

Semantic Technology for Knowledge- and Work Process Management in the Oil & Gas Industry

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Computas AS



Outline

- Introduction
- **Computas in Oil & Gas Integrated Operations**
- **Use case 1: Active knowledge system for integrated operations**
- **Use case 2: Agile Processes for Integrated Operations**
- Concluding remarks

Computas AS

- Norwegian software company specializing in **intelligent work support systems**
- Delivers solutions that **refine, preserve, and activate organizational knowledge**
- **Core competencies**
 - Business Process Management
 - Semantic technology
 - Knowledge management
 - Collaborative work processes
 - Service-oriented architecture
 - Decision support technology
- **Ca 175 employees**

Computas and semantic technologies

- Computas pioneers **application of semantic technologies** in Scandinavia
- Participation in W3C **SWEO** (Semantic Web Education and Outreach IG) and w3C **eGOV** IG
- **Active community participation**
Co-founder of int. Oil and Gas conference (Semantic Days), Initiated and chairs Semantic Web IG in the Norwegian Computer Society, member of the European KnowledgeWeb network

Data to Decisions – Future Integrated Operations

Computas develops knowledge-based work process solutions and intelligent systems for e-field applications (Integrated Operations). Our solutions help people understand data and make better and faster decisions

- Work processes
- Decision support
- Semantic technology
- Collaboration technology
- Data and system integration



Illustration: FMC Technologies / Indok Photo: istockphoto

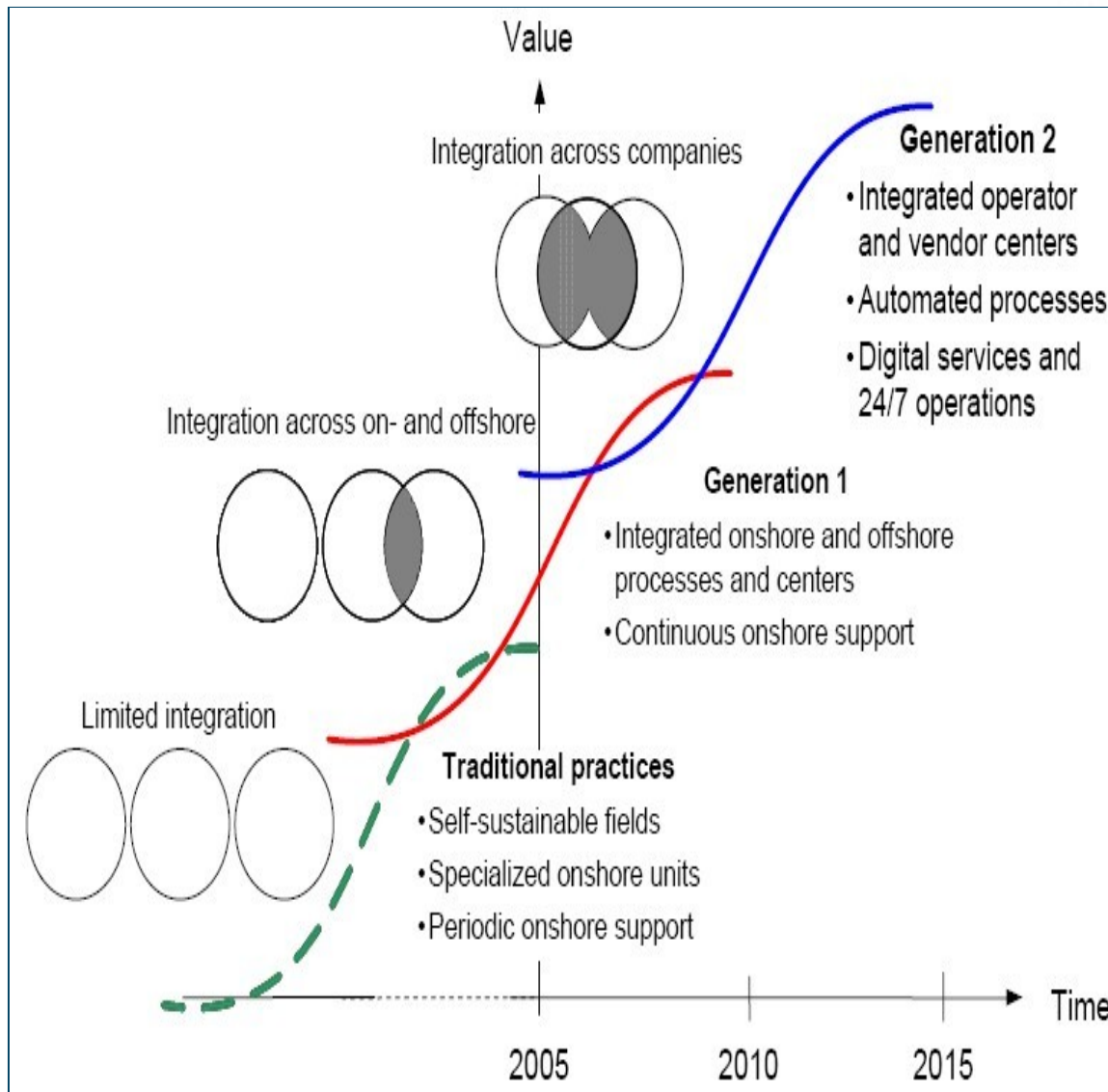


www.computas.com

We create value for our customers by delivering solutions that transform data, manage organizational knowledge, and coordinate work. We rely on 20 years experience in building mission-critical solutions for demanding customers in government and private industry. Customers include StatoilHydro, Conoco-Phillips, FMC Technologies, DNV, and large public sector organizations.

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Computas in IO/Smart fields/iFields...



APRIO

Work Processes, 2009-2011??

