

B.3 Three Pillars of One

Product

Within IHC we have to manage very complex things. We carry out orders but basically what we are, we are products company. We develop and provide fine products to our customers. So really the main dimension if IHC can be the product dimension. And that means that we have to do some serious product management along the way where we decide what producst we want to carry and how we position these products in the market. Supplying these products to our client very often by running projects. Our orders are very high complexity. Project management is the way to manage those important and large size orders. We do that according to IHC's project management method which was developed as part of One IHC. And so we have important management dimensions together with the product management and that is project management

Project

This is a totally different view on the order because a project has very definite result of the order, it has to satisfy the customer within a given budget and on time. So it's a totally different management dimension which we have to support within IHC. Building products, using project management to manage thes orders that still leaves open the issue of how do we manage our operations. Because we run a large number of projects at the same time. And that is why we also have to do separate management of our proceses that transcend in individual project projects. That is why we also have the management dimension process management.

Process

Process management can also be seen very much as in line management. So that is where production and engineering and sales and supply chain all work to optimize our process. And if the 3 management dimensions intersect continuously, they have different interest and different views on the organization. Therefore, they have to be arbitrated between continuously.

B.4 Pillar: Processes

One IHC viewed through four dimensions: Processes, data, IT , organization. One IHC itself does not focus on the organization dimension. Of course, the organization has a heavy impact on everything we're building within One IHC and what One IHC outputs must be accommodated or absorbed by the organization. Therefore, the interaction these things have should not be underestimated.

For processes they have developed a uniform process that describes everything that IHC does in the day to day operations. From the strategic level in the boardroom right until the detailed level in the warehouse and in facility maintenance, and everything in between. And of course, in between are very important core processes of IHC. For data they developed the Parts library. They have also made the setup for maintaining this by corporate data management.

B.4.1 Processes

For processes we have developed a uniform process that describes everything that IHC does in the day to day operations. From the strategic level in the boardroom right until the detailed level in the warehouse and in facility maintenance, and everything in between. And of course, in between are very important core processes of IHC. Which are Sell, Procure Logistics , Define Product (which includes Design Engineering and Cost Estimation), Make (which includes Manufacturing, Assembling and Commissioning) and Service Operations. Alongside, also very important there is project management as a separate process group, operations management and product management (of course, the 3 dimension occur here also). And there are other processes which support the core processes, such as Finance, Human Resources and Facility Services. All of the processes are uniformed for the whole IHC business. So wherever you work, we have uniform IHC procurement process. And wherever you work will recognize a similar manufacturing process etc.

B.4.2 Data

For data we developed the Parts library. We have also made the setup for maintaining this by corporate data management.

B.4.3 IT

The processes have been the starting point for our ICT.

