HFC – forum for human factors in control

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RAPPORT

TITTEL

Menneskelige og organisatoriske faktorer i ulykkesgranskning Resultater HFC Forum, 20. til 21.Oktober 2010, møte #12.

FORFATTER/REDAKTØR

Johnsen S. O.

OPPDRAGSGIVER(E)

HFC forum

RAPPORTNR.	GRADERING	OPPDRAGSGIVERS REF.	
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ARKIVKODE	DATO	GODKJENT AV (NAVN, STILLING, SIGN.)
	26/10-2010	Ringstad, A.J./Statoil

SAMMENDRAG

Denne rapporten dokumenterer presentasjoner, artikler, agenda og deltakerliste fra HFC forum møtet den 20.-21.Oktober 2010 i Stavanger (møte nr 12). De vedlagte presentasjonene er:

J.E.Vinnem	Status/Siste nytt fra gransking av ”Deepwater Horizon”
M. Broadribb	Organizational and Human Factors in Accident Analysis
J.Bunn	Toolbox Talk ”MTO faktorer i ulykkesgranskinger.”
H.Halvorsen	SfS nye veiledning for beste praksis ved granskning av HMS hendelser
F.Strand, J.C.Rolfsen	Air Safety Through Investigations – Bridging Theory and Practice
T. Foss	Medias rolle i dekning av ulykker
Besøk i beredskapssentralen Acona	
H.Alm	Duk i Buk
L. Hansson	Organisasjonsmessige faktore - kvalitetstap over grensesnitt
K. Mearns	Closing the loop between HF in accident investigation and CRM
R.Tinmannsvik	Læring av ulykker
H.Heber	Menneskelige og organisatoriske faktorer i ulykkesgranskingen
C. Weikert, L. Kecklund	Säkerhetskultur, organisation och ledarskap
M. Hessaroeyeh	Short presentation of my master thesis
Workshop – Ulykker v.s. Resilience	

STIKKORD	NORSK	ENGELSK
GRUPPE 1	Menneskelige Faktorer	Human Factors
GRUPPE 2	ISO 11064	ISO 11064
EGENVALGTE	Sikkerhet	Safety

INNHOLDSFORTEGNELSE

1 Evaluering av møtet og innspill

1.1 Innledning

I denne rapporten gis en evaluering av HFC møtet, deltakerliste og presentasjonene fra møtet den 20.-21.oktober i Stavanger. I det nedenstående har vi sakset inn korte punkter fra de evalueringene som deltakerne leverte inn.

Vi minner samtidig om mulighetene for å ta kurset ”*Introduksjon til Human Factors og integrerte operasjoner*” våren 2011. Planlagte datoer i 2011 er første samling 8.,9.og 10. februar; andre samling 15., 16., 17. og 18. mars; tredje samling den 26., 27. og 28. april. Påmelding er via: *videre.ntnu.no/link/nv12296.*

1.2 Evalueringer

Generelt synes det som om de fleste er godt fornøyd med HFC møtene og formen som benyttes, med samling over to dager. Kommentarene vi får er generelt konstruktive og positive, med gode tilbakemeldinger på det faglige og sosiale utbytte. Forumet er bredt med mange forskjellige deltakere, og utfordringen er å gi alle noe, både forskere, konsulenter og industrideltakere. Vi får derfor et bredt sett av innspill med forskjellige meninger.
Tilbakemeldingene gikk i hovedsak ut på at programmet var vellykket og foredragene fikk generelt meget god tilbakemelding. Det var gode foredrag, god servering og interessante deltakere som gjør det mulig å få til konstruktive diskusjoner.

1.3 Formen på HFC møtene

Tilbakemeldingene er generelt positive til formen på møtene. Det ble påpekt denne gangen at det var viktig med tid til debatter, og litt lengere opphold mellom de forskjellige innleggene.

1.4 Samarbeid med HFN i Sverige

HFN nettverket fra Sverige vil fortsatt gjerne delta og bidra inn i møtene, men ber samtidig om at vi fra Norge deltar inn i de seminarer og møter som HFN arrangerer. Det vises til http://www.humanfactorsnetwork.se/indexcoursesWork.html, spesielt:
“From Safety Culture to Safety Intelligence” i Linköping, Sweden, November 22-23, 2010. Med Barry Kirwan, EUROCONTROL, Dr Kathryn Mearns, Aberdeen University samt Ms. Laura Fruhen, Aberdeen University.

> Safety culture is in fashion today in several industries including air traffic management, but what really is safety culture about? Can it really be measured reliably and, more importantly, can it be changed for the better leading to improved safety? These are key questions which will be addressed by the presenters drawing from two industries in particular, air traffic management and the petrochemical industry.

“CRM Seminarium” i Linköping, Sweden, November 24-25, 2010. Med Norman MacLeod, Training Developer and CRM facilitator.

> Det diskuteres vad CRM innebär i verkligheten, vad det betyder att en operatör använder CRM som ett säkerhetsverktyg. Vidare hur CRM är länkat till SMS (Safety Management System). Carl-Johan Wallin kommer att presentera erfarenheter från användningen av CRM inom sjukvården: "CRM för sjukvården: Träning i interprofessionellt samarbete med patienten i centrum".

1.5 Tema og forelesere til de neste HFC møtene

Vi har i tidligere plannotat skissert følgende grove møteplan for HFC møtene, ref tabell-1.

Tabell-1: Tema og forelesere i HFC forum foreslått tidligere

Periode	Forslag til tema og forelesere
Vår 2011	HF i endringsprosesser, "Design for resilience", Perspektiver som Actor-network theory (ANT) i HF granskninger.
Høst 2011	Inntog i det globale: Språk, kultur, tidsforskjell, HF i global setting.
Vår 2012	Fokus på HF i andre land, som USA og Sørøst Asia – erfaringer, muligheter og trusler

Av tema som ble trukket frem som spesielt interessante til neste møte, kan nevnes:

- "Utfordringer og løsninger knyttet til HMI design og HMI designprosess".
- Hva er god vs dårlig HMI, og hvordan skal man designe god HMI.
- Nye grensesnitt og ny teknologi, i.e. "HMI, visualisation tools and interaction design".
- Sikkerhetsklima og psykososialt arbeidsmiljø som risikofaktor.
- Hvordan skal man få til innovasjon i dagens olje og gass miljø?
- Hvordan støtte tverrfaglighet og teamarbeid i fremtidens løsninger?
- Beste praksis innen HMI. Hvordan implementere menneskelige og organisatoriske aspekter i totalrisikoanalyser (TRA/TRABA)?
- Human Factor og resilience, safety i boring, spesielt i lys av ulykker som "Deep Horizon" er interessant
- Google har fjernstyrt biler over 140,000 miles verden over uten ulykker, hvordan er HMI og løsninger utformet for å ivareta sikkerheten?
- Hva er utfordringer og teknikker som kan benyttes ved utforming av HMI løsninger ved sentraliseringer – eks når mange lokale flyplasser skal styres via en sentral kontroll?

Av forelesere ble følgende nevnt (eller har vært trukket frem tidligere uten at de har fått plass):

- Ronald L. Boring (Human Reliability Analysis), C. Weick eller J.Reason, K. Haukelied.
- Fra følgende miljøer hadde det vært spennende: Fraunhofer FKIE(Tyskland), MIT User Interface Design Group (USA), VTT (Finland).
- HFS – Dr. Jørgen Frohm, HCD – Marie/Mark Green. Frode Heldal, Sverre Kvalheim fra Safetek. Ingrid Danielsson – ønskes mht interaksjonsdesign.
- J.Frohm eller K.Gould – Automasjon eller lean production.
- M.Endsley (Situational awareness), G.R. Hockey fra Univ of Leeds, Mark Young.
- Interessant å utvide HF mot community of practice og praksisfellesskap som J.S.Brown, P.Duguide – eks. hvordan mobiliserer man et praksisfellesskap?

1.6 Kontakt opp mot Human Factors fagnettverket i Europa og USA

For de som er interessert i faglig kontakt opp mot Human Factor nettverket i Europa og USA viser vi til: *hfes-europe.org* – som er den europeiske Human Factors and Ergonomics Society. Beskrivelse: "*HFES - The Human Factors and Ergonomics Society, Europe Chapter, is organised to serve the needs of the human factors profession in Europe. Its purpose is to promote and advance through the interchange of knowledge and methodology in the behavioural, biological, and physical sciences, the understanding of the human factors involved in, and the application of that understanding to the design, acquisition, and use of hardware, software, and personnel aspects of tools, devices, machines, equipment, computers, vehicles, systems, and artificial environments of all kinds.*" HFES er tilknyttet den internasjonale Human Factors and Ergonomics Society, Inc. Se *www.hfes.org*.

Deltakerliste og påmeldte fra HFC møtet 20-21/10 2010

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Status fra gransking av "Deepwater Horizon"

J.E.Vinnem

Mere informasjon:
Fra Berkley, se http://ccrm.berkeley.edu/deepwaterhorizonstudygroup/dhsg_articles.shtml

Fra BP http://www.bp.com/sectiongenericarticle.do?categoryId=9034902&contentId=7064891

HFC-forum

Menneskelige og organisatoriske faktorer i ulykkesgranskning

20-21. oktober 2010

Status fra gransking av ”Deepwater Horizon”

Professor II Jan Erik Vinnem

Preventor AS/UiS

Deepwater Horizon Study Group (DHSG), UC Berkeley

Pres HFC 20102010 1

Preventor
Risk management research and development

Oversikt – presentasjon

- Fakta om Macondo
- Oversikt over rapporter og granskninger
- BP interngranskning
- Bakenforliggende årsaker
- Kritiske operasjoner i boring
- Forbedring av granskninger

Pres HFC 20102010 2

Preventor
Risk management research and development

Brønnen

- 19 mars 2008
  - BP (65%) og Anadarko Petroleum (25%) og MOEX offshore (10%) tildelt lisensen av MMS (lease-salg)
- 6 april 2009
  - BPs utforskningsplan godkjent av MMS
- 22 mai 2009
  - BP fikk boretillatelse av MMS
- 6 oktober 2009
  - Boring av MC 252 startet med Marianas (semisub, Transocean)
- 8 november 2009
  - Marianas fjernet fra Macondo brønnen pga skader fra orkanen Ida

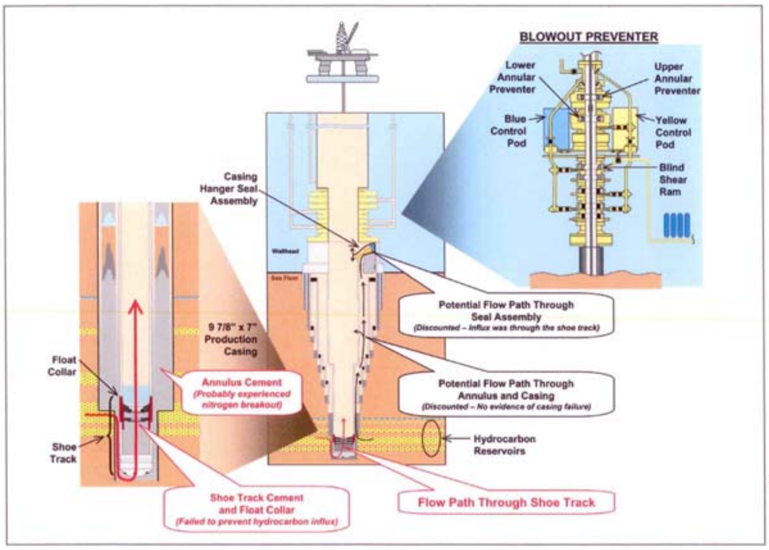
Brønnen

- 14 januar 2010
  - BP fikk godkjent revidert plan for boring av brønnen i forbindelse med skifte av boreinnretning
- 31 januar 2010
  - Deepwater Horizon (Transocean) ankom Macondo brønnen
- 6 februar 2010
  - Deepwater Horizon startet med å fullføre boringen av Macondo brønnen
- 9 april 2010
  - Boreoperasjonene ferdig, logging, opprenskning, produksjonsforingsrør kjørt & sementert

Noen fakta om ulykken

- Ulykken, 20 april 2010
  - 21.40 Borevæske ut på boredekk
  - 21.41 Sprut opp i boretårn, BOP aktivert
  - 21.47 Første gassalarm
  - 21.49 Første eksplosjon, antenning i maskinrom(?)
  - 21.57 Forsøk på frigjøring av stigerør oppgitt
  - 22.00 Evakuering starter
- Utfall
  - 11 omkomne, 17 skadde, alle overlevende evakuert, hovedsakelig i livbåter
  - DH sank 36 timer etter eksplosjonen
  - Utblåsning, ca 650.000 tonn utslipp, 87 dager

Macondo brønnen



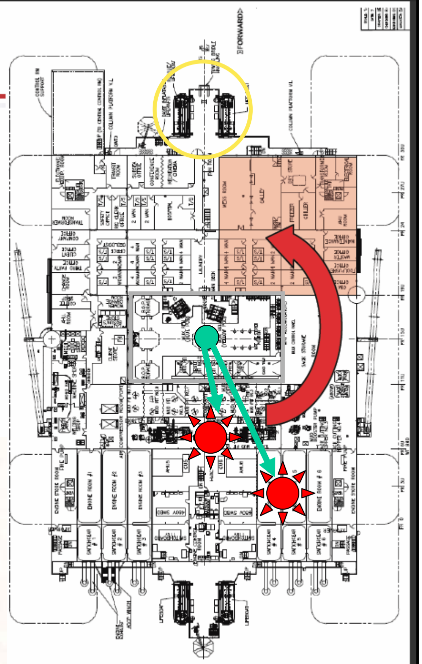
Kilde: BP report (8.9.10)

Evacuation & Response

- **From witness statements**
  - Most damage on 2nd deck, starboard side *(light red area)*
  - Believed blast moved forward from pit/pump rooms through sack room and then into accommodations
  - Main deck significantly damaged on starboard side, fire aft of derrick
- **Areas to evaluate**
  - Muster and orders to evacuate
  - Launching of boats
  - Recovery of personnel
  - Supply boat impact
  - Shore-based response

'Are you f--king happy? Are you f--king happy? The rig's on fire! I told you this was gonna happen.'

