Preface

INTRODUCTION

The predicted "ICT revolution" has gained increasing attention in the oil industry the last few years. It is enabled by the use of ubiquitous real time data, collaborative techniques, and multiple expertise across disciplines, organizations and geographical locations. This has made it possible to develop heavily instrumented and automated oil fields that utilize people and technology to remotely monitor, model and control processes in a collaborative, safe and environmentally friendly way in order to maximize the value of field life. Since the turn of the millennium, most major oil companies and global operating vendor/service companies have increasingly addressed oil exploration and operation enabled by information and communication technology as their future way of doing business. Integrated Operations (IO) is a concept used to describe this new way of doing business. Similar is oil exploration, field development and operation enabled by emerging information and communication technologies.

The field of Integrated Operations and the knowledge associated with this development is increasingly created in the borderland between universities, companies, national legislative/governing bodies, and various global actors. In sum, "Integrated Operations" has become an arena where a multitude of actors meet, often with different agendas and objectives but seen as something that create substantial "efficiency" leaps for the oil industry globally.

The first attempts of designing Integrated Operations were performed by Superior Oil (Booth & Hebert 1989) which established drilling data centers, providing real-time log, and "measurement while drilling" data to shore based teams (Wahlen et al. 2002). These early attempts of improving the procedures for critical drilling projects established the path for the future development of IO within the industry. The idea was based on multidisciplinary teams sharing information in a simultaneous manner, using high-tech instruments to ensure a sufficient flow of information. This mode of operation was anticipated to increase the cooperation between different fields of expertise thus improving decision accuracy in addition to cutting costs.

In relation to the Norwegian oil industry, the first implementation of IO took place around the turn of the millennium. In 1997 Baker Hughes INTEQ (see also Chapter 13) started planning for a project, in cooperation with Norsk Hydro and BP, which was supposed to facilitate the relocation of people from offshore installations to an Operations Service Centre onshore. In 2000 the project launched with a centre capable of supporting five offshore rigs simultaneously (Wahlen et al. 2002). ConocoPhillips went in the same direction, and established an onshore drilling centre in Tananger in 1999 (Herbert, Pedersen & Pedersen 2003).

Norway has been important for the development of Integrated Operations. Since oil first was found and extracted on the Norwegian continental shelf (NCS) in the early 1970s, this industry has served as the main contributor to the rise of Norwegian economy and welfare. As companies in any other industry, the operators on the NCS compete for profits and competitive advantage. Much of the IO work processes, concepts, and new technologies are also developed and tested on the Norwegian continental shelf before it is deployed globally. Some related initiatives among suppliers and operators are referred to as Smart Operations (Petoro), Smart Fields (Shell), Field of the future (BP), Real Time Operations (Halliburton), Smart Wells (Schlumberger), and i-fields (Chevron) (Henriquez 2008 et al.).

Within the petroleum industry the term Integrated Operations basically refers to work processes that allow for a tighter integration of offshore and onshore personnel, as well as operator and service companies (Skarholt et al. 2009). This integration is made possible by modern information and communications technology (ICT), and high bandwidth fiber optic networks that allows real-time data sharing between remote locations (Gulbrandsøy et al. 2004). Experts from different disciplines can collaborate more closely, which facilitates for more rapid response and decision making (Rosendahl & Egir 2008).

Today most major oil companies have IO programs or have moved their operational model in the direction of IO but the the NCS is still regarded by many as the world's most advanced basin in terms of developing such initiatives (Henriquez et al. 2008). The new work processes of IO represent a parallel way of collaborating, which contrasts with the traditional sequential way of performing work (OLF 2005). Various professionals with multidisciplinary backgrounds are now able to analyze real-time data in collaboration, thus making decisions and taking corrective actions to optimize rig site production rapidly. In addition such collaborations are no longer dependent on one physical location because the new technology allows for the onshore assembling of people with the needed competencies (Rosendahl & Egir 2008; OLF 2005).

One of the key components related to IO is the establishment of onshore support centers which has enabled companies to move work tasks from offshore platforms to land. As employees are moved onshore, the need for virtual communication and collaboration between sea and land emerges. Virtuality can be defined as activities between parties that are in different geographical locations (Gulbrandsøy et al. 2004). Accordingly, a virtual organization consists of people working towards a shared goal across space, time, and organizational boundaries made possible by webs of communication technologies (Gulbrandsøy et al. 2004). The technological capabilities are realized in so-called *collaboration rooms*. Such rooms facilitate for cooperation by utilizing videoconferencing, sharing of large data sets, and remote control and monitoring (Hepsø 2009; Henriquez et al. 2008; Rosendahl & Egir 2008; Herbert, Pedersen & Pedersen 2003; Ursem et al. 2003). These rooms contain large screens for sharing of data and possibilities for real-time data transmission between land and sea, vendors and suppliers, and other departments deemed important.