B.5 Introduction to Make

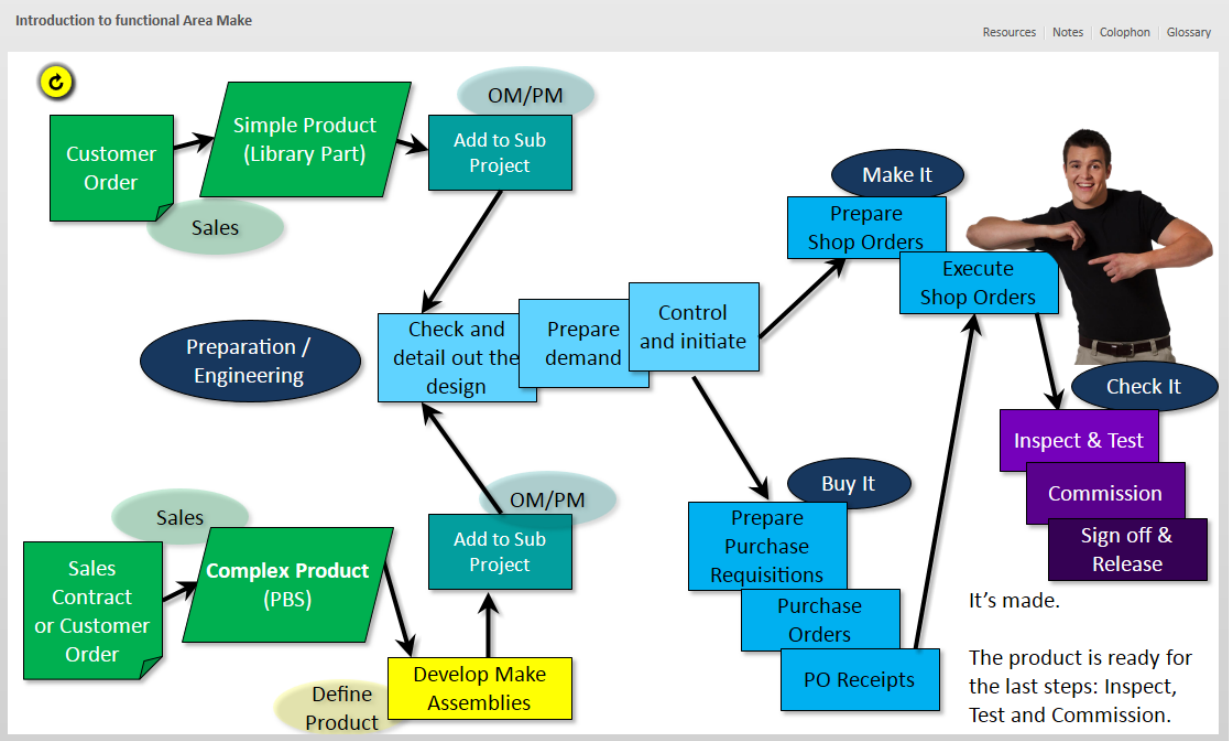

Figure B.1: Introduction to Functional Area Make

B.6 Data Exchange

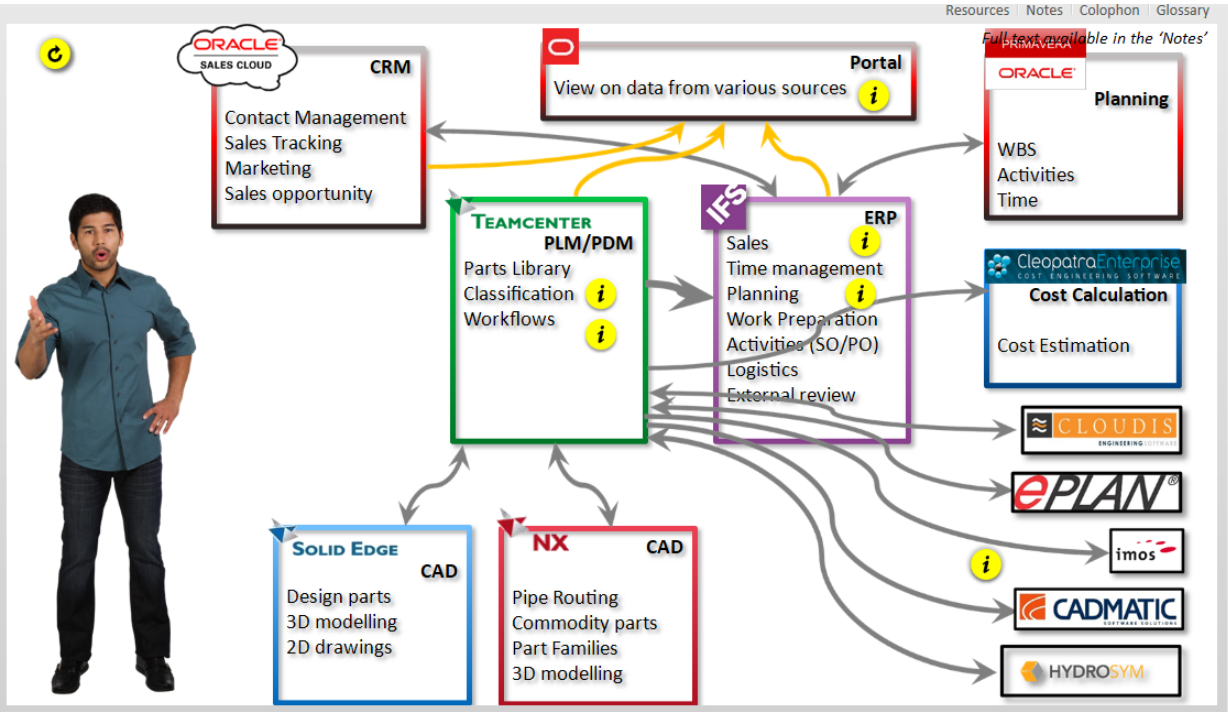

Figure B.2: Data Exchange Landscape

C Observational Study

C.1 Paper Observation

Stakeholder and document	Actions with Document
Work Preparator, *job packages*	• Print documents • Attach documents • Deliver documents to foreman
Foreman, *job packages, time registration list*	• Receive documents from work preparator • Plans shop further according job packages • Deliver documents to operators • Print time lists • Deliver and Receiving time list • Manually data capture time from time list • Receive and store temporary note from fitter*
Saw Operator, *sawlist, weldinglist*	• Receive documents from foreman • Select job according document in machine software • Checks rest lengths on document for nesting pipes • Marks finished spools • Piles documents when finished job

Table C.1: Observations Findings Paper - 1/2

Stakeholder and document	Actions with Document
Bend operator, *bendinglist, CNC data, sketch*	• Picks document previous workstation • Select job according document in machine software • Checks machine settings according to sketch and data
Bend operator, *bendinglist, CNC data, sketch*	• Picks document previous workstation • Select job according document in machine software • Checks machine settings according to sketch and data
Check operator, *sketches*	• Picks or receives document from bender • Checks and measures spools according sketch • Delivers sketches to warehouse (foreman or checker)
Warehouse operator, *material note, sketches*	• receives documents from foreman and/or checker • Pick material according material note • Signs off material according material note • Attach material note, sketch and note fitter to material