Deepwater Horizon installation manager JIMMY HARRELL, on a satellite phone call to Houston as the rig was exploding.



Transocean

DRAFT – WORK IN PROGRESS – SUBJECT TO ADDITIONAL INVESTIGATION AND REVISION

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Framlagte rapporter så langt

- Dept of the Interior ("Salazar rapport")
  - Increased safety measure for energy development on the Outer Continental Shelf, May 27, 2010
- BP
  - Deepwater Horizon Accident Investigation Report, September 8, 2010
- Deepwater Horizon Study Group (DHSG), UC Berkeley, Center for Catastrophic Risk Management (CCRM)
  - Progress Report 2, Deepwater Horizon Study Group, July 15, 2010

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Preventor
Risk management research and development

Granskninger mv

- Pågående granskninger
  - Chemical Safety Board
    - rapport forventes 18.06.12
  - Deepwater Horizon Joint Investigation, (U.S.Coast Guard/ DoI)
    - rapport forventes 27.01.11
  - National Commission on the BP Deepwater Horizon Spill and offshore Drilling. (”Presidential Commission”, “Graham-Reilly Commission”)
    - rapport forventes 12.1.11
  - U.S. Dept of Justice (Civil Division & Criminal Division)
  - National Academy of Engineering / National Research Council
  - National Institute for Occupational Safety and Health
- Andre studier
  - University of California, Berkeley, Center for Catastrophic Risk Management (CCRM)
    - rapport planlegges publisert 1.12.10

Fra BPs rapport (8.9.2010)

Barrier failures (”Eight key findings relating to the causes…”):

1. The annulus cement barrier did not isolate the hydrocarbons
2. The shoe track barriers did not isolate the hydrocarbons
3. The negative pressure test was accepted although well integrity had not been established
4. Influx was not recognized until hydrocarbons were in the riser
5. Well control response actions failed to regain control of the well
6. Diversion to the mud gas separator resulted in gas venting onto the rig
7. The fire and gas system did not prevent hydrocarbon ignition
8. The BOP emergency mode did not seal the well

Hendelser, vurderinger

- Under boringen
  - Poretrykk og oppsprekningstrykk i formasjonen som var forskjellig fra grunnlaget for det opprinnelig brønndesignet, foringsrør settedyp måtte forandres, flere forandringer i det opprinnelige boreprogrammet
  - Brønnkontrollsituasjon medførte teknisk sidestegsboring (alt godkjent av MMS)
- Produksjonsforingsrør (9 7/8"x 7") ble kjørt og sementert
  - Besluttet av Macondo brønngruppe, at en ikke trengte å kjøre en Cement Bond Log (CBL)
  - I strid med BPs krav for verifisering av sement bak foringsrør

Hendelser, vurderinger

- Produksjonsforingsrør trykktestet og godkjent i henhold til plan
- 20. april kl 19.55
  - Negative trykktesten (trykk i produksjonsforingsrør er lavere enn formasjonstrykk) av produksjonsforingsrøret godkjent selv om det kan stilles spørsmål ved godheten av prosedyre og resultater
- Fortsatte med å erstatte borevæsken i stigerøret med sjøvann
  - Selv om det under denne operasjonen kom uklare og alarmerende signaler fra brønnen

Bakenforliggende årsaker - BP

- Diskuteres ikke direkte i rapporten
- Anbefalinger (ofte relevant)
  - BP
    - Procedures and Engineering Technical Practices
    - Capability and competency
    - Audit and Verification
    - Process Safety Performance Management
  - Contractor and Service Provider Oversight and Assurance
    - Cementing Services Assurance
    - Well Control Practices
    - Rig Process Safety
    - BOP Design and Assurance

Fra DHSG Progress Report No 2

- ” The DHSG analysis of this information indicates these failures (failures to contain, control, mitigate, plan, and clean-up) appear to be deeply rooted in a multi-decade history of organizational malfunction and shortsightedness.”

Fra DHSG Progress Report No 2

- "There were multiple opportunities to properly assess the likelihoods and consequences of organizational decisions (i.e., Risk Assessment and Management) that were ostensibly driven by the management's desire to "close the competitive gap" and improve bottom-line performance."

Fra DHSG Progress Report No 2

- " Consequently, although there were multiple chances to do the right things in the right ways at the right times, management's perspective failed to recognize and accept its own fallibilities despite a record of recent accidents in the U.S. and a series of promises to change BP safety culture."

Fra interim presentasjon (juni, 2010)

- …it is clear best practices were not followed:
  - The well design was marginal
  - Human errors in judgment were made at very key operational decision points
  - Warning signs were overlooked on the rig
  - There may have been some failure of equipment
- This was all preventable by following currently in place standard practices

Bakenforliggende årsaker

- Underlag for å konkludere på bred basis i forhold til bakenforliggende årsaker er pt ikke tilgjengelig
- Ikke tilrådelig å spekulere over baken-forliggende årsaker
- Må utstå inntil granskningsrapportene foreligger
- Peke på noen viktige forhold på generell basis

Årsaker til hydrokarbonlekkasjer

Grouped according to BORA structure:

A. Technical degradation of system

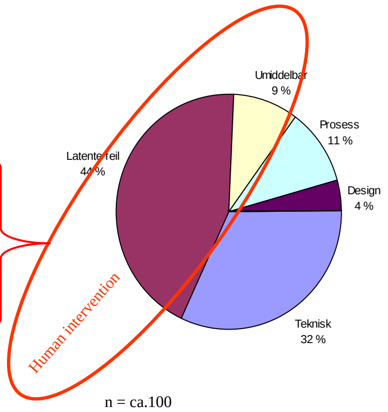
B. Human intervention introducing latent error

C. Human intervention causing immediate release

D. Process disturbance

E. Inherent design errors

F. External events



n = ca.100
Plattformer norsk sokkel
2001-2005

Hva er utfordringene i boreoperasjoner (fra et synspunkt om å forebygge storulykker)?

- Risiko_OMT
  - NFR/Statoil, 2007-2010(11)
  - Hovedvekt på kvalitative og kvantitative modeller for hydrokarbonlekkasjer
  - Kvalitative modeller for tap av brønnkontroll
  - Kvalitative modeller for marine hendelser som kan gi storulykker

Hva er utfordringene i boreoperasjoner (fra et synspunkt om å forebygge storulykker)?

- Risiko_OMT
  - Kvalitative modeller for tap av brønnkontroll
    - Aspekter med stor betydning:
      - Godhet av planlegging og forberedelse av boreoperasjoner
      - Styring av endringer under gjennomføring av boreoperasjoner
    - Ref Snorre A
      - Feil under planlegging og forberedelse
        - » ”Det generelle bildet som fremkommer på grunnlag av materialet som er samlet inn og gjennomgått, er at Snorre A er en organisasjon som har vært drevet med relativt høy operasjonell risiko. Denne operasjonelle risikoen oppstår i samspillet mellom systemkritiske aktiviteter og svake organisatoriske sikkerhetsbarrierer.” (Statoils årsaksanalyse)

Nylige initiativer fra myndighetene

- BOEMRE*
  - Drilling Safety Rule (30.9.10)
  - Safety & Environmental Management Systems Rule (15.11.10)
    - Make mandatory API RP75, Development of a Safety and Environmental Management Program for Offshore Operations and Facilities
      - wrt operations and activities under the jurisdiction of BOEMRE
    - This final rule will apply to all OCS oil and gas and sulphur operations and the facilities under BOEMRE jurisdiction
      - including drilling, production, construction, well workover, well completion, well servicing, and DOI pipeline activities
- Moratorium løftes (12.10.10)
  - Forutsatt at alle påbud imøtekommes (inkl Drilling Safety & SEMS rules)

*Bureau of Ocean Energy Management, Regulation and Enforcement

Forbedring av granskning av storulykkestilløp

- Granskninger av tilløp til storulykker forholder seg normalt ikke til kvantitative risikoanalyser
  - Mange eksempler fra norsk sokkel
- Underkommunikasjon av potensial i hendelsene
  - Bevisst eller ubevisst?
  - Medvirker til lav risikoforståelse

Eksempel - hydrokarbonlekkasje

- Lekkasje i brønnhodeområdet, 2008
  - Høyt trykk, høy strømningsrate
  - Flere alvorlige tilsvarende lekkasjer siste 10 år
  - 1520 kg gass/olje, 5 min varighet
  - 26 kg/s maks strømningsrate
  - 3. største prosesslekkasje på norsk sokkel siden 1996
- Klassifisering i hht selskapsintern granskning:
  - Faktisk konsekvens: Uantent lekkasje, ingen personskade
  - Potensiell konsekvens: lik faktisk, ingen personskade
    - ”Basert på dette vurderes det ikke å være mulig brann/eksplosjon ved ubetydelig endrede omstendigheter.”

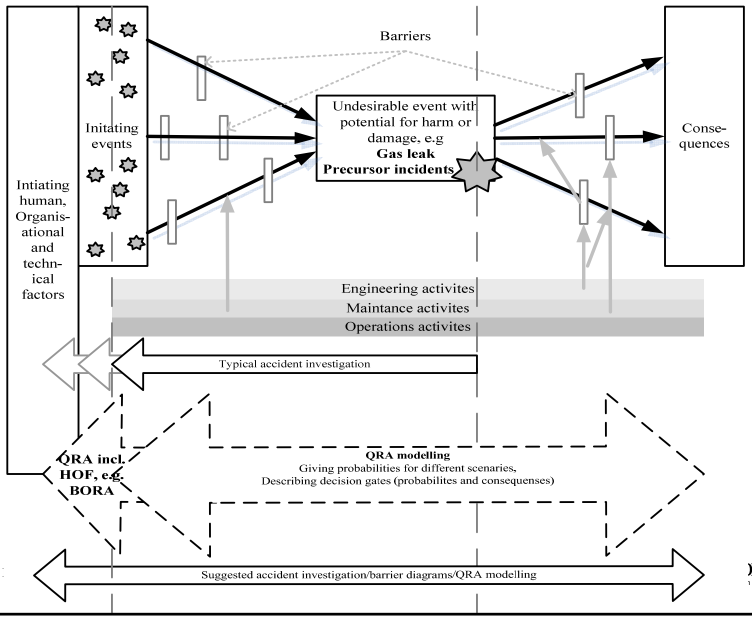
Forbedring av granskninger

- Underkommunikasjon av potensial i hendelsene
  - Gjennomgått ca 20 granskede lekkasjer, 08-09
  - Uheldig definisjon av ”ubetydelig endrede omstendigheter”
    - 50% sannsynlighet for å inntreffe (P(ign) << 50%)
    - Ikke i hht regelverk
  - Medfører
    - Utilstrekkelig fokus på konsekvenser av f.eks. antent lekkasje
  - For svak kobling til QRA/TRA

Forbedring av granskninger

- Dersom risikoanalysene ble konkret og detaljert utnyttet i granskninger:
  - Ville kunne vise konkrete tapspotensial for tilløpshendelser
  - Kunne være en god måte å forbedre både granskning og risikoanalyser
  - Mulighet for å øke risikoforståelse og bevissthet om storulykkesmekanismer

Modell for integrasjon med QRA



Kilde: Skogdalen & Vinnem (2010)

Oppsummering

- BP har påvist 8 tekniske barrieresvikt i Macondo utblåsningen
- Prematurt å konkludere om bakenforliggende årsaker
- Godhet av planlegging og endringsledelse kritiske operasjoner i boring
- Granskning av tilløpt tilstorulykkeshendelser kan få et løft ved kombinasjon med kvantitative risikoanalyser

HFC

"Organizational and Human Factors in Accident Analysis "

M. Broadribb

Mere informasjon:
Fra Wikipedia http://en.wikipedia.org/wiki/Texas_City_Refinery_explosion

Organisational and Human Factors in Accident Analysis

HFC Conference

Stavanger, October 2010

Mike Broadribb
BAKER ENGINEERING AND RISK CONSULTANTS, INC.