AutoConRig

Agent Systems, ontology driven, 2008-2011

CODIO

Decision Support with uncertainty, 2007-2010

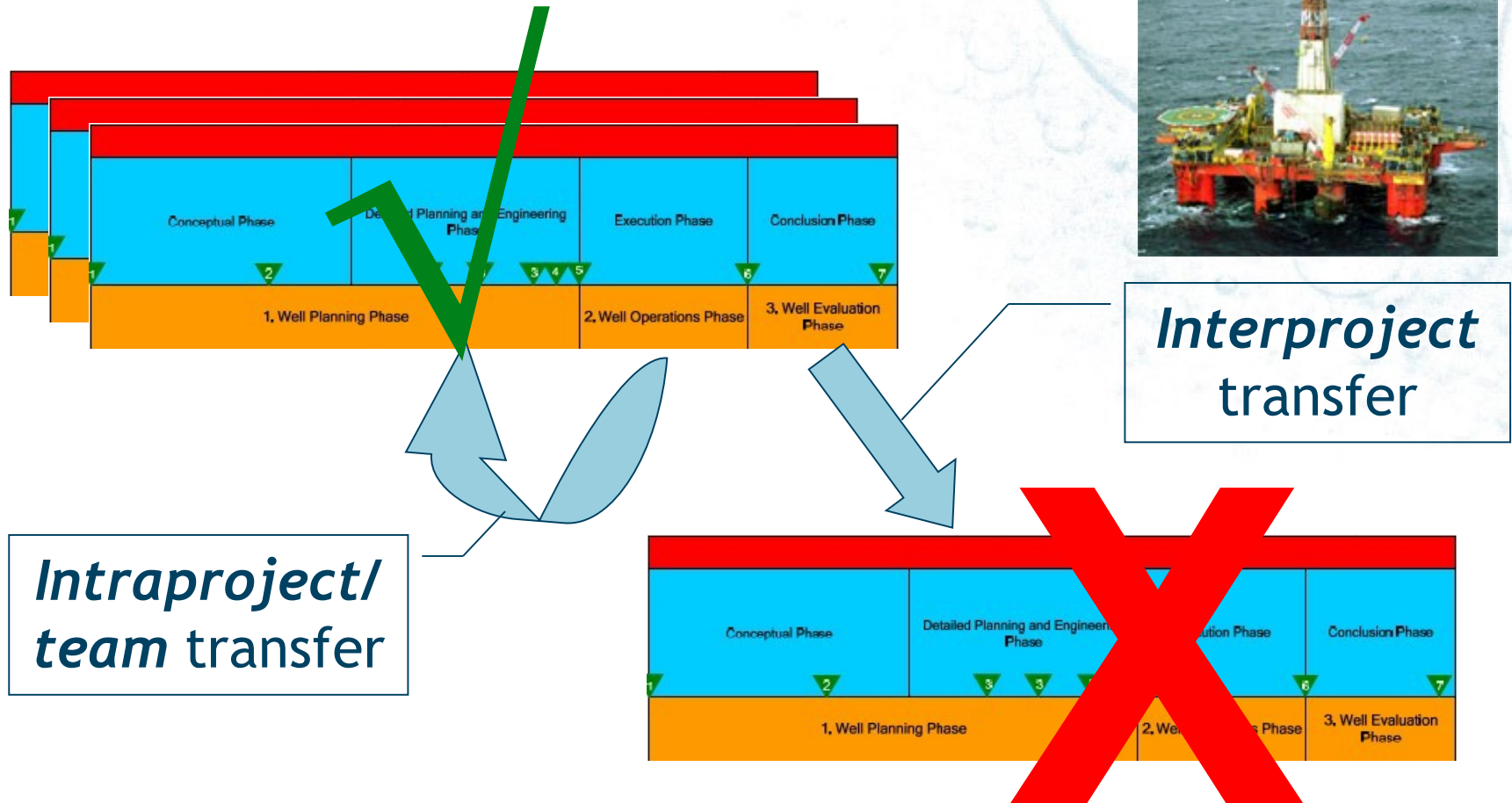
AKSIO

Semantic Technology, knowledge management, 2004-2007

Active Knowledge System for Integrated Operations

- “not make the same costly error twice” and reduce impact of “the big crew change”
- Develop and evaluate an **active socio-technical system** (work process with technology support) for experience transfer in integrated drilling operations
- StatoilHydro, Computas and more

Experience transfer in well construction



Active and facilitated experience transfer



AKSIO Home

AKSIO Initial Sorting

Selected experience has ID: 2287375

Source ID: 2287375

Subject: Leaking suction valve prior to cementing 9 5/8" casing

ID	Subject	Date	Registered by
2287375	Leaking suction valve prior to cementing 9 5/8" casing	2004-11-17	KRMH
21810496	Power Drive Motor failed after drilling 950 meters	2004-08-17	PHI
21799584	Power Drive Shearing capability	2004-06-03	LANROR
22006992	Hydrotest: Drags, sagging as topstream go for lav slammer	2004-11-09	ESAND
21963289	Swarmis drop down do gyro	2004-09-17	EAST
21190032	Kicked off well with ethanol, in wrong direction using milling assembly	2004-09-24	PLS
21865390	Cementing 20"	2004-07-12	KYUR

AKSIO experience overview

ID: 2287375

Source ID: 2287375

Subject: Leaking suction valve prior to cementing 9 5/8" casing

Field: HEDS-04

Well Name: 05077-6-12 A

Section Interval: 12 3/4' x 14'

Section Start Time: 2004-10-19T12:00:00+01:00

Section End Time: 2004-11-19T12:00:00+01:00

Keywords: CEMENTING

Type of Experience: POSITIVE EXPERIENCE

Create Date: 2004-11-17T12:00:00+01:00

Create By: KRMH

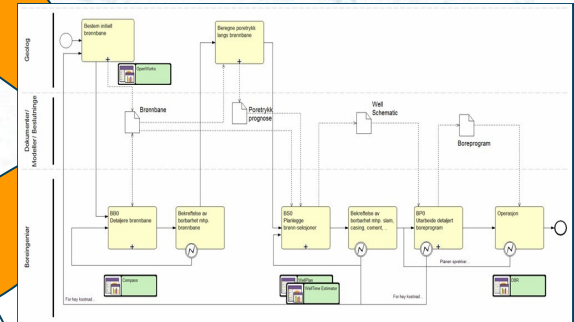
Company Involved: Holburton

Site Report Date: 2004-11-18T12:00:00+01:00

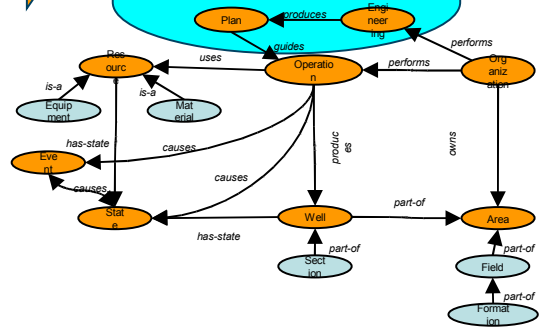
Description: After the cement unit was lined up to the drillfloor... (text continues)

Immediate Solution: Contingency solution was cancelled and original plan resumed.