Fit operator, *sketches*	• Picks or receive documents from foreman • Fit spools according sketch • Occasionally annotation at sketch

Table C.2: Observations Findings Paper - 2/2

C.2 Experts

Jan Miedema, product owner of Make
Hans de Lang, manager of Piping

C.3 Notes

In shop, zie je een vaste groep werkers die allemaal al jaren voor IHC werken. De meeste zijn ook al wat ouder en hebben al veel verandering meegemaakt. Ze laten merken dat elke verandering

voornamelijk in hun nadeel werkt en dat het vroeger zo veel makkelijker ging.

Vb. Vroeger toen ze nog bij Van der Giessen de Noord (scheepswerf overgenomen in 1997 door IHC) werkten toen kregen ze 1 schets waar alle informatie opstond. Daarna zijn het alleen maar meer en onduidelijkere schetsen geworden.
Sommige gaan ook al bijna met pensioen. Alhoewel onderzoek aangeeft dat oude mensen vaker geen zin meer hebben in verandering loopt er ook een voorman die erg voor verandering is en inziet dat er digitaal werken voordelen met zich mee brengt.

Wanneer er gesprekken worden gevoerd over papierloos werken gaan ze hiermee in maar geven altijd aan dat er wel een schets beschikbaar moet zijn. Dit voor de fitters die aan de hand van de schets de spool in elkaar zetten en dit gaat echt niet werken zonder die papieren schets.

Wanneer je het hebt over electronica, tablets oid, schrikken ze wel af. Tablets gaat niet werken in shop. Dit gaat gegarandeerd kapot.

Verschillende opmerkingen over tablets:
• schets is niet goed te zien op tablet
• Touchscreen gaat niet werken met handschoenen/
• Gaat zo kapot door zware omgeving (zwaar materiaal, lasspetters etc.)
• Fitter moet elk moment die schets erbij kunnen pakken. Tablet gaat het niet anders gaat deze kapot.
• Wat als die uitvalt of kapot gaat op moment dat ik er ergens mee bezig ben
• Ik heb net geleerd hoe ik met een touchscreen telefoon kan werken.