BAKERRISK

BAKERRISK

Some people have forgotten the limitations of management systems. All that a system can do is harness the knowledge and experience of people.

Knowledge and experience without a system will achieve less than their full potential. Without knowledge and experience, even the best system will achieve nothing.

Trevor Kletz

Introduction

- Most incidents involve human factors
- Often key causal factor for persons involved in the incident
- Understanding performance shaping factors essential for good investigations
- Human factors can affect other aspects of the investigation
- Examine human factors from the standpoint of all stakeholders

Persons involved in the Incident

- Managers are not human!
- Underlying site culture

Underlying Cultural Issues

- **Business Context**
  - Motivation
  - Morale
- **(Process) Safety as a Priority**
  - Emphasis on Environment and Occupational Safety
- **Organisational Complexity & Capability**
  - Investment in People
  - Layers and Span of Control
  - Communication
- **Inability to See Risk**
  - Hazard Identification Skills
  - Understanding of Process Safety
  - Facility Siting
  - Vehicles
- **Lack of Early Warning**
  - Depth of Audit
  - KPI's for Process Safety
  - Sharing of Learning / Ideas

Persons involved in the Incident

- Human behaviour
- Peer relationships
- Communication

Witnesses

- Least reliable evidence?
- Evidence hierarchy
  - DCS / PI data
  - Paper / electronic documents
  - Multiple witness statements (where consistent)
  - Visual inspection (possibly disturbed by emergency response)
  - Process sample analysis (possibly changed by delay in sampling)
  - Process equipment testing (possibly damaged/changed by incident)
  - Single uncorroborated witness statement
- Interview techniques
- Interview location
- Sometimes no eye-witness

Workforce

- Managers always know best!

Workforce

- Managers always know best!
- Impact on workforce
- Impact on those in authority
- Contractors

Agencies

- Major incident - multiple agencies involved
- Impact on investigation
- Suspicion of foreign company?
- Interest in root causes?

Local Community

- Human behaviour
- Communication

Industry

- Lessons learned
- Communication

Media

- Surveillance
- Headlines and story

Legal Representation

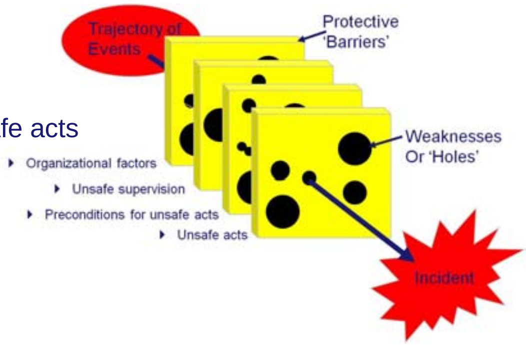
- Impact on investigation
- Lawyers on team?
- Civil / criminal lawsuit
- Public inquiry

Investigation Team

- Objectivity
- Planning
- Organised labour
- Manage evidence
- Manage emotions
- Methodologies for incorporating HF

Methodologies

- Checklists
  - Organisational factors
  - Unsafe supervision
  - Preconditions for unsafe acts
  - Unsafe acts
- ABC Analysis
  - Antecedent
  - (Intended) Behaviour
  - Consequence
- Human Error Analysis
  - Unintended Behaviour
  - QRA
  - Cognitive control theory



Summary

- Human factors influence most incidents
- Human factors can affect the success of incident investigations
- Investigation team needs to manage stakeholders' expectations

HFC

Toolbox Talk: ”MTO faktorer i ulykkesgranskinger”

J. Bunn

Mere informasjon:
HSE Major Hazards website: http://www.hse.gov.uk/comah/

Human & Organisational Factors in Incident Investigations

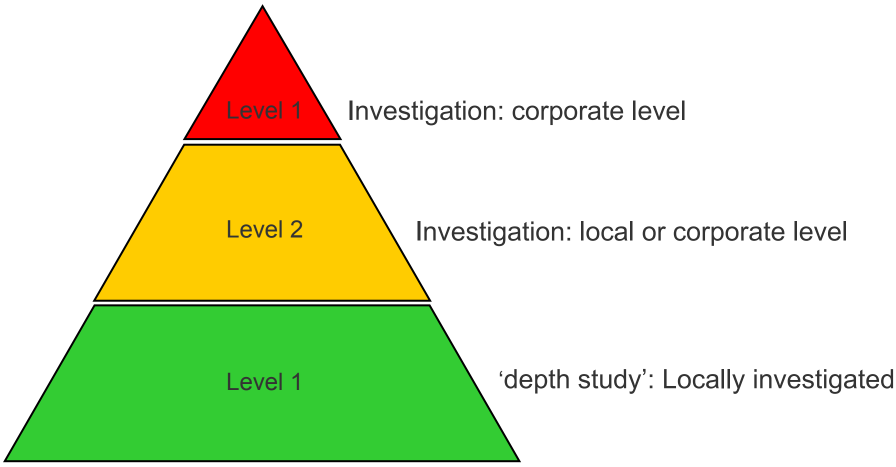
James Bunn

Investigation Career to date

- Educational background: BSc Psychology, MSc Ergonomics
- UK Health & Safety Executive – Ergonomist/Human Factors specialist
  - 9 Fatal incident investigations
  - 3 Serious injury incident investigations
  - Various industries, diverse incident types
  - Supplying evidence as an *expert witness*
- Statoil - Ergonomist/Human Factors specialist
  - 4 incident investigations to date
  - More process-focused, but not exclusively

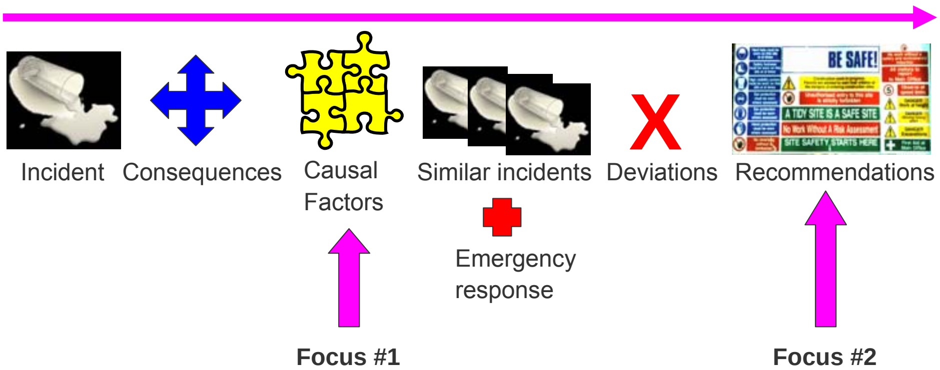
Investigations in Statoil – a coarse overview

Classified according to actual + potential consequences



Statoil Investigation Elements & Philosophy

Work process proceduralised in governing document system

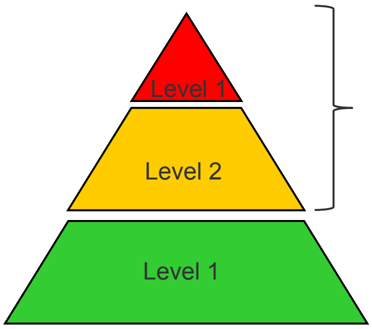


Key deliverables specified in investigation mandate

Human Factors Focus

Resources

Technical discipline specialists



Corporate audit inspectors

- HFAT Training
- Interview technique
- HF Course

Local Investigation team

- HFAT Training
- Interview technique

The Human & Organisational Factors Specialist Role

- What about leadership?
- Was training adequate?
- Was there a poor safety culture?
- Missing communication?
- Could the injured person be seen?
- Understanding of risk?
- Poor interfaces with equipment?
- Were there (adequate) procedures?
- Why did the person react that way?

Fieldwork – practical matters

- Try to get 100% workload allocation to the investigation – inform projects and leaders
- Get out to site as soon as possible
- 'Bli med': Get a deeper understanding by taking part in the technical investigation
- Attend as many interviews as you can, and set questions
- Go outside to look around the incident site – ask 'stupid' questions
- Share information as you work – explain what and why
- Focused, professional, but approachable

Gathering H & O Evidence

- **Pictures Pictures <u>Pictures</u>**
- Interviews: semi structured, various levels in organisation
- Organisation chart: who interfaces with who
- SCADA system data: what happened and when
- Shift logs
- Permits to work
- Training records
- Relevant procedures (if available)
- Change / modifications
- Roles and responsibilities

Statoil

A Starting point for interviews: 14 Keywords

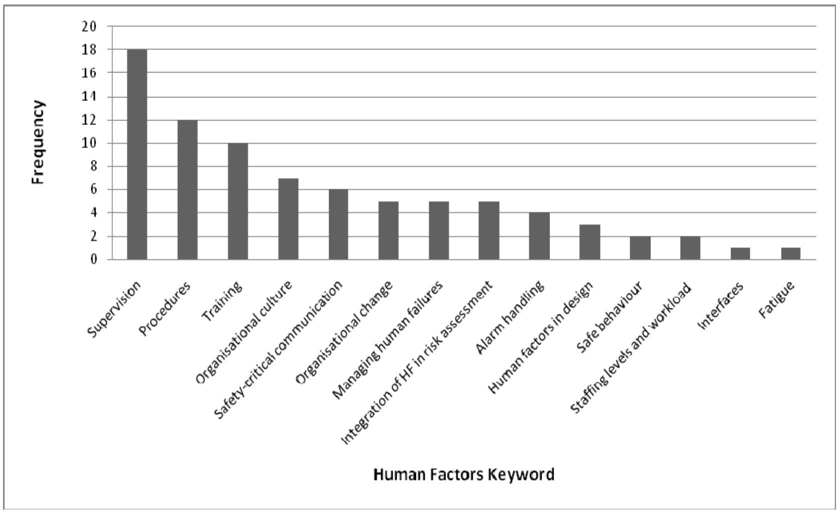
HSE *Major Hazards* website

- **Alarm handling**
- **Interfaces (human-machine)**
- **Safety-critical communication**
- **Supervision – management, leadership, & control**
- **Safe behaviour**
- **Procedures**
- **Training and competence**
- **Organisational change**
- **Staffing levels and workload**
- **Managing human failures**
- **Fatigue from shiftwork and overtime**
- **Organisational culture**
- **Integration of Human Factors into risk assessments and investigations**
- **Human Factors in design**

Statoil

Distribution of HF keywords (Norway offshore):

2009 Hydrocarbon Leakages Project



Clear mix of HF and Organisational Factors at micro and macro scale

Analyses – some useful tools and methodologies

- **Task Analysis** – key to understanding direct HF causes
- **HFAT** (Human Factors Analysis Tools) – framework for HF
- **Fatigue/Risk Index** – Individual focus based on shift data
- *Quantitative HRA*: HEART, SPAR-H, - Likelihood of failure
- **Alarm Systems**: EEMUA 191 Guidance – Alarm flooding
- Conspicuity, glare, other **visual factors** – direct cause
- **Global People Survey** – can show up troubled organisations

Quantitative analyses interface well with engineering disciplines

HFAT (Human Factors Analysis Tools)