Solution for the future: It is very important that all involved parts are... (text continues)



Process 1. Screen and annotate knowledge



Process 2. Search and activate knowledge

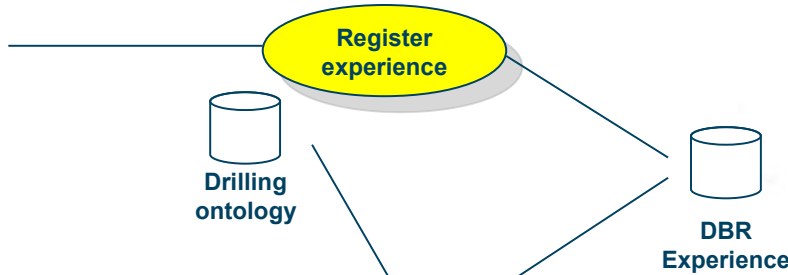
Experience capture interface



Drilling Projects



Discipline Advisors/ Networks



Knowledge Resource Map



B&B experts



Governing documents

Embedded in Sharepoint/ TeamSites

Queue of experiences

Actions to be taken

Feedback to Drilling engineer

Details of an experience

Search and filters

Subject	Date	Registered by
Ice-plugs in Halliburton GP equipment	2007-02-28	Wenn Torgeir
Problems during cleaning of surface equipment	2007-02-28	Wenn Torgeir
Problem to get good MU curves for 5-1/2" Vam Ace/Vam Top tubing	2007-02-28	Wenn Torgeir
Pup joint in top of THRT/DPLS	2007-02-28	Wenn Torgeir
M/U 13 3/8" Whipstock	2007-02-28	Christensen Arid
18 3/4" Wellhead restriction	2007-02-28	Juvik Jon Ola
N-5 template. Hatches and heights on template and WH for landing BOP.	2007-02-27	Opsal Morten
Float sub infuded on Smith Red Baron assemblie made up onshore	2007-02-27	Furulzkken Nina

AKSIO initial Sorting
Selected experience has ID: 23986731

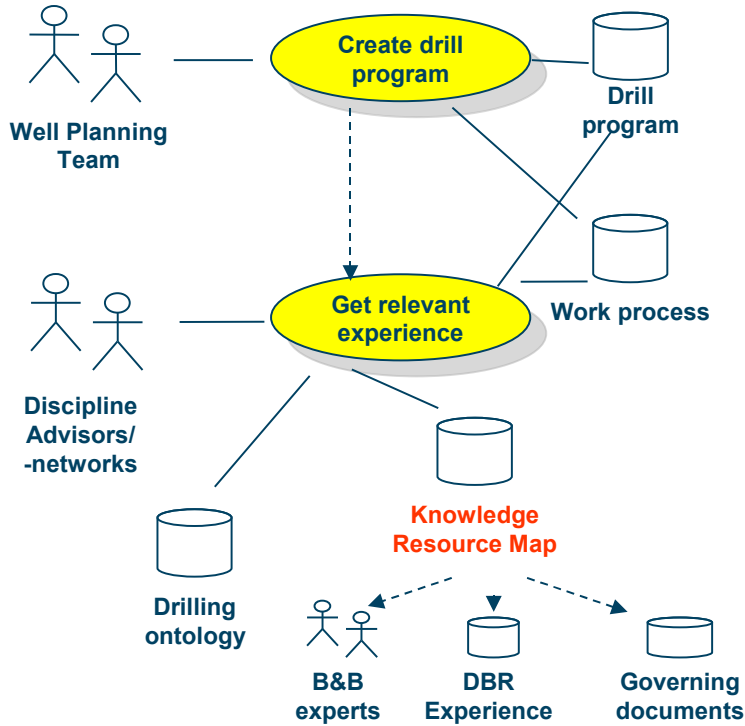
AKSIO experience overview
Original source

Id 23986731
kr-id 1173825648273
attachment_kind NEGATIVE EXPERIENCE
attachments_s 23986731
bsasc_s 85

description During washing of surface equipment the casing cleaning fluid, BaraClean, caused severe problems because of foaming. Interface levels in pits and tanks were not detected because of the foam. BaraClean has been used earlier both on Stena Don and Heidrun TLP with no problems. The reason for the foaming problems encountered may be the hurry during mixing of the fluid and use of too small pit for mixing of the casing cleaning fluid.

field_id HEIDRUN SUBSEA
include_on_fwv YES
interval COMPL_SCWPR
keywords PUMPING
keywords_ref PUMPING
object_s 23182849
object_t OPERATIONS
row_create_date 2007-02-28T12:00:00+01:00

Experience re-use



Search for concepts or free-text

Search filters

click below to enable filter

- discipline
- equipment
- state
- Corrosion (1)
- Erosion (2)
- Lack Of Maintenance (2)
- Leak in barrier elements (5)
- Scale Deposition (1)
- Too High Mud Density (1)
- Well Integrity Problem (7)
- keywords_ref
- wellbore_id_ref
- field_id
- EXPLORATION (1)
- GULLFAKS (1)
- GULLFAKS SDR (1)
- HEIDRUN (1)
- HULDRA (1)
- MIDGARD (2)
- RIMPFAKS (1)
- SNORR (1)
- SORR (2)

Results 1 - 7 of 7

1. **Top plug/20" EZSV** 55% [annotate](#) [comment](#)

Description: Experience: In a "standard" OPR design, the upper cement plug would cover the 13 3/8" out as well as...
 EXPLORATION NO 6406/1-1 PA PLUGBACK/KICK-OFF
 2007-06-12T07:05:58Z
 Cementing Network Sementeringsnettverk Directional Drilling Network Directional Drilling Network Bronnintgritet Well Integrity Problem
2. **RH with drill stem teststring.** 50% [annotate](#) [comment](#)

Description: RH with drill stem teststring. Took weight when entering 7" liner with test string. Worked same pas...
 RIMFAKS NO 34/10-J-4 H DST DRILL STEM TEST
 2007-06-12T07:05:58Z
 Bronnintgritet Well Integrity Problem
 Completion string component Completion string component Downhole tester valve Downhole tester valve Bore string Drilling string Subsea production tree Subsea test tree Subsea test tree Surface test tree Surface test tree Well test packer Well test string Well test string Well test string components
3. **Flowing well** 47% [annotate](#) [comment](#)

Description: The well was temporary handed back to production during changeover from slick line to 5/16" cable fo...
 HEIDRUN NO 6507/7-A-20 WIREL Holi Trond OTHER
 2007-06-12T07:05:58Z
 Cementing Network Sementeringsnettverk Technical Sidetrack Tekniske Sidesteg Bronnintgritet Well Integrity Snubbing safety head Snubbing safety head UBD none return valve UBD none return valve
4. **Fill drop sub assy prior to making up packer for barrier assy to avoid possible trapped pressure.** 39% [annotate](#) [comment](#)

Description: Fill drop sub assy prior to making up packer for barrier assy to avoid possible trapped pressure...
 HULDRA NO 30/2-A-6 8 1/2 Rodvelt Knut T/A PLUGS & MECH, PLUGS
 2007-06-12T07:05:58Z
 Cementing Network Sementeringsnettverk Bronnintgritet Well Integrity Deep set tubing plug Deep set tubing plug Leak in barrier elements Leak in barrier elements Scale Deposition Scale Deposition Well Integrity Problem Well Integrity Problem
5. **20" casing test failed** 35% [annotate](#) [comment](#)