Een ander voorbeeld waar velen in shop naar terug refereren zijn scanners die een aantal jaar geleden zijn geimplemteerd en na korte tijd er weer uit zijn gehaald. Ze werkte voor geen meter. Batterij was altijd op, te veel handelingen waardoor belemmerd in hun werk, barcode was vaak kapot (sticker op pijp). En daarnaast is het gefaald en heeft het heel veel geld gekost. Hiervoor hadden we een paar keer mooi op vakantie kunnen gaan (gequote door meerder mensen in shop). Met de scanner kon je je pijp scannen, elke scanner was gekoppeld aan operator in shop en zo werd er bij gehouden hoelang er aan een pijp gewerkt was.

Ook geven ze aan (na langer met ze te spreken, en altijd voorzichtig en met niet te veel woorden) dat ze zich erg gecontroleerd voelde. Big brother is watching you. Alsof ze boven geen vertrouwen hadden in de mensen op de werkvloer. één geeft ook aan dat ook al was het niet de bedoeling om mensen te controleren er wel mensen waren aangesproken op hun tijden.

- Komt er iemand van hogerop (uit kantoor) die even zegt hoe wij beter kunnen werken. En uiteindelijk helemaal niks heeft toegevoegd en alleen maar kosten heeft gemaakt. (scanners werd geïmplementeerd door iemand die zij niet kenden en in hun ogen even de boel daar kwam regelen.)

Aart, voorman van de grote shop is nooit lang op 1 plek. Hij rent van hot naar her om materiaal te regelen, spoedjes er doorheen te krijgen, spools aan mensen toe verwijzen, groot buis materiaal te regelen, job pakketjes op te halen, materiaallijsten naar magazijn etc.
Je merkt dat het echt zijn shop is. En het gaat op zijn manier en dat weet ook iedereen.

Wanneer ik met hem in gesprek ga over de wat er gaat veranderen in shop ziet hij in dat dit gebeurt om uiteindelijk IHC als bedrijf te verbeteren en efficiënter te werk te gaan. Alleen hij heeft nog geen vertrouwen in hoe dit effectief gaat veranderen op de werkvloer.

- Wanneer ze (One) laat zien hoe het er straks uit gaat zien dan komen ze met een voorbeeld van 20 spools, dit is natuurlijk geen realiteit, hoe gaat dat straks goed komen?
- Het werkt nog niet helemaal
- Er komt een groot project aan waarmee we het druk krijgen. Dan kunnen we geen systeem gebruiken wat niet werkt.

Hij geeft zelf ook aan dat hij helemaal geen zin heeft om te veranderen. Hij is al oud en heeft zoveel veranderingen meegemaakt.

Wel ziet hij in dat hij op dit moment met veel taken bezig is die eigenlijk niet bij zijn functie horen. En is hij veel tijd kwijt aan tijdschrijven. Wat dan ook weer verholpen wordt met de nieuwe One solution.

De andere groep werkers, inleners. Zijn niet vast in dienst bij IHC. Alhoewel sommige al een tijdje bij Piping werken nu. Dit zijn voornamelijk buitenlandse mensen. Je ziet dat deze mensen meer op zich zelf zijn. Ze hebben ook minder een mening over papierloos werken. En sommige zien juist alle voordelen ervan en het grotere plaatje. Deze mensen zijn gewend om op verschillende locaties te werken en zullen ook geen/minder weerstand bieden. Zij komen om zoveel mogelijk uren te maken en zijn flexibel omdat ze verschillende manier van werken kennen en gewend zijn.

Hydraulic shop
Bij hydraulic staat bijna altijd hetzelfde team in shop. Deze shop is vele malen schoner en kleiner. Een eigen magazijn tot hun beschikking. Maar materiaalafmelding wordt gedaan door hoofdmagazijn. Deze mannen zijn redelijk op elkaar ingesteld. Zo tapet de nameter de pijpen zodat de volgende weet welke flens erop te bevestigen.

Regelmatige “frustaties”

• Wanneer pijp op hold wordt gezet, wordt dit vaak te laat of niet doorgeven. Zonde van material
• Wanneer nieuwe spools aan Delivery unit worden toegevoegd wordt dit niet doorgegeven waardoor het van logistiek weer terug komt

Ze geven aan dat er veel onnodig papier wordt gebruikt. De schets natuurlijk is wel echt nodig voor lassers en nameter maar de hoeveelheid papier kan onoverzichtelijkheid creëren.