The Keil Centre, Edinburgh

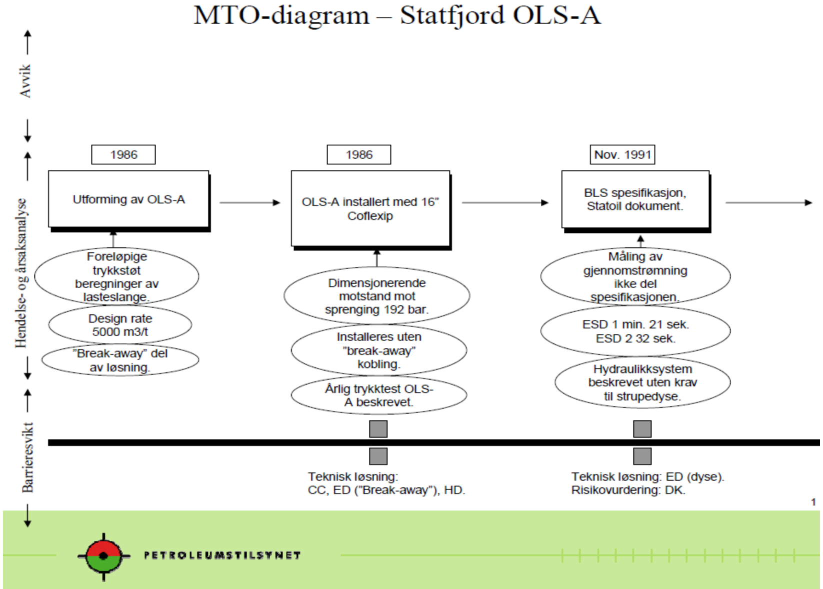
Behaviour

- Intentional → ABC* Analysis → Desired A+C → **Recommendations**
- Unintentional → Human Error Analysis → **Recommendations**

Human Error Analysis
↓
Error type, mode, mechanism
↓
Performance Shaping Factors (PSFs)

* Antecedents, Behaviour, Consequences

MTO-diagram – Statfjord OLS-A



MTO - Organising Information and Knowledge

Report Writing

- Stick closely to facts
- Respect the potential audience – tell the 'story' in an inclusive way
- Use a logical progression to introduce evidence and arguments
- Write clearly, efficiently, and directly - break up lengthy text
- Avoid jargon
- Avoid journalistic clichés and dramatic language
- Use images, figures, and tables
- Be a strict editor of your output

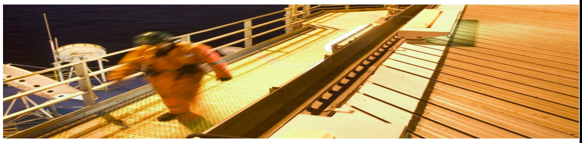
Writing Recommendations

- **Specific**
- **Measurable**
- **Achievable**
- **Realistic**
- **Timebound**

A workplace cliché perhaps, but useful nonetheless

Following Up……

- Updating Incident database
- Experience transfer database
- Risk education days, workshops, gatherings (*samlinger*)
- Discipline networks
- Internal Media
- *Revisit?*



Thank you

Human & Organisational Factors in Incident Investigations

James Bunn
jbun@statoil.com
www.statoil.com

HFC

Samarbeid for Sikkerhets nye veiledning for beste praksis ved granskning av HMS hendelser

H. Halvorsen

Mere informasjon:

www.samarbeidforsikkerhet.no og anbefaling 029 N - ”Beste Praksis for Undersøkelse og Gransking av HMS- hendelser” (02/10)

Working together for Safety

(Samarbeid for Sikkerhet)

Human Factors in Control, Oct 20, 2010

Hugo Halvorsen
Daglig Leder, SfS

History:

Conflicts in public discussions
Doubts regarding safety level
Different views re safety level
Low thrust between various parties
Poor general reputation

Foundation in Gov. White Papers

Mandate:

Improve Safety
Improve confidence in the industry between workers
Strengthen thrust+cooperation between the various parties
Improve industry reputation

Work in SfS

Principles:

- Tripartite cooperation
- Subject Matter Experts + users in work groups
- Employee involvement critical to ensure operability/ownership

Status Oct 2010:

- 10 Seminars/conferences
- 38 Work Groups established
- 29 Recommendations published
- 26 Safety movies

Ongoing work :

- Hot work – Chemical health risks
- Common alarms and signals (Onshore sites)
- Curriculum - Fall arrest and rescue equipment
- Curriculum - Investigation leaders
- Best Practice - Habitat as a barrier
- Best Practice - Hazards and Risk
- Toolbox for HVO & VO
- Safety films

Where do I find this ?

www.Samarbeidforsikkerhet.no

Recommendation 029 E
”Best Practice for Investigation and Inquiry into HSE Incidents”

Reason for establishing the work group

- Ensure a high quality and objective investigation
- Ensure follow-up aimed at avoiding recurrences
- Ensure experience transfer

Task given to work group:

- Identify the common practices and procedures for initiating an investigation, including specific criteria
- Identify who should participate
- Identify required skills
- Identify how to ensure integrity
- Consider how to ensure quality in the conclusions and follow-up of these internally and across the industry.

Guiding principles

- The recommendation must be aligned with the PSA's (Petroleum Safety Authority) definitions and requirements
- Overall aim of investigations is to uncover the facts of what has happened and recommend measures to prevent recurrence
- The processes that companies currently use to classify events and their potential or risk should be retained
- The best practice should endeavor to make sure that all parties in an event are handled in a correct and fair manner

SfS
Samarbeid for Sikkerhet
(Working Together for Safety)

Recommendation 029 E
"Best Practice for Investigation and Inquiry into HSE Incidents"

TABLE OF CONTENTS

SfS Samarbeid for Sikkerhet

Mandate - content

a) The actual course of events and consequences,
b) Other potential courses of events and consequences,
c) Any nonconformities in relation to requirements, processes and procedures,
d) Human, technical and organisational causes of the hazardous or accident situation, and in which processes and at which level such causes can be found
e) Which barriers have failed, the causes of barrier failure and which barriers should have been established,
f) Which barriers functioned, i.e. which barriers contributed towards preventing a hazardous situation from developing into an incident, or which barriers reduced the consequences of an incident,
g) Immediate compensating measures and measures that should be implemented to prevent similar hazardous and accident situations.

Mandate – content 2

h) Define the authorisations of the Investigation Leader in matters such as stopping work, cordoning off and releasing areas, etc.
i) Define the incident owner
j) Members of the Investigation Group (Team membership is crucial for the quality of the investigation)
k) Client/Principal (mandate owner)
l) Timeframe
m) A brief description of the incident
n) Assurance from the Principal that personnel who will be involved are secured through the Working Environment Act and rules and regulations

SfS Samarbeid for Sikkerhet

The Investigation Team

The team should include the following:

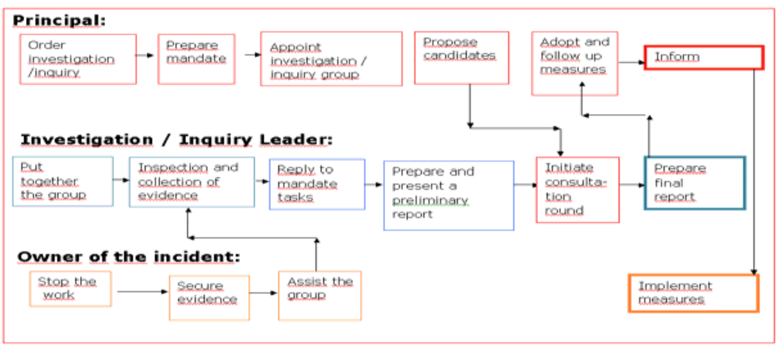
Leader
Method Specialist (root cause expert)
Discipline Specialist /Subject Matter Expert
Safety Delegate designated by the HVO
Representatives from other companies (if relevant)

A person can have multiple roles in the group. The group should be composed in such a way that their combined expertise is fully adequate for the event

Investigation Process

- No specified method (other than MTO approach)
- Disagreements with respect to conclusions re causes etc does not have to be resolved must be covered in the report

Appendix 1: Investigation / inquiry process - distribution of work



Quality Assurance

- The draft report should be quality assured/ controlled by a established Panel ("Review Panel") or an ad-hoc panel set up by the client and the investigation leader.
- Panel should include personnel from involved units, legal, HSE, and any external companies involved.
- Comments from the panel should be reviewed by he team, who decides what comments will be accepted, before the final report is prepared and sent to the client.

Report

The report should contain:

Summary of the main points
The group's members, mandate and signatures
Responses according to the mandate
Diagrams and/or models that explain methods and conclusions
Other findings/matters & relevant material

SfS Samarbeid for Sikkerhet

Follow-up

- All agreed actions must recorded in the company's system for undesired events, If the client decides not to implement an action, this shall be justified and documented in the system for monitoring adverse events.
- Action items should be closed by the various people responsible but formally approved by their supervisor.

Experience Transfer

- There should be a system for internal experience in each company
- Investigation reports with an overview of measures adopted should be presented in relevant AMU's
- "One-pagers" are suitable for both internal and external experience transfer
- Consider sharing externally, e.g. by using the lesson learned website.

Thank You

www.Samarbeidforsikkerhet.no

SfS Samarbeid for Sikkerhet

HFC

Air Safety Through Investigations – Bridging Theory and Practice.

F.Strand, J.C.Rolfsen

Mere informasjon:
www.dnv.com

Air Safety Through Investigations – Bridging Theory and Practice

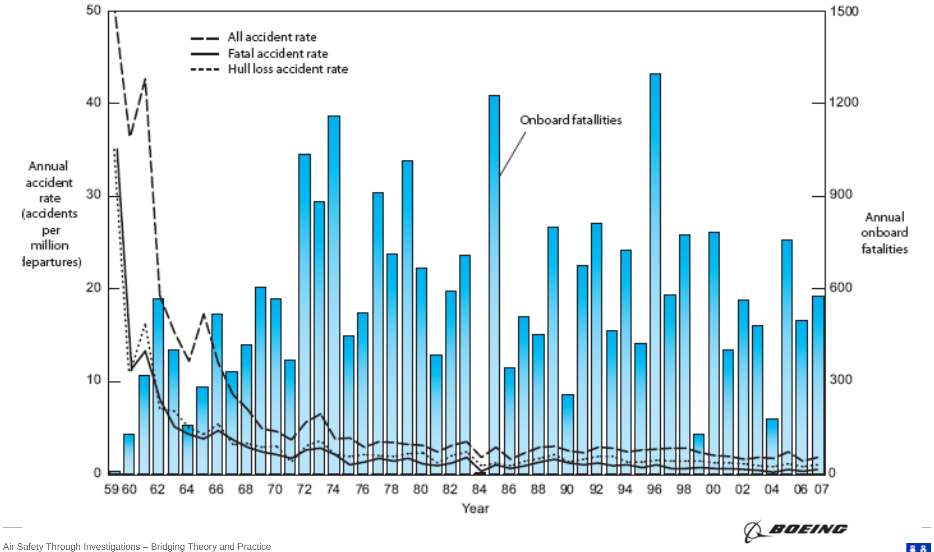
HFC 20/10-10

Jens Rolfsen, Fredrik Strand
20 October 2010

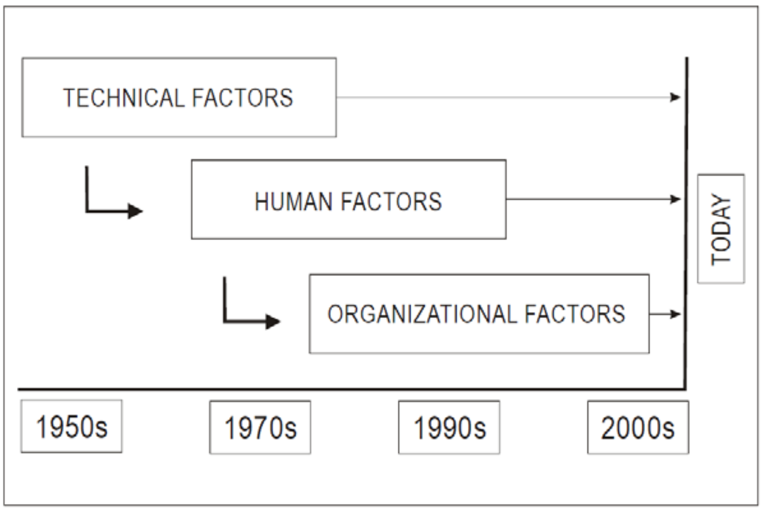
Agenda

- Airline safety
- How has accident and incident investigations contributed?
  - A case study
- Why has accident and incident investigations contributed?
  - "Process risk" vs "individual risk"
  - Reporting and initial screening
  - Organising for investigations
  - Human factors role in investigations
- Spin-offs and dilemmas