Description: The cement was displaced with seawater and 95% pump eff. (incl. half shoe track) - no bump was observ...
 GULLFAKS SDR NO 34/10-F-2 Y1H 26" Samulsen Kjetil CEMENTING
 2007-06-15T02:15:22Z
 Cementing Network Sementeringsnettverk Bronnintgritet Well Integrity Cementing Equipment Cementing Equipment Technical Sidetrack Tekniske Sidesteg Bronnintgritet Well Integrity Problem Well Integrity Problem
6. **TRO plug element found on shaker.** 34% [annotate](#) [comment](#)

Description: A major part of the rubber element from the TRO plug was found on the shaker. Visual inspection con...
 VISUND NO 34/8-A-4 AH COMPLXTINS Hernes Sindre T/A PLUGS & MECH, PLUGS
 2007-06-15T02:15:22Z
 Cementing Network Sementeringsnettverk Bronnintgritet Well Integrity Deep set tubing plug Deep set tubing plug Leak in barrier elements Leak in barrier elements Scale Deposition Scale Deposition Well Integrity Problem Well Integrity Problem
7. **Retrieve lower GT plug at 2811 m in 17 hrs, now losses during pulling.** 33% [annotate](#) [comment](#)

Description: Retrieve lower GT plug at 2811 m in 17 hrs, now losses during pulling. One seal element + 1/8 of sec...
 MIDGARD NO 6507/11-Y-2 H COMPL T/A PLUGS & MECH, PLUGS
 2007-06-12T07:05:58Z
 Cementing Network Sementeringsnettverk Bronnintgritet Well Integrity Deep set tubing plug Deep set tubing plug Leak in barrier elements Leak in barrier elements Scale Deposition Scale Deposition Well Integrity Problem Well Integrity Problem

Filter on discipline, operation, equipment, state, dbr keyword, wellbore and field

Expand to read all details

Abstract of experience

Positive or negative experience

Relevance ranking

Give feedback

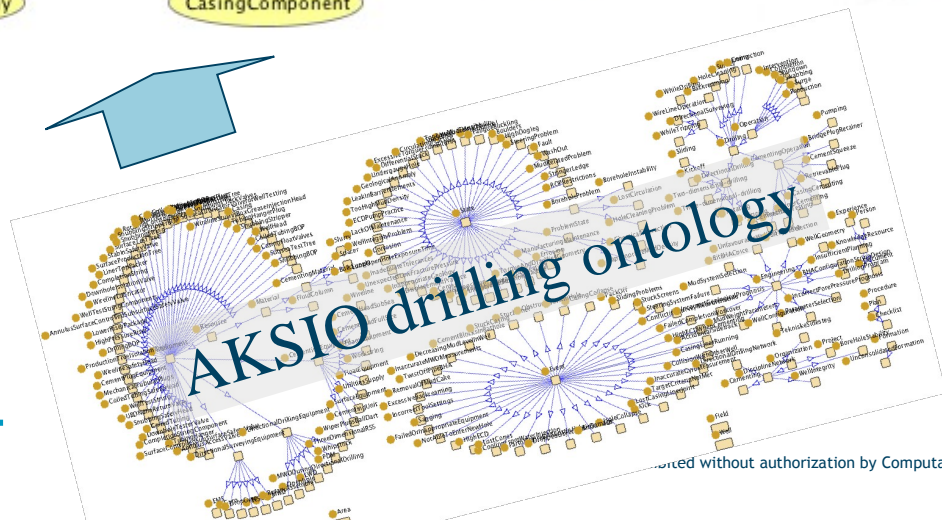
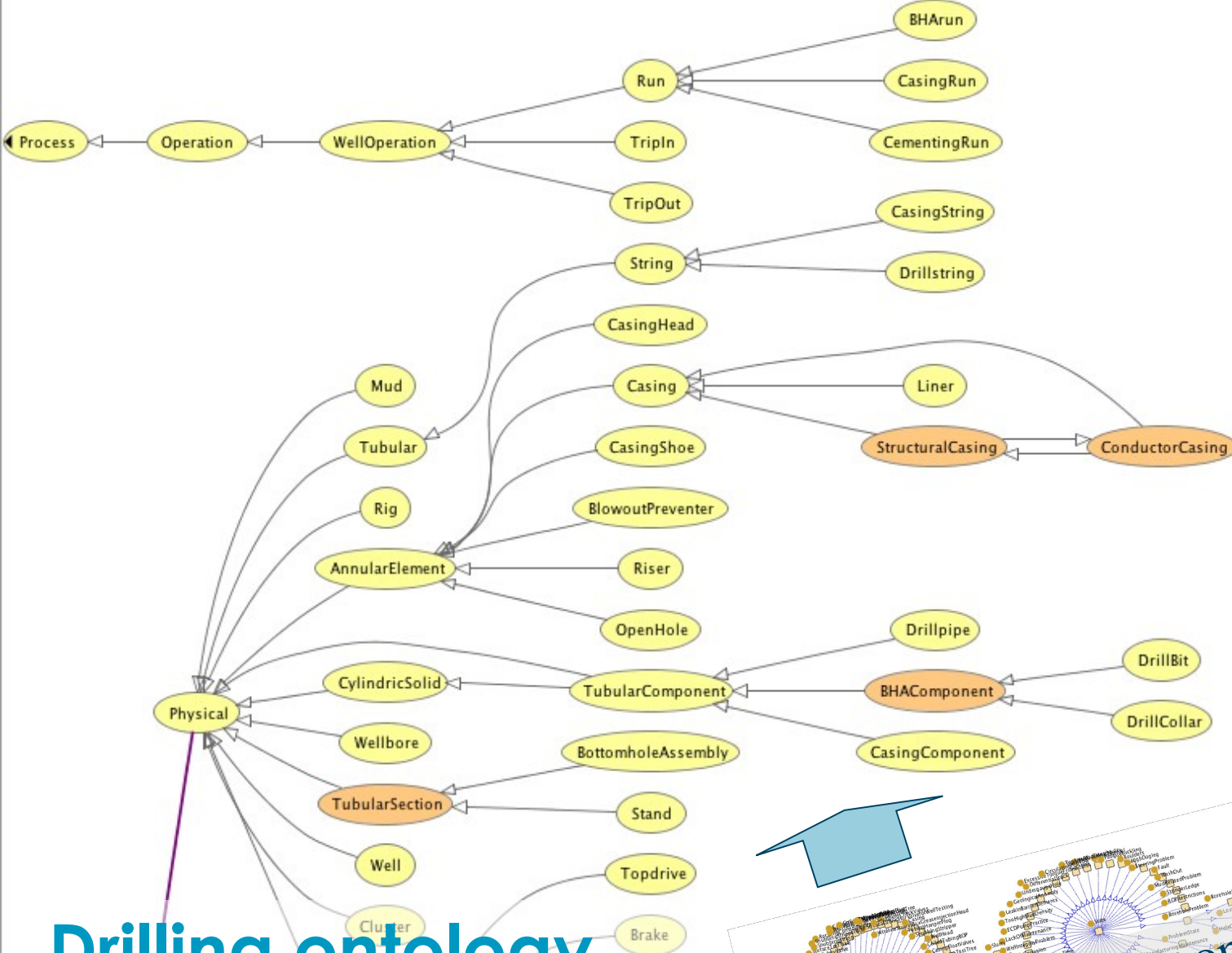
Knowledge sources vs. activities