Why Implement IO?

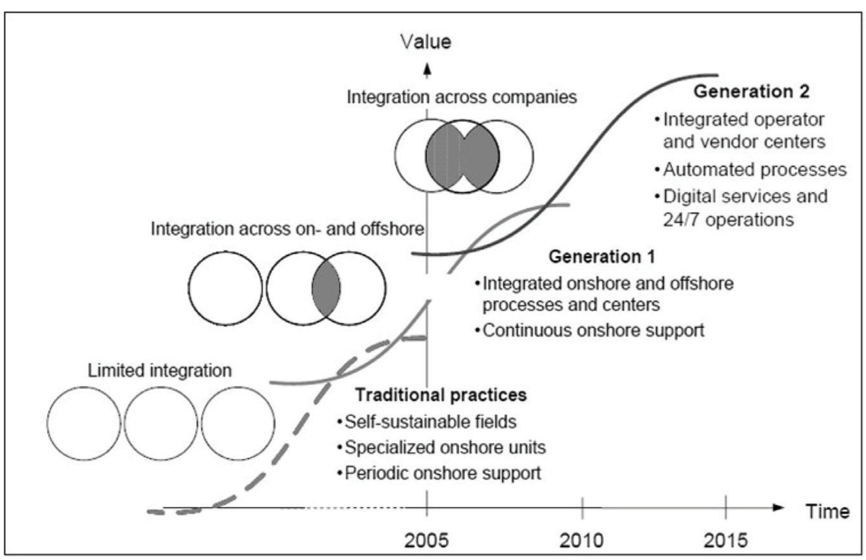
In general the rationale behind implementing IO is based on the belief that this way of organizing work will streamline operations and increase effectiveness, thus leading to a competitive advantage and increased profits (OLF 2005). Based on the definition of IO which was presented earlier, it is anticipated that the organization by integrating its operations will improve its decisions, both with respect to time and accuracy. Further, the fact that technology provides the opportunity to control offshore processes and equipment from onshore locations implies more effective operations. The ability to assemble important functions on an onshore location will also include a reduced need for offshore personnel. Already in 2003, a study by OLF on a drilling pilot project found that on some platforms, a reduction of up to 70 percent in personnel had been carried out without reduction in security.

In addition to the positive implications for effectiveness, implementation of IO is expected to have beneficial effects on Health, Safety and Environmental issues (HSE) in the industry (OLF 2007). Greater continuity and integration of activities will enhance the integration of management offshore and onshore, and potentially improve HSE issues. Offshore management can focus more of its attention on operational issues and less on administrative tasks, while performing the planning and work preparation onshore will increase the long-term focus on each asset, increase safety, and reduce the risk of environmental hazards (Grøtan & Albrechtsen 2008; Henriquez et al 2008; Ringstad & Andersen 2006).

In a report from 2007 the OLF estimated that if the oil and gas companies in the Norwegian shelf were to quickly integrate their operations, revenues from the shelf could be increased by approximately 300 Billion NOK (OLF 2007). This is around 50 Billion USD. Such an estimate provides a good incentive for companies within the industry to rapidly implement IO in their organizations. It also displays some of the belief that IO represents the future for the oil industry, and that the companies who first adapt to this operational mode will gain an advantage. It was foreseen that IO would be implemented over three generations (OLF 2005) with increasing integration; across geography, across disciplines and across organizational borders (Figure 1).

According to OLF (2005) the first generation (G1) processes will integrate processes and people onshore and offshore using ICT solutions and facilities that improve onshore's ability to support offshore operationally. The second generation (G2) processes will help operators utilize vendors' core competencies and service more efficiently. Utilizing digital services and vendor products, operators will be able to update reservoir models, drilling targets, and well trajectories as wells are drilled; manage well completions remotely; and optimize production from reservoir to export.