Wanneer ik over nieuwe systemen en elektronica praat. Leggen ze uit dat wanneer er weer met een nieuw systeem gewerkt gaat worden. Dat er de mogelijkheid moet zijn om hier ook mee om te leren gaan. Niet kijkend over iemands schouder maar door zelf te oefenen. Op dit moment staat er een werkstation waar de pijpen af worden gemeld (Extended). Het heeft even geduurd om te leren werken met extended, niet iedereen weet hoe het systeem werkt maar met een nieuw systeem vinden ze dat iedereen het moet leren.

Manager Piping – review feedback
1. Al systems should work without failures. Too often routines do not work.
2. There should be more knowledge of the Piping working environment in the make group.
3. Less changes in the ONE Group. Every time new faces present the review.
4. Too many open issues are skipped to the implementation fase.
5. Processes are presented as single topic and not as integrated process. This creates an unre-

alistic scenario.
6. Often nothing is done with the given feedback during the review.

C.4 Survey

Geen omschrijving over hoe het op de werkvloer gaat veranderen is gegeven. Operators weten dat ik bezig ben naar het kijken van papierloos werken in shop. En verder hebben 2 operators het systeem een keer gezien, alleen Pipecut.
Questions in survey
4. I do not like change
5. I am always willing to learn new things
6. When informed of significant change regarding the current way of working, my initial reaction would be to feel resistance.
7. If I was involved in the significant change, I would be less resistant to the change .
8. If I feel a change/procedure has been implemented incorrectly, I have an opinion about it and will speak up.
9. If asked for feedback regarding the change, I am willing to provide feedback with suggestions for improvement if needed.
10. I have experienced a lot of change at IHC.
11. I am well aware of the changes at IHC.
12. I understand why these changes occur.
13. I have confident that these changes will help in the future.
14. I am very content with the current way of working and do not see how change will help us.
15. I can work with computers/tablets and other similar electronic devices.
16. If I can choose, I rather work from a workstation (fixed computer) than a mobile device (tablet/laptop) in shop.
17. If I do not have a printed sketch of pipe, this will be a hindrance in performing my job.
18. If electronic device are introduced, I need to have my own rather than sharing with others.
19. I am afraid that I am not able to learn working with new computer systems.
20. If training and guidance is provided to teach me how to learn the new way of working, I would be less afraid

C.4.1 Results

Question	Disagree	No opinion	Agree
4	38%	19%	44%
5	13%	13%	75%
6	63%	13%	25%
7	25%	25%	50%
8	6%	6%	88%
9	6%	19%	75%
10	13%	6%	81%
11	13%	13%	75%
12	19%	25%	56%
13	13%	25%	63%
14	19%	19%	63%
15	6%	19%	75%
16	31%	25%	44%
17	19%	31%	50%
18	25%	6%	69%
19	75%	13%	13%
20	13%	19%	69%

Figure C.1: Survey Results

Bibliography

[1] Shipbuilding innovation: New product, new development technology. *Stategic Direction*, 22(8):33–35, 2006.

[2] R. Ackerman and T. Lauterman. Taking reading comprehension exams on screens or on paper? a metacognitive analysis of learning texts under time pressure. *Computers in Human Behavior*, 28(5):1816–1828, September 2012.

[3] K. Aldred. Aerospace manufacturer takes off with paperless manufacturing system. 34(1):55, September 1998.

[4] Apriso. Apriso redefines paperless manufacturing. http://www.apriso.com/about$_a$*priso/news/announcem*

[5] P.S. Barr, J.L. Stimpert, and A.S. Huff. Cognitive change, strategic action, and organizational renewal. *Strategic Management Journal*, 13:15–36, 1992.

[6] R. Beckhard. A model for the executive management of transformational change. In Jack Gordon, editor, *The Pfeiffer Book of Successful Leadership Development Tools*. Wiley.

[7] J.M.G. Coenen J.A.J. Kaarsemaker B.J. Thakker, A. Asmara. Portals in shipbuilding. *14th International Conference on Computer and IT Applications in the Maritime Industries, Ulrichshusen*.