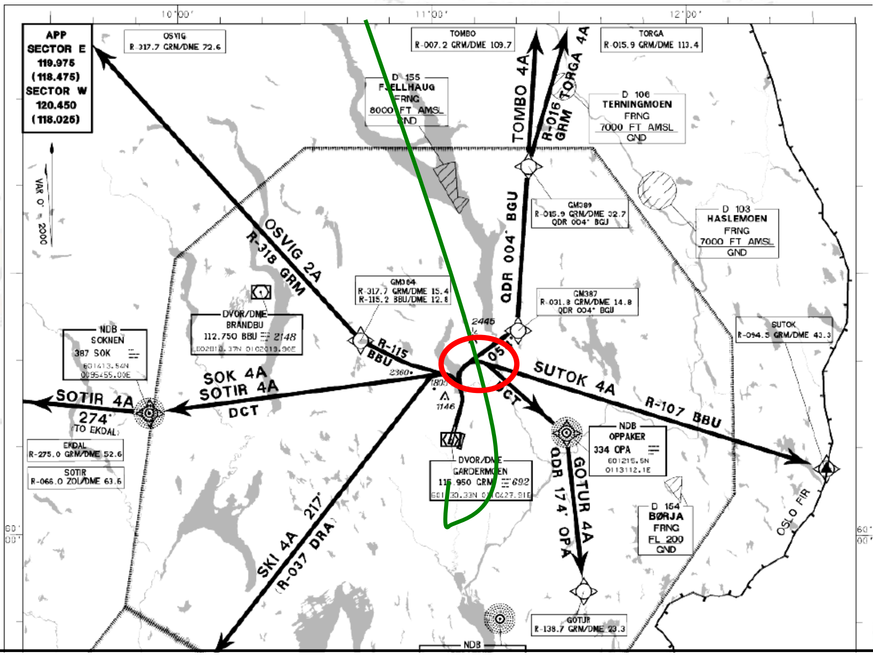
A success story

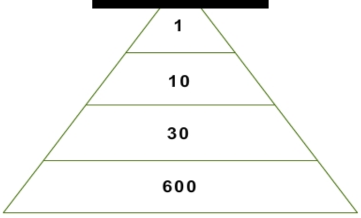


The evolution of safety thinking in aviation



A Case Study: TCAS Hotspots FL90/FL100







MANAGING RISK DNV

Process Risk

Individual Risk

Frank Bird Pyramide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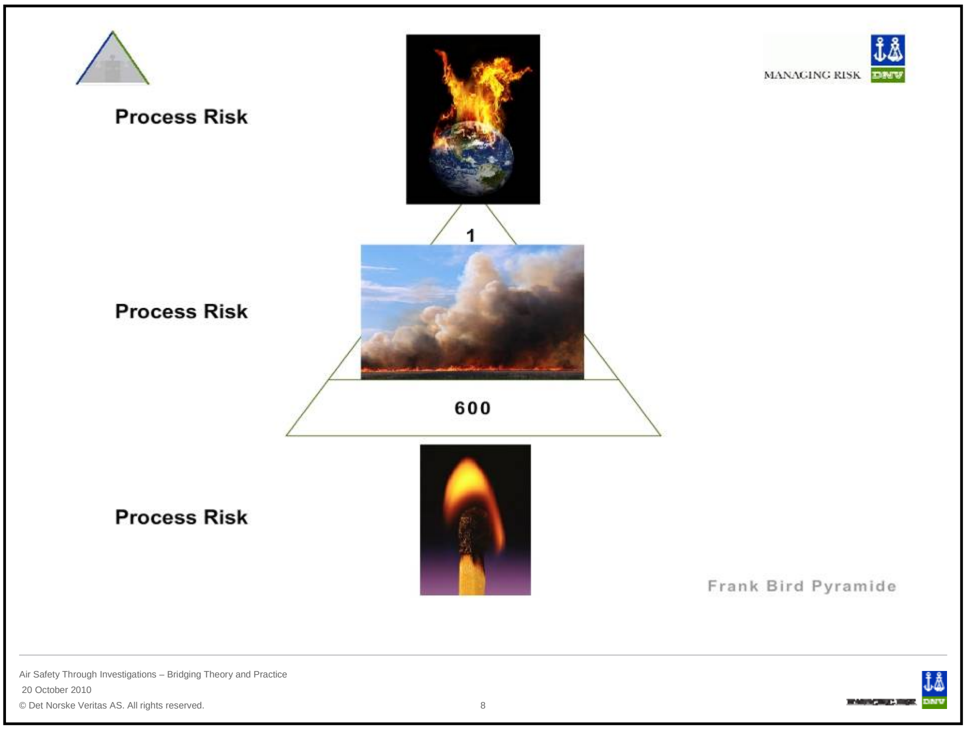
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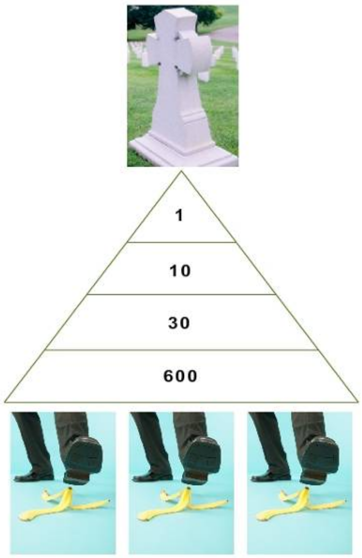
MANAGING RISK DNV

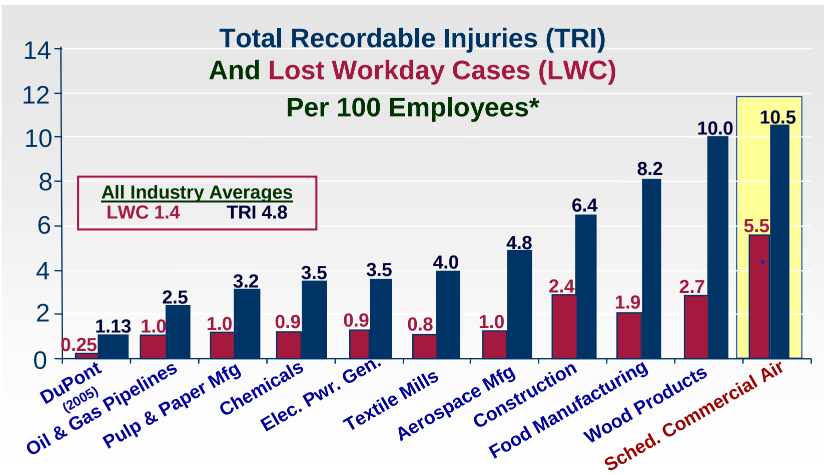
Individual Risk



Individual Risk

Frank Bird Pyramide

A success story?



* U.S. Bureau of Labor Statistics, 2004 Data

First step – reporting and initial screening

- An electronic report comes in
  - Confidential vs anonymous
  - "Call back" option
- Screening and classification
- Further action
  - Transfer to data base, or
  - Follow up by safety officer, or
  - Company investigation, or
  - Alerting authorities and full investigation
- The importance of reliable and valid data

The *wrong* mitigating actions can potentially make things worse

Do you want the green pill or the red pill?

Objective of the investigation

- ICAO Annex 13, Aircraft Accident and Incident Investigations
  - ICAO – International Civil Aviation Organization
  - Convention on International Civil Aviation

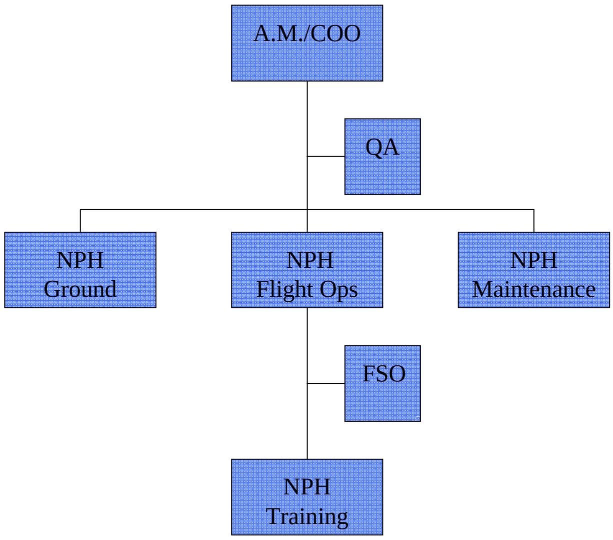
The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability

- Accident and Incident Investigations are key activities for continuous improvement and organizational learning

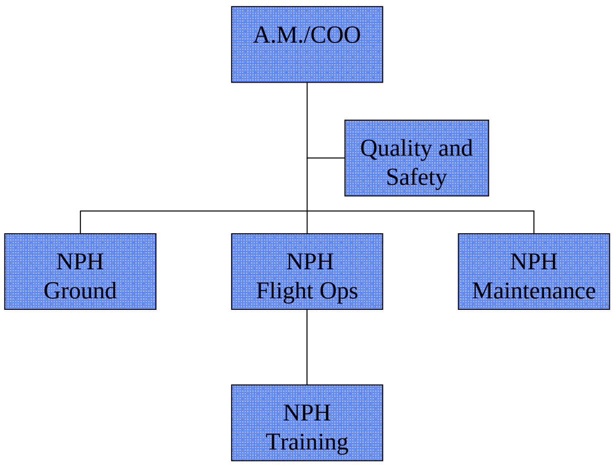
Organising for investigations

- Mandate
- Manning
  - Solid technical background and understanding, but also experience with modern SMS, human factors and MTO
  - Investigator training
  - Access to expertise (networking)
- Method
  - The investigator can utilize a variety of methods and approaches
    - FDM Analysis, STEP, MEDA, HFACS etc
  - However, the report should use well-known concepts and models
    - Reasons Swiss cheese, SHELL, CRM/TEM etc
- Format
  - ICAO Annex 13

Organizational chart - traditional

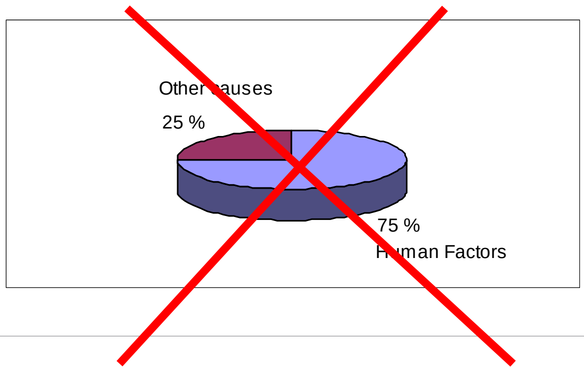


Organisational chart - today



HF always involved

- ”Human Factors” are always involved in incidents in aviation
- Human factors knowledge and expertise must be an integrated part of any investigation process



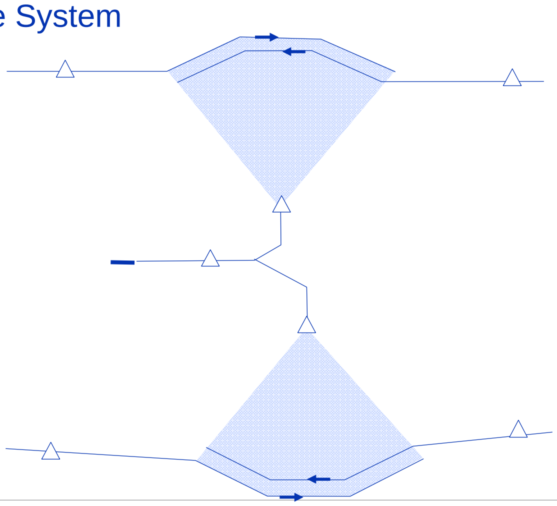
The investigation – process and results

- Trend analysis
- Clustering of events indicating a safety issue
- Establishing the context – intense discomfort and stress as experienced by the crews
- Company investigation initiated
- Systemic deficiencies in the arrival and departure structure around OSL highlighted
- A high quality report making it difficult for other stakeholders to ignore the problems
  - Involvement by the MoT / CAA / ANSP (Avinor) in order to change the system
  - Agreement amongst the airlines to change operational procedures to further mitigate risk
- Changes implemented
  - Increased vertical separation
- Problem solved – close to zero collision warnings around OSL

Long-term solution: Radical re-design

Oslo ASAP
Oslo Advanced Sectorization & Automation Project

Point Merge System



Spin-offs

- The debrief done as a part of the investigation process:
  - Provides the crew with an opportunity to discuss their experiences
  - Nearly all crews involved give positive feedback
- The report in itself highlight the organizations commitment towards safety
  - Communicating the results is an important part of building and maintaining a safety culture
  - Transparency builds confidence

Dilemmas

- A loose cannon on deck
  - An investigation gone wrong can inflict larger damage to crews than the incident itself
  - A destructive report can represent a higher risk factor than a serious incident
- What happens if nothing happens?
  - Failure to correct known problem = gross negligence
  - “Paralysis by analysis”
- Transparency vs “Safety by Ignorance“
  - Media has problems understanding how a well functioning SMS works
    - Systematic, well documented and transparent
  - No systematic safety efforts, no reports, no media attention
  - Criminalization of accidents

A harnessed process is essential!