Workstep	Knowledge source	People/Networks								Documents/databases								IT Tools								
Detail well path																										
	Check dogleg	x	a		a	a						a			a		a	a		x	x					
	Check interference with previous wells	x	a		a	a						a			a		a	a		x	x					
	Overall method choice	x	x	x	x	x	x	x				x	x	x	x	x	x	x				x		x	x	x
Confirmation of ability to drill the well path												a									x	x				
Plan well sections																										
	Trial with standard hole and casing dimensions	x			a	a						a			a		x	x				x		x	x	
	Decide depth of forings; rsko and number of sections	x			a	a			x	x		a			a	x	x	x	x			x		x	x	
	Perform simulation ECD and T&D	x	a		a	a						a										x			x	
	Decide further progression planning	x	a	a	a	a						a													a	
	With small margins contact SSC / Experts	x	a	a	a	a	a	x																	x	
	Updated estimate time/costs for well drilling	x											x	a				a					x	x		
Confirmation of ability to drill in relation to slam, casing, cement		x			a	a												a				x		x	x	
Develop detailed drilling program																										
	Document detailed method choice	x			a					x	x		x	x	a			a						x		
	Document chosen drilling technology	x			a					x	x		x	x	a			a						x		
	Chose supplier / undersupplier	x	a	a	x	x	a	a				x	a	x				a	a	x				x		
	Describe special well HSE conditions	x	a	a	a	a	a	a			x	x	a	x	x			a	a	a	a			x		
	Choose starting point for doc. (maximize reuse)												x											x		
	Work out detailed timeplan in DBR	x			a									x										x		
	Detail detailed operation plan	x	a	a	a	a	a	a	x			x	a					a	a	a				x		
	Describe detailed completion plan	x	a	a	a	a	a	a	x			x	a					a	a	a				x		

Legend: x = used, a = can also be used

AKSIO drilling ontology

- Created **in collaboration** between
 - Knowledge engineers: Ontology structure, methodology
 - Discipline advisors (domain experts): Domain concepts
- **Question-driven ontology scoping** related to **specific application**
 - “Which pressure-related *problems* are most frequent in this type of geological formation?”
 - “What can cause borehole instability?”
 - “What equipment is used in the cementing process?”
- Scope: to **“tag” experiences with concepts,** relations used to navigate and search
- **Evolving** into a generic OWL-DL drilling ontology



Drilling ontology (OWL DL)

- part of the AutoConRig project

Challenges and AKSIO answers

NOW

- Unsystematic and insufficient registration and qualification of new experience
- Lack of common terms for discussing and describing experience
- Insufficient tools to search for relevant experience
- Inadequate linking of “tacit” and “explicit” knowledge
- Not integrated with normal work flows for people

AKSIO

- New experience reports routed to domain experts for screening and annotating using domain ontology
- Defined a common ontology for the drilling domain
- Embeds an advanced search tool in the work process
- Lets experts and users annotate reports incl. links to experts
- Embeds experience recording and reuse in work flows

AKSIO – Indicated benefits

- **Increased quality of experience base**
- **Increased rate of knowledge reuse**
 - More rapid take-up of best practices
 - Avoid repeating mistakes
- **Better decisions and improved drill plans**

Agile Processes for Integrated Operations

- A major focus of Integrated Operations is to **improve work processes**
- **Work processes is**
 - a set of coordinated tasks and activities, both manual and automated, whose purpose is to accomplish a specific business goal
- **Design and execute**



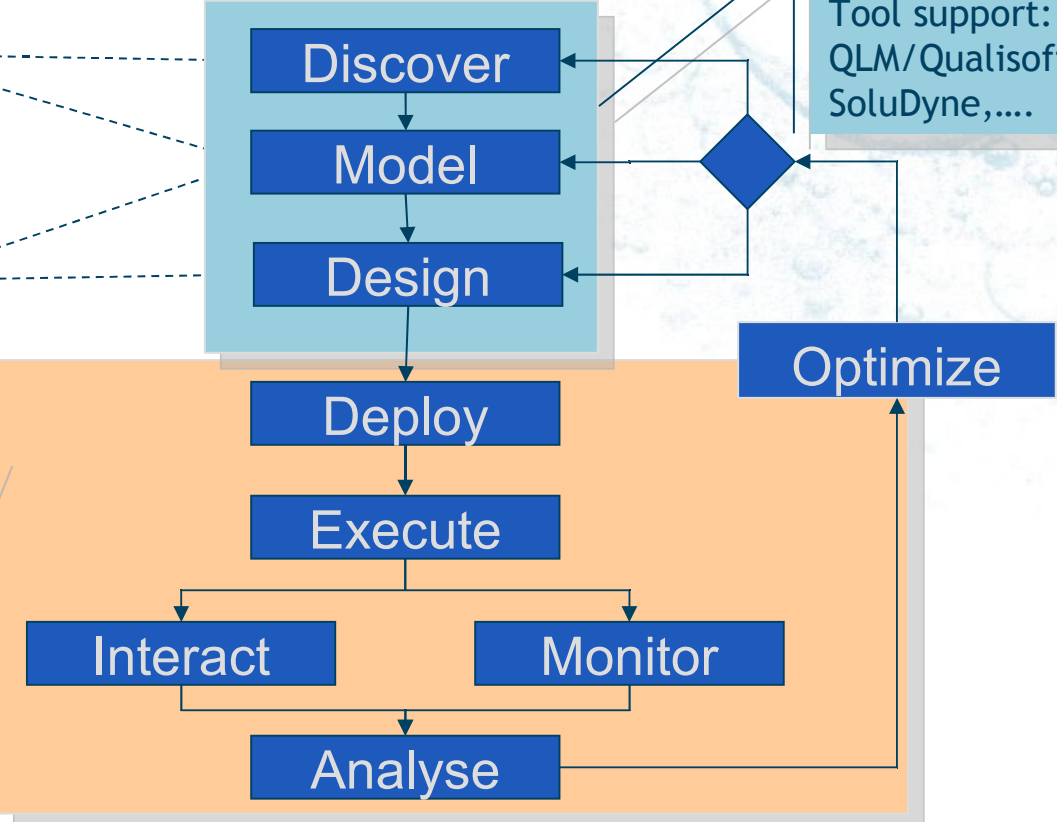
Design and execute

Business:
Process owner

Operations:
End users

"Do the work" (APRIO)
Tool support:
FrameSolutions, K2,...

"Design the work"
Tool support:
QLM/Qualisoft, Aris,
SoluDyne,....