Figure 1. Existing and future practices (OLF, 2005)



Issues in Implementing IO

IO as a concept tap into technological issues in the oil industry, as well as issues related to the organization, its people, and its work processes (Rosendahl & Egir 2008; Ringstad & Andersen 2006; Herbert, Pedersen & Pedersen 2003; Ursem et al. 2003). To capture these different aspects of the organization, literature has proposed the concept of Man-Technology-Organization (MTO) (Andersson & Rollenhagen 2002). If IO-related work processes are to be successfully implemented it will require considering all three aspects of this system perspective. Although it appears in retrospect that the implementation of IO on the NCS has been relatively successful, severe challenges were faced regarding the development of new work practices and the management of change – the combined integration of people, processes, and technology (Rosendahl & Egir 2008; Hepsø 2006; Ringstad & Andersen 2006). Over the last ten years Integrated Operations have gone from initiatives started by enthusiasts, through pilot testing and broad implementation of new IO practices. Some efforts of implementation of IO have been scalable and sustainable; others have never been able to pass the general adoption threshold or chasm (Hepsø. et al. 2010) of piloting and good intentions.

According to Hepsø (2006) and Edwards, et al. (2010) there was an overoptimistic belief in IO at the turn of the millennium, as to how easy it would be to implement and gain results from it. The Norwegian Ministry of Petroleum and Energy (NOU 2003) defined IO almost ten years ago as: “Use of information technology to change work processes to achieve improved decisions, remote control of processes and equipment, and to relocate functions and personnel to a remote installation or an onshore facility.” Much of the early work on IO was technology biased and was treating human and organizational issues as a remaining factor (Hepsø 2006). Remote control was heralded with great technological enthusiasm. Ten years after we see that remote control has not proven to be as important as promised. On the other side, it was also heralded that Integrated Operations was all about people and processes and nothing about technology. In a sense both technology and social determinist views on IO were wrong. The implementation of IO involves the restructuring of work processes and the management of employees, which are undoubtedly two of the cornerstones of change. Different factors can drive the change forwards, while at the same time, other factors may hinder the change. As a consequence, being able to successfully manage change is of the utmost importance.

A CAPABILITY PERSPECTIVE

In this anthology we are interested in a capability approach to Integrated Operations that documents research and development in the oil industry. A capability perspective is a natural continuation of an IO change perspective that started with a man, technology and organization (MTO) perspective already presented (Andersson & Rollenhagen 2002, Ringstad & Andersen 2006, Grøtan & Albrechtsen 2008). By a capability we mean the combined capacity and ability to plan and execute in accordance with business objectives through a designed combination of human skills, work processes, governance and technology.

The capability perspective addresses the human, process, governance and technology issues of Integrated Operations through a holistic approach (Edwards et.al 2010). It can be used to understand how firms engage in networked relationships to impact learning/performance and develop distinctive practices rather than focusing only on technology. Given that the organization exists in a networked setting with heterogeneous resources, the challenge is how to configure the firm’s resources into scalable and sustainable capabilities that achieve desired actions and outcomes.

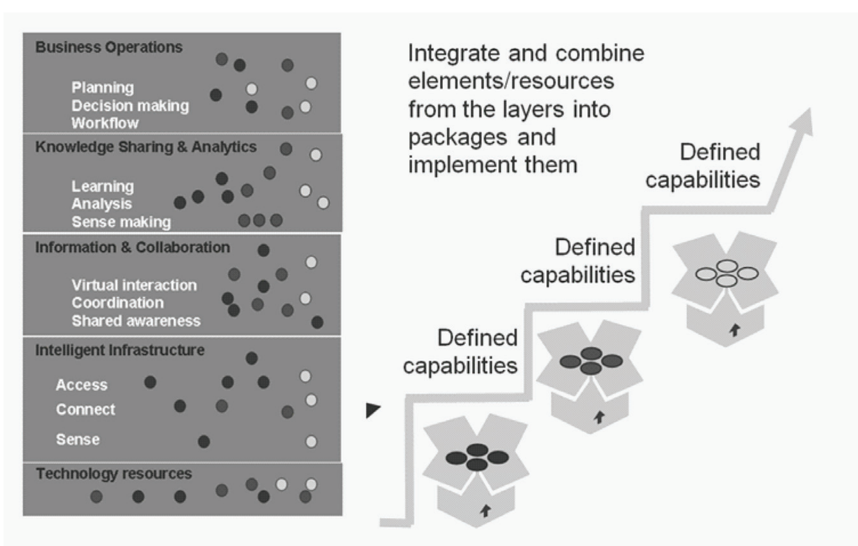
- **Technology:** Buildings working environments, facilities, plants, pipelines, equipment and systems, automation, IT and communication, software, and data_
- **Process:** Business processes - workflow, roles and responsibilities, and collaboration
- **People:** Skills, competence, experience, leadership, and all other soft people issues
- **Governance:** Organization, positions (decision rights), location of resources, business structure, internal/external sourcing, contracts, agreements, rules, and regulations