Establishing objective, mandate, manning, method and format is paramount

Nevertheless – remember that the final report is not the end, but the beginning of the company's decision process

Air Safety Through Investigations – Bridging Theory and Practice
20 October 2010

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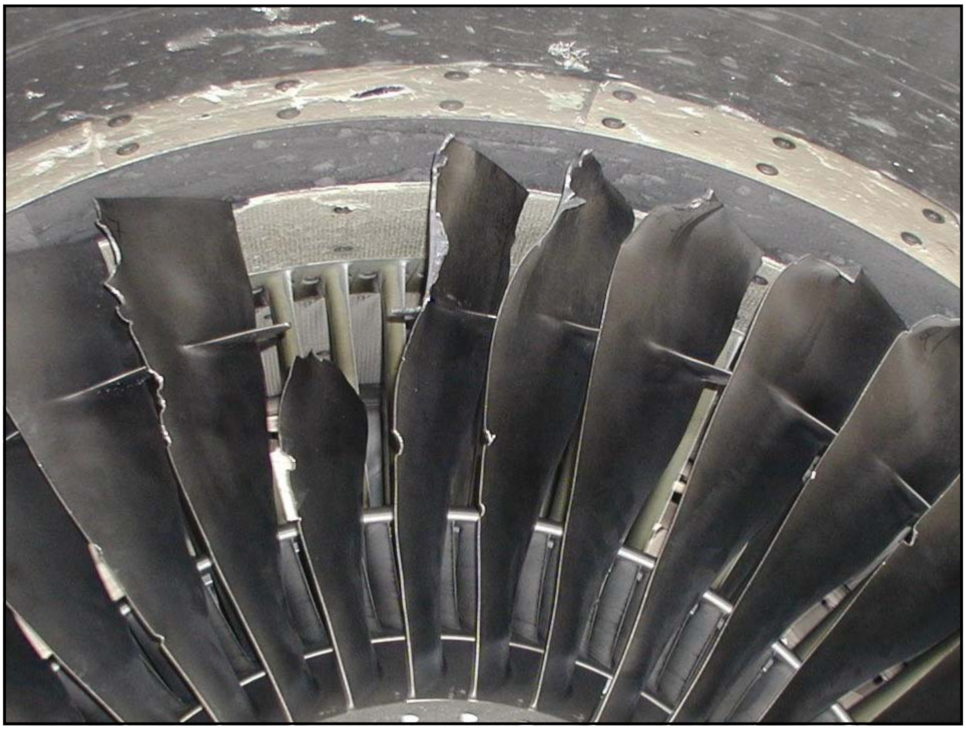


Safeguarding life, property
and the environment

www.dnv.com

MANAGING RISK DNV

HFC

Beredskapssentral via Acona

V.Gade

Mere informasjon:

http://www.aconawellpro.com/ og http://www.aconawellpro.com/Beredskap

INCIDENT COORDINATION CENTRE

The Incident Coordination Centre is a professional, reliable service, comprising a fully staffed Action Team with trained and highly experienced individuals filling each role.

The Emergency Preparedness organization is in total more than 160 personnel with experienced experts in all functions. It is a robust organization able to handle situations of hazard and accidents in an effective manner in order to fulfill the client`s obligations. The ER - team is on duty 24/7.

We work in "State of the Art" facilities with web based information system (CIMTM). A highly professional concept handling crisis and emergency situations for clients which also can be available with dedicated experts in all areas including: Next of Kin care centre, reception centre and media support functions.

A professional all-inclusive arrangement which consists of:
The Emergency Response (ER) Action team
An experienced and well trained group of personnel forms the core of the ER team. It consists of Action Manager, Rig Coordinator, HSE Coordinator, Oil Spill Coordinator and Environmental Advisor, Logistics Coordinator, Media Coordinator, Human Relations Coordinator and Administrative Support.

The organization is able to handle prolonged emergency situations or simultaneous actions.

acona wellpro
Acona Wellpro as Laberget 24, P.B. 216 NO-4066 Stavanger
Tel. +47 52 97 76 00 www.aconawellpro.com

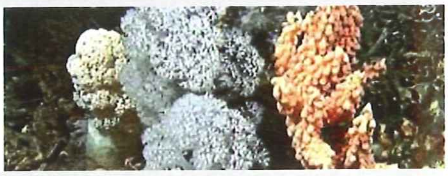
EMERGENCY SUPPORT (ES) TEAM FUNCTIONS

In support of the client and the Emergency Response Action team we provide professional media and communication experts, Media Response Teams, Next of Kin team leaders and team, Local Reception Teams, Well control teams and duty doctor -/Medevac Agreement.

LIAISON FUNCTIONS

Our Liaison functions are set up and trained; Liaison Hospital, Liaison to Joint Rescue Coordination Centre (JRCC), Local Rescue Centre (Police) and drilling Contractor liaison.

INCIDENT COORDINATION CENTRE



FACILITIES AND SYSTEMS

Acona Wellpro Incident Coordination Centre is established at Forus in Stavanger. It consists of:

- Operations Room
- Management collaboration room
- Next of Kin Care centre
- Media centre (Media Response Team call centre & Media Monitoring)

SYSTEMS

Acona Wellpro has implemented a number of web based information systems:

- CIMTM & Issue Manager – Information Software
- Duty Rooster – Notification & Alert Consept
- DaWinci – POB Data integrated
- Web based Vessel Movement Monitoring Concept
- Vissim Advanced Traffic Display

TRAINING & COMPETENCE

Acona Wellpro organize, plan and execute additional services for clients:

- Training of all types of Emergency response organizations
- Walk through, Talk through, Table tops, Exercises
- Documentation: Emergency Response Plans, Bridging documents, etc
- Strategic Emergency Management
- Comprehensive emergency related courses are offered according to the Norwegian Oil Industry Association (OLF) guidelines
  www.aconawellpro.com/courses

NEW SERVICES

Acona Wellpro provides operational, tactical and strategic support including a number of services on duty for immediate action & support:

- Emergency experts called out in support of the customer`s organization (Oslo, Stavanger)
- Investigation teams on duty
- Reception teams on duty
- Virtual training, based upon computer game concept
  www.criseware.com

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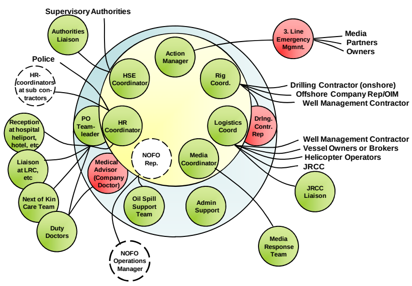
Emergency Preparedness Services
Incident Coordination Centre (ICC)

THE INCIDENT COORDINATION CENTRE

A highly professional concept



- A fully staffed and well trained Level 2 emergency organization
- More than 45 persons filling the Action Team Roles
  - 6 persons in each role, all Acona Wellpro staff
  - Experienced experts in all functions (Have similar functions as their daily work)
- In total more than 180 persons involved
  - Including all Support Team members
- State of the art facilities, systems and equipment, including web-based information system (Crisis and Issues Manager) from One Voice
- Available as a full, all-inclusive package based on fixed daily fees
  - Individual elements can also be provided separately, e.g.; Next of Kin care centre, reception centre, media support functions

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EMERGENCY RESPONSE ACTION TEAM

- **Action Manager**
  - Manages the ER Team
  - Maintain contact with 3. line management
- **Rig Coordinator**
  - Be the primary contact with the incident site
  - Maintain the contact with drilling contractor and drilling department
- **HSE Coordinator**
  - Contact with Supervisory authorities and Oil Spill/NOFO
- **Logistics Coordinator**
  - Coordinates helicopters and marine resources, contact with JRCC and JRCC Liaisonn
- **Human Relations (HR) Coordinator**
  - Coordinates POB status, medical support, information to Next of Kin, Liaisons to hospitals, hotels, heliports, LRC and Police in close cooperation with Action Manager.
- **Media Coordinator**
  - Provides strategic advise, assists in preparing press releases, etc.
- **Admin Support**
  - General assistance and support to the team.
- **IT Support**
  - In addition to the Core team members, IT-support will also be available.

EMERGENCY SUPPORT TEAMS

- **Media Response Team**
- **Environmental and Oil Spill Support Team**
- **Next of Kin Team (Pårørende omsorgs- gruppe)**
- **Reception Teams at all heliport locations**
- **Vicar**
  - An arrangement with "Den norske kirke" to provide a high priority support when called for
- **Liaison team:**
  - Liaison Hotel, Hospital, Local Rescue Centre, JRCC
- **Duty Doctor**
  - Agreement with Global Medical Support (GMS)
- **Well Control Support Team**

PRESENT ENGAGEMENTS

- All Inclusive Level 2. Emergency Organization
  - West Alpha (Petro Canada)
  - Transocean Winner (Lundin)
  - Maersk Guardian (Lundin)
  - Songa Delta (Nexen)
  - Rig TBN (Idemitsu - 2011)
  - Rig TBN (Premier - 2011)
- Media Advisors and Media Response Team
  - Marathon
  - GDF Suez
  - Petro-Canada
  - Noreco
- Alert and Notification arrangement
  - Island Offshore
  - OSM
- HR-function in Customer's organization
  - BG
  - Eni Norge
- Next of Kin and/or Reception teams
  - BP
  - BG
  - AGR
  - Aibel
  - Exxon
  - Talisman
  - Eni Norge
- Exercises and Training
  - Eni Norge
  - Total
- A comprehensive Course-offer
  - Training-hub
  - www.aconawellpro.com/courses
- Investigation Services
  - Experienced investigation team leaders and teams available on short notice

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HFC

Patient Safety Investigation Through the Lens of FRAM - ”Duk i Buk”

H.Alm

Mere informasjon:

Vedlagte paper, "Patient safety investigation through the lens of FRAM” som kommer i “Human Factors: A system view of human, technology and organisation” Dick de Waard, Arne Axelsson, Martina Berglund, Björn Peters, and Clemens Weikert (Eds.), Shaker Publishing. ISBN 978-90-423-0395-9

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Patient safety investigation through the lens of FRAM

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Abstract

The purpose of this study was to apply the systemic Functional Resonance Accident Model and its associated Analysis Method (FRAM; Hollnagel, 2004) to an incident investigation in a health care context. FRAM is a novel systemic approach to system safety and resilience engineering, with a specific aim to unravel functional interdependencies and non-linear effects of performance variability in complex socio-technical systems.

In health care a substantial number of people die or are seriously injured due to preventable adverse events that occur during treatment. Since 2005, the County Council in Östergötland, Sweden, has a dedicated patient safety unit (PSU). This unit investigates health care incidents using an analytic method that combines root cause analysis (RCA) with huMan, Technological and Organisational (MTO) aspects.

The FRAM analysis was applied to a case (concurrently investigated by the PSU) where surgical materials were left in a patient's abdomen during a surgical procedure. In comparison to the investigation done by the PSU this study found that FRAM had a number of advantages most prominently because of its facility to expose the complexity often found in the health care domain. The study concludes that FRAMs more extensive investigation process facilitates finding more complex and systemic interdependencies than other methods may allow, and that the method is still under development, necessitating further research.