APRIO

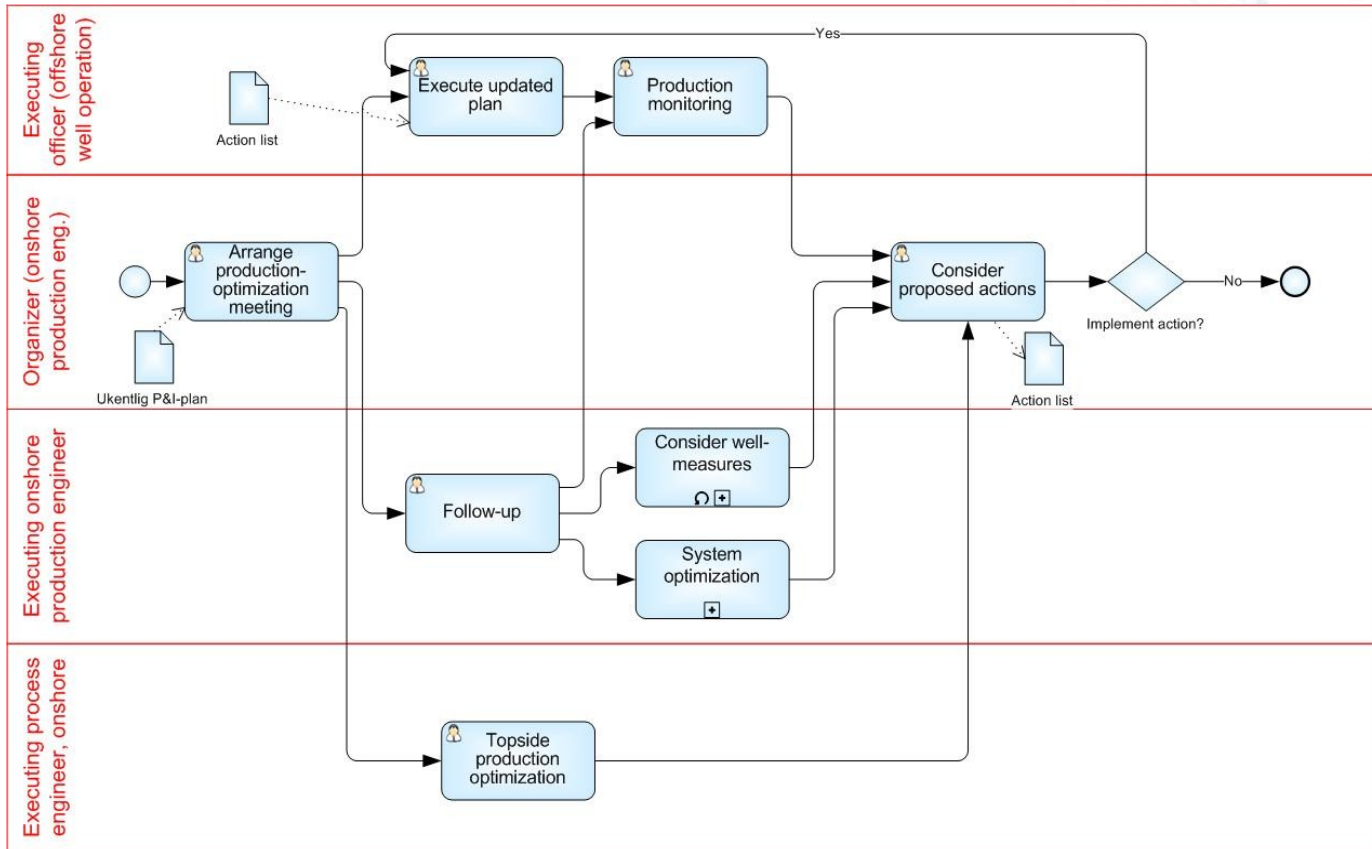
Document based & mostly manual work process -> solutions to **detect and alert changing operational situation,** and **actively assist**

- **Improved HSE**
 - **Repetability**
a task will be done the same way each time
 - **Tracability**
the system keeps track of actions and decisions taken
 - **Governance**
management gets global "dashboard" view of performance & compliance
- **Improved productivity**
 - **More efficient collaboration**
collaborate IO work practice actively supported
 - **Overcome information overload**
improved and timely access to information and tools
 - **Better business alignment**
processes designed by process owners and operational personnel

Preliminary work - semtask

- An architecture for an active support system for **work processes** based on **Semantic Web technology**
- An **OWL-DL ontology for BPMN**, resulting in a standard storage format (serialization) for BPMN diagrams
- **Tested by**
 - a description of (parts of) a Daily Production Optimization work process in BPMN (described in RDF)
 - an execution model for SemTask to connect tasks, data sources, and decisions; as well as an execution engine relying on rules

The Daily Production Optimization work process (DPO)