Henderson et.al in Chapter 1 in this anthology define the key elements of a capability approach in Integrated Operations for oil and gas application. Capability development is placed in an ecosystem/ecology framework. Henderson et al. argue that there are a number of layers or niches that can be used to provide a strategic view of the ecology of Integrated Operations. All IO development work is about creating and sustaining different configurations of these layers:

- Technology resource layer
- An intelligent infrastructure
- Information and collaboration layer
- Knowledge sharing and analytics layer
- A business operations layer

A stepwise approach of capability development means that for each step in the development process a unique configuration of the four capability elements must be set up; people, process, governance, and technology. Scalability and sustainability will result when the layers are configured with the proper combinations of the four capability elements, see Figure 2.

Figure 2. The proper combinations of the capability elements



A PRESENTATION OF THE CHAPTERS IN THE ANTHOLOGY

The anthology is a collection of ongoing work with IO and many of the authors have worked with IO for many years, some of them experts both in research and deployment of IO in the oil and gas business. The geographical distribution of the authors signals that IO is a global phenomenon; Norway, Denmark, Great Britain, Austria, USA, Brazil and Holland. The authors are oil company employees, from oil and gas vendors, consultants, researchers or university faculty members. The different chapters in this anthology share to large degree the content of these IO definitions presented in the introduction, even though there is some variety in the understanding and use of IO in the chapters. The contributors of the anthology has to a larger or lesser sense focused on various parts of the capability stack. Not all the chapters are using the capability language explicitly but all authors stress the need to have a holistic perspective on Integrated Operations.

In the first section, *Introduction and Definitions*, after the introduction by Rosendahl and Hepsø that you are currently reading, we start with an introduction to the key concepts in the anthology. This is given by Henderson, Hepsø, and Mydland in their chapter *What is a Capability Platform Approach to Integrated Operations? An Introduction to Key Concepts*. They argue that the capability language allows us to unpack the role of technology by emphasizing its interaction with people, process and governance issues. Further, they address the importance of a capability approach for Integrated Operations and how it can improve our understanding of how people, process, technology and governance issues are connected and managed to create scalable and sustainable practices. Also, the authors describe the development of capabilities as something that is happening within an ecology.

Section 2, *People, Process, Governance, and Technology Capabilities*, consists of eight chapters. Skarholt, Hansson, and Lamvik show *'How Integrated Operations Has Influenced Offshore Leadership Practice'* in their chapter. They discuss how IO has affected new ways of working, and address leadership practice in particular. Also, they investigate both the positive and negative effects of IO in terms of virtual leadership teams and local leadership offshore, and how this may affect safety on board. The chapter *'Creating an IO Capable Organization - Mapping the Mindset'* by Madsen, Hansson, and Danielsen, starts by claiming that IO is an organizational change process where the mindset of the organization and the mindset of individuals affects this change process and vice versa. In the chapter the authors discuss the changes introduced by IO, requirements to the change management process, and a concept called IO Mindset.

In his chapter, *Collaborative Work Environments in Smart Oil Fields: The Organization Matters!*, Guldemond claims that in the last decade, oil companies are increasingly viewing Collaborative Work Environments as an important component of their Smart Oil Fields programs. Collaborative Work Environments (CWEs) have been implemented by several major oil companies, to support the use of technology in Smart Oil Fields. The implementation of these Collaborative Work Environments is not without problems. After major oil companies successfully implemented the hardware, tools and applications in CWEs, organizational design challenges remained unsolved. The biggest challenge is to change behavior of staff and to effectively integrate people across disciplinary boundaries, he states.

Chapter 5, *Connecting Worlds through Self-Synchronization and Boundary Spanning: Crossing Boundaries in Virtual Teams*, by Filstad, Hepsø, and Skarholt, investigates knowledge sharing in collaborative work. Through two empirical studies of personnel working offshore and onshore in an oil company, they address the role of self-synchronization and boundary spanning as practices for improving collaboration in Integrated Operations. The authors focus on the following enabling capabilities for collaborative work: management, knowledge sharing, trust, shared situational awareness, transparency, information and communication technology. In the next chapter, *Teams: The Intersection of People and Organisational Structures in Integrated Operations*, Taylor describes the success and sustainability of the IO initiative within the oil and gas industry. IO is discussed in relation to the ways people work together and the organizational structures which support that work. Whilst collaboration has become a defining concept in the industry for optimal working, this chapter argues that other characteristics found in the concept of teamwork are of equal importance in achieving the aims of the IO project.