Introduction

Accident models are conceptions of how accidents occur, often implicit in the minds of accident investigators or in their guidelines. As these conceptions determine what accident investigators look for during investigation, and thereby which contributing factors are found and prescribed to be fixed (Lundberg et al., 2009), accident models are important to recognize, identify, and reflect upon when discussing system safety and the control of risk. Early accident models, often aim to attribute an accident to a root cause. However, although possibly useful in straightforward cases, the root cause concept is problematic because of its neglect of the often fuzzy and coincidental combination of numerous events and circumstances preceding and surrounding an adverse event. This observation leads to the importance of accident models to adequately describe and understand accidents.

Safety science has come up with a wide range of accident models since the 1930s. Accident models have been classified by Hollnagel (2004) into simple linear, complex linear, and systemic accident models. Simple linear models, such as Heinrich’s Domino model, examine accidents by focusing on linear cause-effect relationships between components. Complex linear or epidemiological models, such as Reason’s Swiss Cheese model and the Scandinavian MTO method, decompose socio-technical systems by their structure and consider linear relationships, but of interdependent components. Latent conditions (e.g., fatigue, bad design, management production pressure) affect how active failures (such as unsafe acts or human error) can penetrate or defeat the barriers (e.g., safety regulations and procedures, supervisor checks) in the system to cause an accident. As scholars have recently argued, the linear models of accident causation, and the view on safety as a hunt for human error, do not suffice to model and understand the complex nature of many contemporary accidents, and more "systemic" models of accidents and safety are necessary (Amalberti, 2001; Dekker, 2004; Hollnagel, 2004; Leveson, 2004; Rochlin, 1999).

In health care a substantial number of people die (and a much larger number are seriously injured) due to preventable adverse events that occur during treatment. Statistics indicate that these health care injuries might even outnumber the lethal accidents in traffic (Kohn, 2000). Some leading researchers (Lundberg et al., 2009) have suggested that the application of a systemic accident model such as FRAM may be particularly useful in understanding adverse events in modern complex health care systems. In this study, FRAM was applied concurrently with a PSU health care incident investigation to examine if FRAM is applicable to health care and to compare it with today's method.

Summary of the incident

The following description summarises the incident that was studied. Firstly, the actors involved are presented, and secondly, the course of events and the circumstances of the incident.

Staff present in the OR

- Main surgeon – specialist doctor, very familiar with the procedure
- Assisting surgeon
- Surgical nurse – had recently passed the examination and took part in an orientation program at the time
- Supervising surgical nurse (supervisor) – a senior surgical nurse, in the OR to supervise the surgical nurse but stayed outside the sterile area, taking care of the assistant nurse's tasks
- Assistant nurse – only present at the preparations and the closing part
- Nurse anaesthetist
- Anaesthetist – not in the OR during the surgical procedure but nearby in case the nurse anaesthetist needed help

Course of events and circumstances

The main surgeon initiated the abdominal surgical procedure together with the assisting surgeon. The two surgeons worked as a team and had agreed upon their roles (main/assisting surgeon) before they started the procedure. Early on the surgeons where asked if they could perform two urgent surgical procedures on other patients in other operating theatres, which they accepted. This is something that happens occasionally in the concerned clinic, the surgeons usually try to perform any urgent surgical procedure in between the planned ones. In this case the telephone in the OR rang frequently during the surgery, as staffs in other ORs were awaiting support from the surgeons, which was perceived as stressful. When the tissue sample was excised the assisting surgeon left the OR to begin working on the first urgent surgical procedure. Measures to obtain haemostasis (blood-stopping) were undertaken for the surgical procedure investigated here.

When the assisting surgeon returned the main surgeon asked him to come to the wound to assist the haemostasis, which continued to be a problem. Large amounts of sponges were consumed. The surgical nurse counted all the instruments and materials when the abdominal sponge (large cloth for haemostasis) and disarp (disposable abdominal retracting pad) were still in the patient's abdomen but did not report the result to the surgeon. As the patient took part in a study, the surgical nurse prepared a syringe with a special kind of analgesic that was

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to be used in the wound. The assisting surgeon removed the retractor and asked for the main surgeon to close the wound without his assistance. He then left the OR and performed the second urgent surgical procedure. At this time the main surgeon received the information that her next patient was ready for the pre-operative briefing. She informed the staff working on that surgical procedure that she would arrive as soon as she was done with the suturing (closing the wound). She started suturing and asked the surgical nurse to assist. Neither the surgical nurse nor the supervising surgical nurse made an extra check of materials or reported that there may be materials left in the abdomen.

Concurrently the supervising surgical nurse, who then primarily performed the tasks assigned to the assistant nurse, checked the papers regarding the study and realised that the prepared syringe contained the wrong analgesic. The three nurses had a discussion to determine which analgesic to use. They discarded the syringe and the surgical nurse prepared a new one with the right analgesic. The telephone rang again as the staff on the main surgeon's next surgical procedure anew wondered when she would join them. When analgesic was given and the wound was sutured the main surgeon left the OR.

The surgical nurse and the supervising surgical nurse did a final counting of the instruments and materials and realised that the abdominal sponge and disarp were missing. Everyone in the OR was informed and they tried to contact the two surgeons on both telephone and pager. The nurse anaesthetist was just waking up the patient, the anaesthetic was reversed and the patient had already been extubated but was quickly intubated and anaesthetised again. In this case the nurse anaesthetist would have preferred to have support from the anaesthetist when intubating and re-anaesthetising, but this wasn't possible as the only telephone in the OR was occupied. The supervising surgical nurse got hold of the main surgeon who confirmed that she would return immediately to retrieve the material.

A new surgical procedure was quickly prepared, the abdomen was opened and the materials removed. The patient didn't wake up enough to remember anything of the situation but was informed of the incident and didn't suffer any permanent harm due to this incident.

Method

With the aim of getting a better understanding of patient safety and the RCA-MTO method a course in patient safety arranged by the County Council of Östergötland was attended by the first author (HA). In order to get insight in the work performed in an OR, HA conducted interviews with four experts (not present during the surgery investigated in the study) as well as two days of observations of surgical procedures.

The RCA-MTO and the FRAM method were applied simultaneously during the investigation. The PSU applied their RCA-MTO method as the official investigation, while HA applied FRAM. Interviews with the OR staff were conducted primarily by the PSU but HA attended two of the interviews. The FRAM team had access to all PSU interview transcripts, written reports from the concerned personnel, documentation from the surgical procedure and guidelines. When both analyses were completed a focus group was arranged with three participants from the PSU and HA to discuss the different methods and results.

The RCA-MTO method

The analysis method employed by the PSU is based on an epidemiological or complex linear accident model (Lundberg et al., 2009). It is based on the Root Cause Analysis (RCA) method created with inspiration from work on patient safety in the USA, England and Denmark, adjusted to fit Swedish conditions (Socialstyrelsen et al., 2005). The analyses represent incidents as a chain of negative events and takes huMan, Technological and Organisational (MTO) aspects into consideration as either causal factors or latent conditions. The method consists of eight steps, 1. Initiate analysis, 2. Collect data, 3. Describe the event, 4. Identify causes, 5. Analyse barriers, 6. Draw up measures and method for follow-up, 7. Create final report and 8. Decide on measures, experience feedback and follow-up. The method used by the PSU will be abbreviated here as the RCA-MTO method.

A team of five persons performed the analysis of this event, a team leader from the PSU, a surgical nurse, a specialist doctor, an anaesthetist nurse and a deputy health care manager.

Results gained with the RCA-MTO method

The RCA-MTO analysis found five root causes and came up with five measure proposals. Each cause is connected to a measure, with one exception, as described in Table 1.

Root cause	Measure
There is no procedure for how to handle sponges.	Develop a procedure for how to handle sponges and make sure that it is complied.
Lack of respect for the ongoing work in the OR.	Establish a work group to discuss how the telephones should be used in the OR.
Lack of communication between the surgical nurse and the surgeon.	Improve the communication between the surgical nurse and the surgeon before the wound is sutured.
The surgical nurse got insufficient support during the surgery due to lack of communication between her and her supervisor.	As a supervising surgical nurse and as a nurse undergoing introduction - make sure to have a continuous dialogue to determine whether there is a need for extra support.
Increased productivity and higher efficiency demands on the work	
	Introduce a timeout before each surgical procedure starts where all personnel declare their function.

Table 1. Root causes and corresponding measures identified by the PSU with the RCA-MTO method.

FRAM - Functional Resonance Accident Model

Rather than aiming to identify root causes, FRAM seeks to identify essential socio-technical system functions, and then to understand how their performance varies over time and how this variability spreads through loose and tight couplings among functions. Rather than only system failures it aims to also understand “normal” day-to-day work practise and successful system performance. In the case of analysis of a negative event, FRAM tries to assess how various functions’ variability could coincide and spread so that undesirable function outputs become reality. The concept of function is therefore central. A function is ”a set of actions that a system performs or is used for, which are valuable for the achievement of a set of goals” (Woltjer, 2009, p. 23).

The Functional Resonance Accident Model (FRAM; Hollnagel, 2004) describes socio-technical systems by means of the functions they perform rather than by their structure. FRAM aims to capture the dynamics of such systems by modeling non-linear dependencies and the variability with which functions are performed in actual operations. FRAM assumes that both normal performance (success) and failure are emergent phenomena that cannot be attributed to specific system components. Performance variability is natural in socio-technical systems, enabling people to cope with complexity and uncertainty. Such approximate adjustments of performance are necessary in order to meet the demands that result from the under-specification of systems and situations in complex environments (cf., the ETTO

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principle, Hollnagel, 2009). Thus, every function has a normal weak variability. In FRAM, functional resonance is the detectable signal (an undesirable event) that emerges from the unintended interaction of the weak variability of many signals. This model was coined by Hollnagel (2004) for accident modelling and complex system analysis purposes under the acronym FRAM, but the acronym has over time also come to mean Functional Resonance Analysis Method, referring to the method associated to the model.

FRAM - Functional Resonance Analysis Method

The steps of FRAM as they were applied in the present study are presented here, relatively closely following their initial description (Hollnagel, 2004).

Step 1. Identifying functions

Table 2 describes the six aspects that a FRAM-module addresses for each function that is identified (input, output, preconditions, resources, time, and control). In a graphical notation a function may be illustrated with a hexagon with each of the function aspects at its corners, as illustrated below in Figure 1. To find the FRAM-modules, one may start with the top-level goal, which may translate into the top-level function, or one may start with any function and move on to identify related functions.

Function aspect	Description
Input	That which the function uses or transforms
Output	That which the function produces
Preconditions	Conditions that must be fulfilled for the function to be carried out
Resources	That which the function needs or consumes when it is carried out (e.g. matter, energy, information, manpower)
Time	Time available/needed, as a special kind of resource or constraint
Control	That which supervises or adjusts the function (e.g. controller, guideline, plan, procedure)

Table 2. FRAM-module description of function aspects (Hollnagel, 2004).

Step 2. Assessment and evaluation of variability

Eleven common performance conditions (CPCs) are identified in the FRAM method (Hollnagel, 2004) to be used to identify potential or actual variability: 1. availability of personnel and equipment, 2. training, preparation, competence, 3. communication quality, 4. human-machine interaction, operational support, 5. availability of procedures, 6. work conditions, 7. the number of goals and the extent to which they are in conflict, 8. available time, 9. circadian rhythm, stress, 10. team collaboration, and 11. organisational quality.

These CPCs address the combined human, technological, and organisational aspects of each function and describe the contextual factors relevant for a particular incident. After identifying the CPCs, the variability needs to be determined in a qualitative way by describing and assessing in which way normal performance could vary, i.e. how output of functions typically varied on a day-to-day basis, and which situational factors and particular circumstances in the specific case contributed to this variability.

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Step 3. Defining functional resonance

The output of the functional description of step 1 is a list of functions each with their six aspects. These functions may be linked together through their aspects. For example, the output of one function may be an input to another function, or produce a resource, fulfil a pre-condition, or enforce a control or time constraint. When the links between functions are found, through thorough analysis of functions and common or related aspects, these links may be combined with the results of step 2, the characterization of variability. That is, the links together with the CPCs specify where the variability of one function may have an impact, or may propagate that influence. Once variability begins to propagate, the CPCs of other functions determine whether the variability that their aspects are exposed to is damped or amplified. This analysis thus determines how a (stochastic) resonance can occur as a result of variability across functions in the system. For example, if the output of a function is unpredictably variable, another function that requires this output as a resource or an input may be performed unpredictably as a consequence, if that function's performance conditions allow for the variability to propagate to its output. Many such occurrences and propagations of variability may have the effect of resonance; the added variability (usually occurring under the normal detection threshold, a.k.a. "noise") becomes a recognisable ”signal”, a high risk or vulnerability.