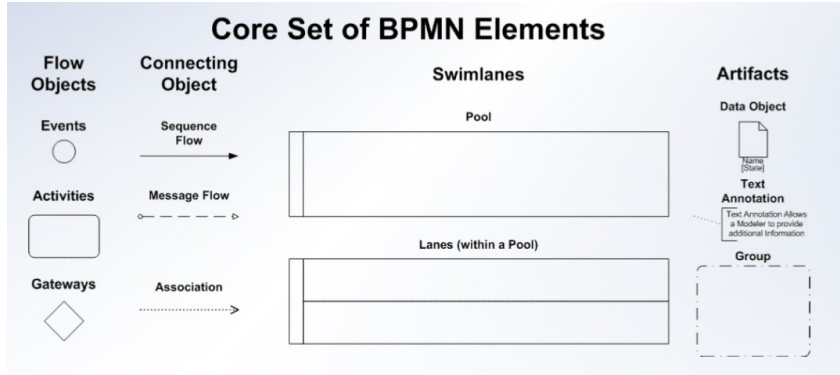


Challenges

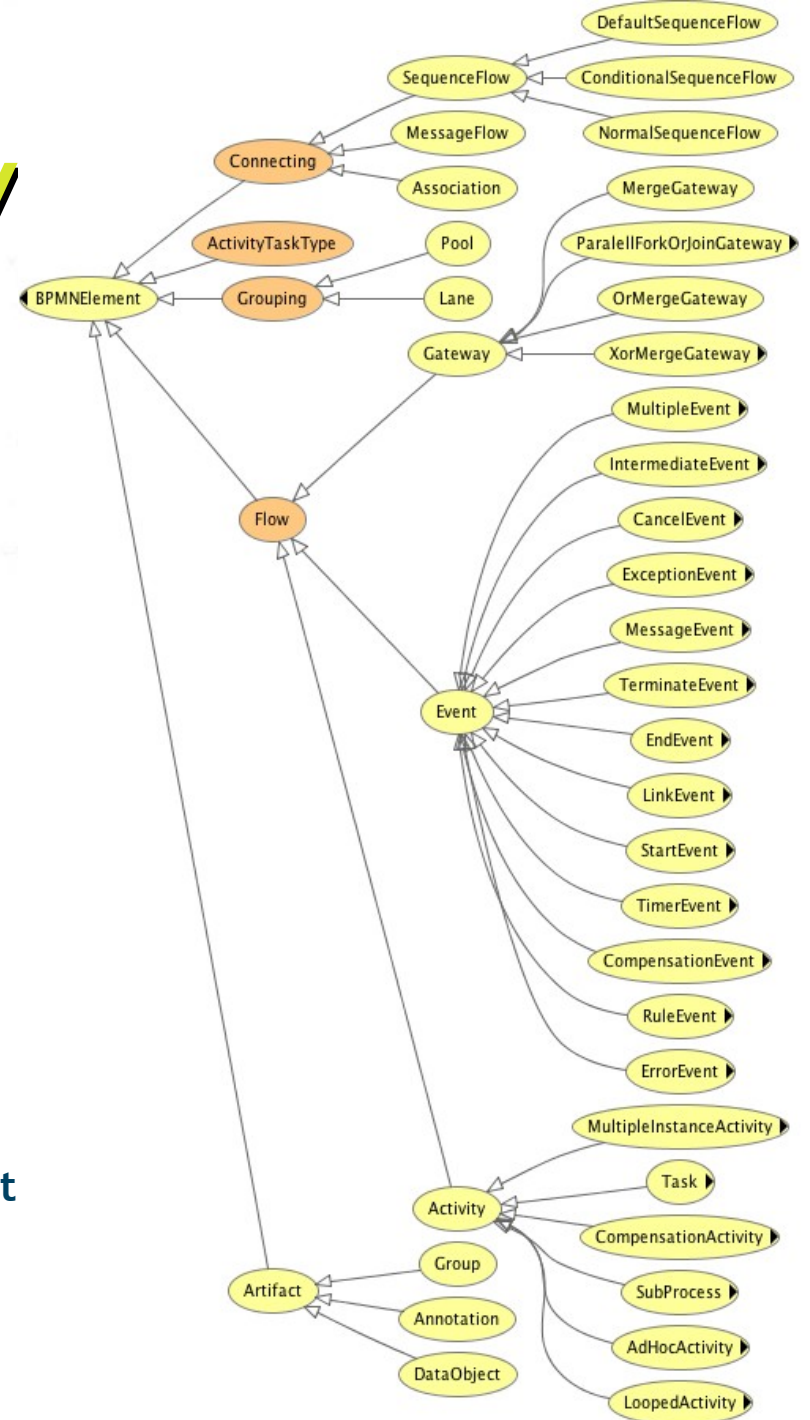
- Information overflow
- Loss of intellectual capital
- Work process improvements

"Understand the work processes that create the data" - Jim Compton, Chevron

A BPMN ontology

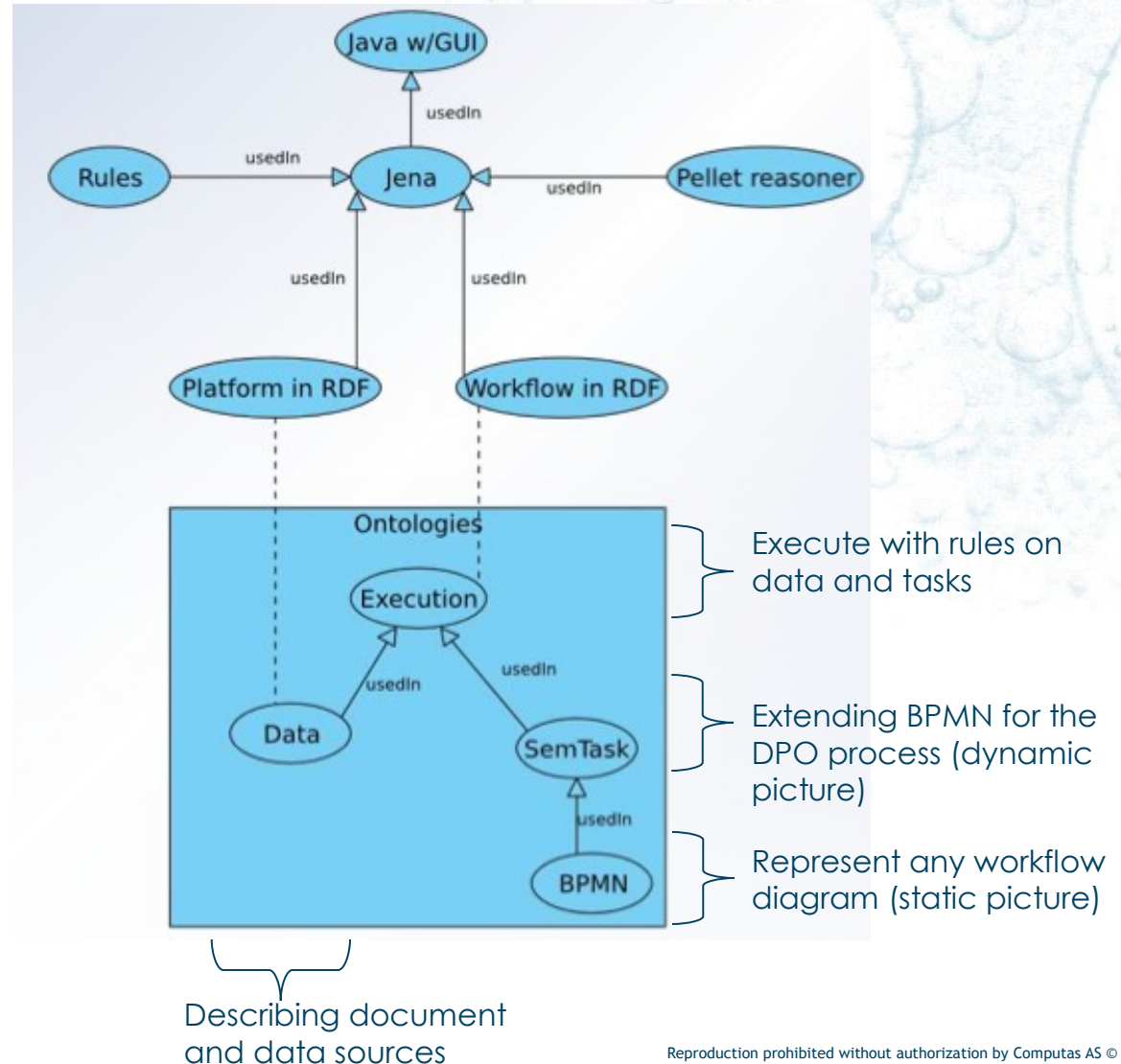


The *Business Process Definition Metamodel (BPDM)* is a newly released process definition standard that provides full support for all BPMN objects, BPDM will be incorporated into the BPMN standard as its default interchange format BPDM has not been considered here.



Why?