In his chapter, *Managing Team Leadership Challenges in Integrated Operations*, Larsen gives an empirically based account of leadership of teamwork in Integrated Operations settings, or "IO teamwork" as it is termed here. First, a brief presentation of the characteristics of IO teamwork and its leadership is provided. Then follows an overview of relevant theoretical perspectives to the study of team leadership in IO settings. Next, central challenges regarding leadership of IO teamwork are discussed, and empirical examples of how leaders of IO teams go about managing these challenges are provided. Elke, in Chapter 8, *Implementing iE – Learnings from a Drilling Contractor*, argues that utilization of iE has been regarded as a vital measure for avoiding a rapid decline in production. Implementation has however proven to be challenging, and an un-harvested potential still exist. Taking a capability approach to such implementation may help us attain this remaining potential. Doing so requires us to have a good understanding of what factors that secures a successful and sustainable iE-implementation. Here, a case study of how a drilling contractor has adopted iE is used as basis for identifying such factors.

Chapter 9, the last in this section, is entitled *Good IO-Design is More than IO-Rooms*, written by Moltu. She argues that IO is about employing real time data and new technology to remove barriers between disciplines, expert groups, geography, and the company. IO has been associated with so called IO rooms. IO is technology driven, but is neither room nor technology deterministic. A network understanding of IO, based on Science and Technology Studies, gives a process of different *actants* chained in networks, pointing the same directions by the same interests, to obtain the anticipated effect as is comes to efficiency and good HSE results. This chapter develops the seamless web of the IO design and describes good design criteria based on studies in Operational Support Rooms.

Section 3, *Planning, Concurrent Design, and Team*, starts with a chapter by Rosendahl, Egir, and Rolland, titled *How to Implement Multi Disciplinary Work Processes in the Oil Industry: A Statoil Case.* They explore possibilities for using Concurrent Design at Statoil, seeking to understand how they should proceed in implementing this kind of work, and consider potential pitfalls of using this method. The authors offer ideas that can minimize the time required to implement the multi-disciplinary approach of Concurrent Design. Chapter 11, *Implementing Integrated Planning: Organizational Enablers and Capabilities*, by Ramstad, Halvorsen, and Holte, focuses on how transferring the IO principles to the planning domain has led to the development of the concept of Integrated Planning. The concept represents a holistic perspective on planning, emphasizing the interplay between planning horizons, between organizational units, and among cross-organizational partners. Based on findings from three case studies, the purpose of this chapter is to present how three companies in the oil and gas industry has approached integrated planning, illustrating some of the challenges they have experienced in the planning domain. Skjerve, Rindahl, Sarshar, and Braseth complete Section 3 with their chapter *Promoting Onshore Planners' Ability to Address Offshore Safety Hazards*. Here is a development of a new generation of Integrated Operations, where the number of offshore staff may be reduced and more tasks allocated to onshore staff. As a consequence, onshore planners may increasingly be required to address safety hazards when planning for task performance offshore. The chapter addresses the question of how onshore planners' ability to address offshore safety hazards during planning of maintenance and modification tasks can be promoted by use of visualization technology.

Also Section 4, *Cases*, consists of three chapters. First Fraser, Dagestad, and Jones introduce *Baker Hughes IO & BEACON with a Focus on Downsizing Personnel Requirements at Rig-Site*. The authors describe how Baker Hughes, an IO pioneer, for more than a decade has developed a number of IO applications and WellLink technologies building its BEACON (Baker Expert Advisory Centre Operation Network) platform for the digital oilfield. The scope of BEACON is remote access of real-time rig data, drilling data and wire line data, production and pump monitoring and static file management. These technologies have enabled the company's collaboration centers around the world primarily to monitor, support and optimize operations without having to be physically present at rig site. In chapter 14, *Integrated Operations in Petrobras: A Bridge to Pre-Salt Achievements,* Lima and Adilson describes Petrobas as an integrated energy company that operates in all segments of the oil industry. The company has a broad management experience and uses a multidisciplinary approach, which applies to different areas. Recently, the impressive discoveries of the Pre-Salt reserves have created an exciting scenario in multiple aspects. Petrobras expects to produce by 2020 more than 5 million bpd of oil, out of which 1 million only from Pre-Salt. This leads to an approach that will require scalable and sustainable solutions that take into account the better understanding of how people, processes, technology, and governance issues are connected and managed. The last chapter in this section, *The Introduction of a Hand-Held Platform in an Engineering and Fabrication Company*, by Lorentzen Hepsø, Waldal, and Rindal, focuses on the organization Fabricom, and seeks to uncover which capabilities lies within the hand-held devices, and which effects the implementation of such devices could have on Fabricom's work processes. Through an abductive approach, based on observations, semi-structured interviews, and document analysis, the authors focus on the workflow and communication practices in Fabricom.