[8] J.M.G. Coenen J.A.J. Kaarsemaker B.J. Thakker, A. Asmara. Process and knowledge integration via portals in shipbuilding. *International Conference on Computer Applications in Shipbuilding*, 2015.

[9] Jim Brown. *The Complementary Roles of ERP and PLM*. Tech-Clarity.

[10] M. Pardo del Val and C. Martinez Fuentes. Resistance to change: A literature review and empirical study. *Management Decicion*, 41(2), 2003.

[11] K. M. DeWalt and B.R. DeWalt. *Participant observation: a guide for fieldworkers*. Walnut Creek, CA: AltaMira Press.

[12] M. Djassemi and J.A. Sena. The paperless factory: A review of issues and technologies. *International Journal of Computer Science and Network Security*, 6(12), December 2006.

[13] Tadeusz Dyduch. When digital isn't paperless. http://www.apriso.com/blog/2013/09/when-digital-isnt-paperless/, 2013.

[14] R. Eisenstat, B. Spector, and M. Beer. Why change programs don't produce change. *Harvard Business Review*, 68(6):158–166, 1990.

[15] A. Ellis and R.A. Harper. *A nNew Guide to Rational Living*. Wilshire Book Company.

[16] V.C. Chaitanya Ganta, V. Chittabbai, and Dr. N. Kishore Babu. Managing organizational change. *International Journal of Combined Research Development*, 2(2):2321–2241, February 2014.

[17] J. Goldstein. A far-from-equilibrium systems approach to resistance tochange. *Organizational Dynamics*, Autumn:5–17, 1988.

[18] L.D. Goodstein and W.W. Burke. Creating successful organization change. *Organizational Dynamics*, 19(4):5–17, April 1991.

[19] Allen Graves. Effort/impact matrix. http://www.sixsigmadaily.com/effort-impact-matrix/.

[20] Jonathan Grey. The benefits of a digital shopfloor. https://www.aero-mag.com/benefits-digital-shopfloor/, 2016.

[21] G. Gulipalli. 10 effective ways to data capture. *Logistic and Payment Solutions Invensis Technologies*, Feburary 2016.

[22] M. Han, W.K. Kim, and M.G. Park. Development of a collaboration system based on mobile framwork in the field of ships and marine industry. *International Journal of Multimedia and Ubiquitous Engineering*, 9(4):121–126, 2014.

[23] B. Blumenthal P. Haspeslagh. Toward a definition of corporate transformation. *Sloan Management Review*, 35(3):101–106, April 1994.

[24] IFS. Enhance usability and agility with ifs lobby™ in ifs applications™ 9. http://www.ifsworld.com/no/service/ifs-upgrade/ifs-lobby/.

[25] I.L. Janis. *Groupthink: Psychological Studies of Policy Decisions and Fiascoes*. New York: Houghton Mifflin.

[26] J.P. Kotter. *Leading Change*. Harvard Business School Press.

[27] J.P. Kotter and L.A. Schlesinger. Choosing strategies for change. *Harvard Business Review*.

[28] F. Kretzschmar, D. Pleimling, J. Hosemann, S. Fussel, I. Bornkessel-Schlesewsky, and M. Schlesewsky. Subjective impressions do not mirror online reading effort: Concurrent eeg-eyetracking evidence from the reading of books and digital media. *PLOS ONE*, 8(2).

[29] P.R. Lawrence. How to deal with resistance to change. *Harvard Business Review*, pages 49–57, May/June 1954.

[30] K. Lewin. *Field theory in social science*. Harper Collins.

[31] P. Luff and C. Health. Mobility in collaboration. *Proceedings of the 1998 ACM conference on Computer supported cooperative work*, CSCW '98.

[32] W.E. MacKay. Is paper safer? the role of paper flight strips in air traffic control. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 6(4):311–340, December 1999. Special issue on interface design for safety-critical interactive systems: when there is no room for user error.

[33] C.C. Marshall. Annotation: from paper books to the digital library. *DL '97: Proceedings of the second ACM international conference on Digital libraries*, DL '97.