- **Processes and data are treated in the same model!**
- Foundation in set theory and description logic.
- Extensability
- Consistency check on diagrams
- Data may lead to the execution of activities
- Unambiguous syntax
- Tool support



Conclusions

- **Work processes are related to Knowledge Management, in that a process can be seen as codified piece of “know-how” knowledge**
- **We believe that efficient support for work execution, will result in dramatic improvements in increased productivity, reduced cost, and enhanced HSE.**
- **Furthermore, we believe that Semantic Web Technologies can be a key enabler to achieve those benefits.**
- **We support the creation of a Oil and Gas Interest Group**

...other Semantic Web activities



- Fagressurs
- Dokumentar
- Kortdokumentar
- Tid
- 1940-1949
- 1900-1909
- Spillefilm
- Genre

Gamlebyen

Følg utgravninger og trafikkregulering i Gamlebyen hvor det opprinnelige Oslo lå. Arkeologene går under jorda, fremtiden avdekker fortiden.

Fagressurs

- VIS ALFABETISK
- VIS KRONOLOGISK
- VIS POPULÆRE

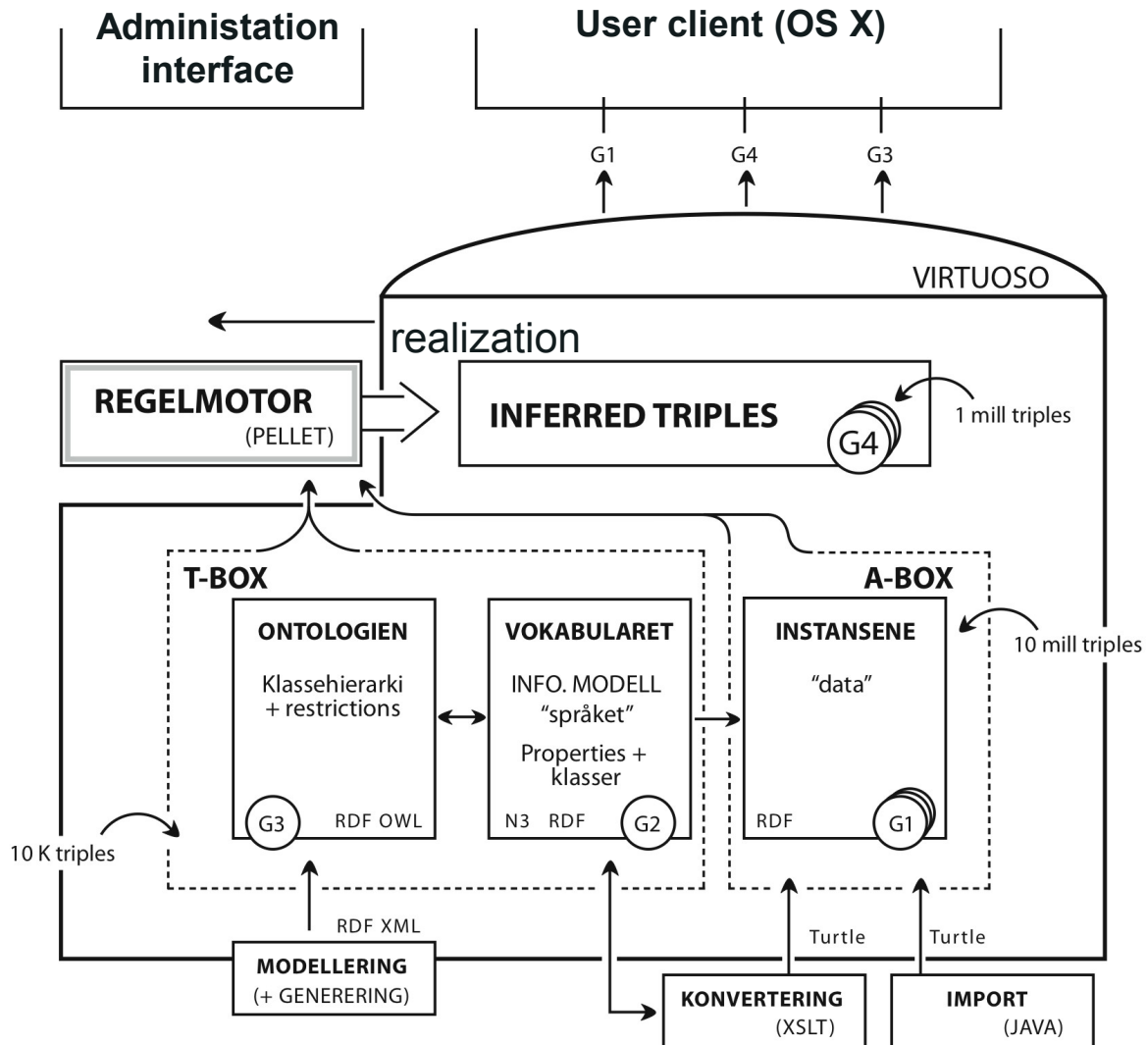
- KUN FILM
- KUN LYD
- KUN BILDER
- KUN TEKST
- BARE NORSK
- MEST FOR BARN

1850 1860 1870 1880 1890 1900



Gamlebyen

Proof of concept



Semantic Days

2009, May 19-

20 International
conference in
Stavanger

- Focus on Semantic Technologies in the oil & gas industry
- StatoilHydro, Shell, Chevron, ...



Conference programme

Semantic Days 2008

Clarion Hotel Stavanger
21 – 23 April

Free tutorials 21 April and ordinary programme 22 and 23 April

Semantic Days is an annual conference that has become a meeting place for industrial use of Semantic Web technologies with significant contribution also from research institutions and universities.

Semantic Days 2008 focuses on development, use and benefits of Semantic Web technologies in:

- Oil & Gas Industry
- Universities and research institutions
- Capital intensive projects across industries
- IT industry
- Defence and defence industry

Three tutorials on Semantic Web technologies will be given Monday 21 April, the day before the conference.

Organizers

Two global organizations:

The World Wide Web Consortium (W3C) and the POSC Caesar Association (PCA)

Four international companies:

Det Norske Veritas (DNV), IBM, National Oilwell Varco (NOV) and StatoilHydro

Nine Norwegian organizations and companies:

OLF (The Norwegian Oil Industry Association), Abelia (Business Association of Norwegian knowledge- and technology based enterprises), Computas, FSI (Business Association of Norwegian defence and safety based enterprises), NorStella, Norwegian Defence, SINTEF, Standards Norway and University of Oslo



Semtask

- A. Blomskøld, F. Klingenberg: SemTask Semantic Task Support in Integrated Operations, MSc. Thesis, Univ. of Oslo, Dept. of Informatics, Aug. 2008
 - An architecture for SemTask, an active support system for work processes based on Semantic Web technology
 - An OWL-DL ontology for BPMN, resulting in a standard storage format (serialization) for BPMN diagrams
 - Description of (parts of) a Daily Production Optimization work process in BPMN/RDF
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