Section 5, *Leadership and Learning*, starts with chapter 16, *Adaptive Advisory Systems for Oil and Gas Operations*, by Al-Kinani, Cakir, Baumgartner, and Stundner. This chapter describes a framework that captures knowledge in an organization and applies it in daily operations. Knowledge capturing is one of the biggest upcoming challenges to oil and gas organizations as operations become more remote, more challenging and many experts are leaving the oil and gas industry. A methodology is described to capture the knowledge of experts centrally and apply it throughout all operations in the organization. The next chapter describes *Integrated Operations from a Change Management Perspective*. The authors, Rosendahl, Egir, Due Sørensen, and Ulsund, are focusing on trends in implementing Integrated Operations across companies. Findings are presented in a modified version of Kurt Lewin's Force Field Analysis. They found multiple forces that have affected the implementation of Integrated Operations to various extents, and this chapter focuses on three of them: understanding the rationale of IO, establishing support for change, and technological solutions.

In chapter 18, *Knowledge Markets and Collective Learning: Designing Hybrid Arenas for Learning Oriented Collaboration*, Bremdal and Korsvold argue that "Knowledge Markets" might be used as a term to describe how individuals can be engaged in a democratic process where their competence, background and personal information resources are mobilized in full in a broad and non-biased process. The contribution of each individual is aggregated and averaged in a way that the authors believe will yield more accurate results, personal involvement and learning than traditional approaches to group efforts. *The Terms of Interaction and Concurrent Learning in the Definition of Integrated Operations,* by Steiro and Torgersen, completes this section of the book. This chapter introduces a new definition of IO adapted to the oil industry. This definition focuses on interaction. Such an approach, we believe is necessary to emphasize learning processes in the organization's various echelons. It is an important assumption for the success of IO as a flexible and complex organization. The term "Interaction" is elaborated with special emphasis on "Concurrent Learning."

The last section, *Resilience & HSE*, starts with chapter 20, *IO, Co-agency, Intractability, and Resilience*. The author, Hollnagel, claims that technological developments continuously create opportunities that are eagerly adopted by industries with a seemingly insatiable need for innovation. This has established a forceful circulus vitiosus that have resulted in exceedingly complicated socio-technical systems. The introduction of Integrated Operations in drilling and off-shore operations is one, but not the only, example of that. This development poses a challenge for how to deal with risk and safety issues. Where existing safety assessment methods focus on descriptions of component capabilities, complicated socio-technical systems must be described in terms of relations or even functional couplings. In order to design, analyze, and manage such systems, we must acknowledge that performance adjustments are a resource rather than a threat. Safety can no longer be achieved just by preventing that something goes wrong, but must instead try to ensure that everything goes right.

In chapter 21, the authors Albrechtsen and Weltzien discuss *IO Concepts as Contributing Factors to Major Accidents and Enablers for Resilience-Based Major Accident Prevention*. On the one side inadequacy of IO-concepts can, in combination with other factors, contribute to major accidents. On the other side, work processes and technology within an IO-context contribute to prevent major accidents. This chapter shows how IO concepts can enable a resilience-based approach to major accident prevention by employing a case study of an onshore drilling center. Interviews indicate that drilling and well operations justify a resilience approach, as these operations are complex and dynamic. Finally, in chapter 22, *Introducing IO in a Drilling Company: Towards a Resilient Organization and Informed Decision-Making?,* the authors Osborg Ose and Steiro shows that the introduction of Integrated Operations in the offshore oil and gas industry makes distanced and distributed decision-making a growing part of normal work. Some functions have been transferred from offshore installations to onshore offices as a consequence of the technologies that have recently become available. They analyze whether the onshore organization is ready for increased responsibilities by increasing the resilience in its work patterns, since resilience is important for maintaining or increasing safety level compared to current operation, where personnel on board installations can observe the plant at first hand.

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