[34] G.L. Frankwick M.D. Hutt, B.A. Walker. Hurdle the cross-functional barriers to strategic change. *Sloan Management Review*, 36(3):22–30, 1995.

[35] S.J. Mezias and M.A. Glynn. The three faces of corporate renewal: institution, revolution, and evolution. *Strategic Management Journal*, 14(2):77–101, February 1993.

[36] E.W. Morrison and F.J. Milliken. Organizational silence: A barrier to change and development in plurastic world. *Academy of Management Review*, 25(4):706–725, 2000.

[37] M. Morrow. How to improve your manufacturing culture to land the best talent? *Journal of Ship Production*, 26(2):111–116, 2010.

[38] C. Nemeth. Managing innovation: When less is more. *California Management Review*, 40(1):59–74, September 1997.

[39] Tim Nichols. Changing the shipbuilding technology conversation. https://community.plm.automation.siemens.com/t5/Digital-Transformations/Changing-the-shipbuilding-technology-conversation/ba-p/412702/, May 2017.

[40] Tim Nichols. Shipbuilding 4.0: the digital thread in shipbuilding technology. https://community.plm.automation.siemens.com/t5/Digital-Transformations/Shipbuilding-4-0-the-digital-thread-in-shipbuilding-technology/ba-p/401021, 2017.

[41] S. Nomura, E. Hutchins, and B.E. Holder. The uses of paper in commercial airline flight operations. *CSCW '06: Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*.

[42] S. K. Piderit. Rethinking resistance and recognizing ambivalence: A multidimensional view of attitudes toward an organizational change. *Academy of Management Review*, 25(4):783–794, 2000.

[43] C. Freese R. Schalk, J.W. Campbell. Change and employee behaviour. *Leadership Organizational Development Journal*, 19(3):157–163, 1998.

[44] S. Robbins and T.A. Judge. *Organizational Behavior: Concepts, Controversies and Applications*. Prentice-Hall.

[45] R. Rumelt. Inertia and transformation. *Resources in an Evolutionary Perspective: Towards a Synthesis of Evolutionary and Resource-based Approaches to Strategy*, 1995.

[46] R.H. Schaffer and H.A. Thompson. Successful change programs begin with results. *Harvard Business Review*, 70(1):80, January-February 1992.

[47] E.H. Schein. *Organizational Culture and Leadership*. Jossey-Bass.

[48] R.A. Schmuck. *Practical Action Research for Change*. SAGE Publications.

[49] Abigail J. Sellen and Richard H.R. Harper. *The myth of the paperless office*. The MIT Press.

[50] Newport News Shipbuilding. Ford-class shipbuilders go digital. http://nns.huntingtoningalls.com/employees/pub/media/currents/050916.pdf, July 2016. A weekly publication of Newport News Shipbuilding.

[51] Siemens. Paperless manufacturing. http://camstar.industrysoftware.automation.siemens.com/en/resources/glos manufacturing/, 2017.

[52] M.D. LeCompte S.L. Schensul, J.J. Schensul. *Essential ethnographic methods: observations, interviews, and questionnaires*. Walnut Creek, CA: AltaMira Press.

[53] S. Sonenshein. We're changing - or are we? untangling the role of progressive, regressive and stability narratives during strategic change implementation. *Academy of Management Journal*, 53(3):477–512, 2010.

[54] W.H. Starbuck, A. Greve, and B.L.T. Hedberg. Responding to crisis. *Journal of Business Administration*, 9(2):111–137, 1978.

[55] J. Teresko. The plm revolution. *Industry Week*, December 2004.

[56] J. Thomas. Force field analysis: A new way to evaluate your strategy. *Long Range Planning - Elsevier*.

[57] B.S. Lawrence T.R. Zenger. Organizational demography: The differential effects of age and tenure distributions on technical communications. *Academy of Management Journal*, 32.

[58] D.D. Nadler M.L. Tushman. Organizational frame bending: Principles for managing reorientationt. *The Academy of Management EXECUTIVE*, 3(3):194–204, 1989.

[59] D. Waddell and A.S. Sohal. Resistance: a constructive tool for change management. *Management Decision*, 36(8):543–548, 1998.