Herrera and Woltjer (2009), following Hollnagel (2008) have used the concept of instantiations to describe the actual couplings between functions that occurred during specific time intervals in order to create manageable graphical representations of the spreading of variability among functions over time.

Step 4. Identifying systemic improvements

FRAM aims to identify systemic improvements to function performance, in order to damp unwanted variability (barriers and performance conditions), to detect unwanted variability (through indicators) where variability is necessary and variability damping is detrimental, and to adapt performance conditions, function aspects and couplings where appropriate.

Barriers are hindrances that may either prevent an unwanted event from taking place, or protect against the consequences of an unwanted event (Hollnagel, 2004), and adding barriers can imply new functions and/or modified function aspects in FRAM. Indicators, and modifications to performance conditions, function aspects and couplings, may be applied in any of the functions modelled.

Results of the Application of FRAM

The results from the FRAM analysis are presented following the four steps.

Step 1. Thirteen functions were identified

The set of essential system functions was established in an iterative fashion throughout the study. The final set is the following: *Using abdominal sponge, Excising tissue sample, Injecting analgesic into the wound, Supervising the surgical nurse, Informing about the study, Placement of the disarp, Counting (instruments and materials) during surgery, Re-counting after surgery, Suturing the wound, Re-anaesthetising and re-intubating the patient, Performing urgent surgical procedure (Procedure 1 and Procedure 2)* and *Waking and extubating the patient.*

The aspects of each of the functions were described based on information from interviews with experts, observations and relevant regulations and guidelines, as illustrated in Table 3.

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Function aspect	**Description for Function *Counting (instruments and materials) during surgery***
Input	• List with unpacked material • Check tags • The unpacked material
Output	• Counting during surgery finished • The surgical nurse reports the result to the surgeon
Preconditions	• The main surgical procedure is done (but not sutured) • Baseline count before the surgery starts
Resources	• List with unpacked material • Check tags • Surgical nurse • Supervising surgical nurse (if needed)
Time	• When the main surgical procedure is done • Before wound closure • No set time limit but according to the guidelines the surgeon must give the surgical nurse requisite time to perform this counting
Control	• Supervisor if needed • According to guidelines: If deviations from current regulations have occurred during surgery the surgeon is responsible for implementing prescribed control measures

Table 3. Example of function aspect description, for the function Counting (instruments and materials) during surgery.

Step 2. Each function's variability was characterised

The eleven common performance conditions (CPCs) were used to identify the variability for each function. The CPCs of each function were described primarily based on information regarding the incident (interview transcripts, written reports from the concerned personnel). The result is illustrated in Table 4.

CPC	**Variability for Function *Counting (instruments and materials) during surgery***
Availability of personnel and equipment	The surgical nurse tried to perform this action by herself, the supervisor was in the OR but not active as supervisor.
Training, preparation, competence	The new surgical nurse was on her second surgery at this ward but didn't get the supervising she required.
Communication quality	Lack of communication/communication about other issues (analgesic and suturing)
Human-machine interaction	N/A
Availability of procedures	The surgical nurse was not familiar with the set of equipment and therefore had a large need of time and support.
Work conditions	Hectic and stressful.
Goals, number and conflicts	At the same time as this task was performed the surgical nurse was asked to hold equipment to assist the surgeon and to prepare the analgesic syringe.

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Available time	The surgeon did not give the surgical nurse requisite time to perform this counting (and was not alerted).
Circadian rhythm	N/A
Team collaboration	Everybody in the team took for granted that the others carried out their own tasks, without sufficient communication. The surgical nurse was stressed and felt consistently disrupted with too many tasks, the supervisor had taken on other tasks and did not coach her.
Organisational quality	The supervisor was not the expected support. The surgeons are both stressed because of the two upcoming urgent surgery procedures.

Table 4. Example of function variability for the function Counting (instruments and materials) during surgery.

After applying the CPCs it appeared that many functions had a substantial variation, for example Injecting analgesic into the wound, Supervising the surgical nurse, Informing about the study and Counting (instruments and materials) during surgery. In order to understand if, why and how these functions affected each other the next step had to be taken.

Step 3. Functional resonance determined through functions' variability and couplings

The aspects of each function were examined in order to find couplings between the functions. Together with a review of the CPCs it was clear what aspects of each function that had the largest variability and also where expected connections were missing.

The graphical representation was divided in two instantiations: before (see Figure 1) and after suturing. The aspects with the largest impact/variability have two extra rings in Figure 1, and the aspects with significant but less impact/variability one extra ring. Resonance occurs when variability of the output of one function spreads to an aspect of another function where this variability is amplified in combination with variability of other aspects. Figure 1 also illustrates this concept of functional resonance.

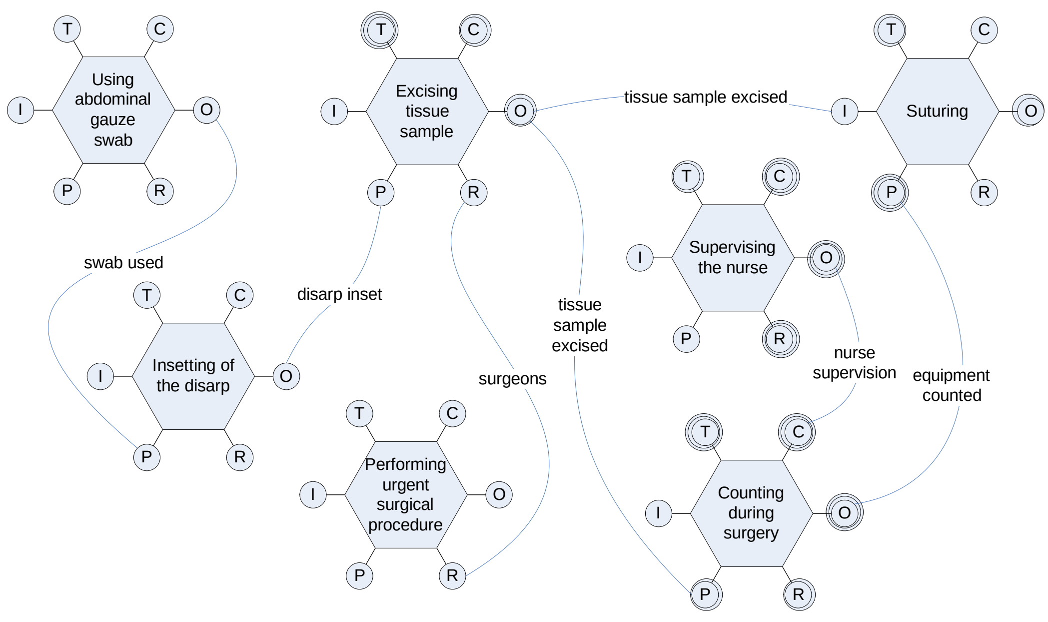

Figure 1. A graphical presentation of some of the functions employed before suturing in the particular instantiation of this case.

The analysis detected a number of problems/deficits that, in their turn resulted in a number of measures. All of the problems can, together, have contributed to the functional resonance. It is hard, if not impossible, to find out exactly how this functional resonance emerged due to the very tight couplings and the great complexity of the task performed in the OR.

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Step 4. Recommendations for systemic improvements were proposed

Recommendations should be proposed by a person with significant experience in performing the procedure and knowledge of the organisation. Without that knowledge it is hard to present measures that are appropriate and viable. Recommendations have nevertheless been suggested, based on the FRAM analysis, such as:

- Introduce supervisor training or forum to support the supervising nurses in establishing their role, and monitor their performance (Control aspect of function Supervising the nurse).
- Create a guideline making sure that the surgical nurse never should hand over the suture before the counting during surgery is accomplished (Control and Precondition of Suturing), and monitor in which situations such a guideline is difficult to follow.
- In a demanding situation like this the nurse anaesthetist must have a reliable way to contact the anaesthetist (improving Resource aspect of anaesthetist functions), for example by an extra telephone line in the OR.
- Introduce a procedure for how to handle the abdominal sponge when used (improving Control aspect of function Using abdominal sponge).
- Make sure the information on patients taking part in studies reach staff treating the patient in the OR (strengthening the coupling between Control aspect of function Injecting analgesic and Output of Informing about study).
- Rearrange the staffing so that the surgeons do not have to interrupt one planned surgical procedure to perform an urgent surgery (loosening coupling between Resources of Performing urgent surgical procedure).
- Make sure that one person in the OR has overall control (Control aspect of several functions).
- Work at the climate in the OR to make sure that all personnel dare to ask for help and also feels free to speak up if someone else makes a mistake (Communication CPC for several functions).

FRAM compared to the RCA-MTO method

As opposed to the RCA-MTO method, FRAM makes no attempt at identifying root causes. According to Hollnagel (2004) an accident investigation should seek explanations rather than causes. This is a noteworthy difference between the compared methods. In the FRAM result it is clear that some functions vary more than others (in this case e.g. Counting during surgery, Informing about the study, Injecting analgesic into the wound and Supervising the nurse) but it cannot be said that one of the functions was a direct cause to the incident. It is possible to explore the variances and make recommendations for how to dampen the negative variance. Still one must remember to allow the performance variability that makes it possible for the staff at the OR to adapt to the situation at hand.

The RCA-MTO analysis resulted in five root causes, a somewhat drastic simplification of a complex incident in an OR. Compared to FRAM the method stays closer to the incident scenario in both time and space. When it comes to recommendations the handbook for the RCA-MTO method (Socialstyrelsen et al., 2005) suggests that the analysis should propose three to five measures which should be substantial, realistic, efficient and possible to implement within a reasonable timeframe, and should not lead to a higher level of complexity, new risks or apply new steps to the procedure. One of the root causes found in the RCA-MTO analysis is an organisational cause “Increased productivity and higher efficiency demands on the work” but that cause has not been connected to a recommendation.

In total five recommendations where given from the RCA-MTO analysis, three of the recommendations concern procedures, the other two concern communication. There is a risk that the restrictions regarding recommendations hinder comprehensive measures before they get a thorough evaluation, which makes it easier to recommend small and easily implemented recommendations. Lundberg et al. (2009) emphasise that the method employed by the PSU supposes that human errors are placed at the end of the chain of events. This becomes clear when almost all the PSU measures address the routines in the OR, they do not concern the conditions in the context of work. The PSU method, though with an epidemiologic perspective, emphasises what Reason (1994) calls active failures.

The investigation utilising FRAM resulted in ten measures. Two of these measures regard procedures, two concern communication and the other six deals with various organisational solutions. FRAM can be a help to see the situation from a broader perspective, capturing more of the complexity of the situation and providing a more systemic perspective with an emphasis on work context and resulting variability of performance.

Conclusion

The two methods RCA-MTO and FRAM are based on different conceptions of how accidents occur and have been shown to lead to different results. FRAM has, in this study, resulted in measures directed towards the organisational context while most of the measures resulting from RCA-MTO concern procedures in the OR. FRAM seems to give a more profound understanding of the complex situation investigated.

This study has shown that FRAM is applicable to investigations of health care injuries. At the same time it is important to remember that there probably are accidents in health care where the complexity of FRAM is unnecessary, and it is a rather new method in need of further development.

Acknowledgements

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Patient safety investigation through the lens of FRAM

"Duk i buk"

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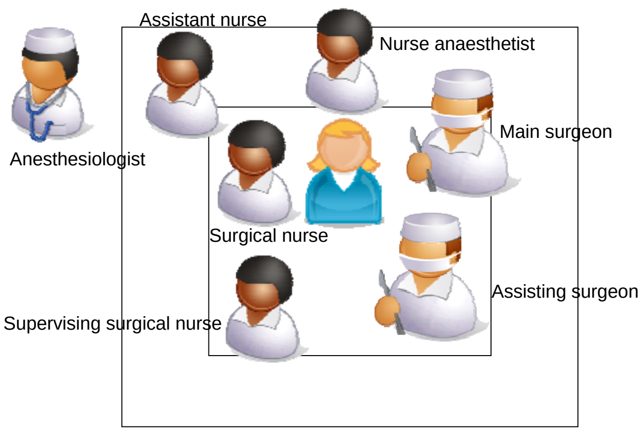
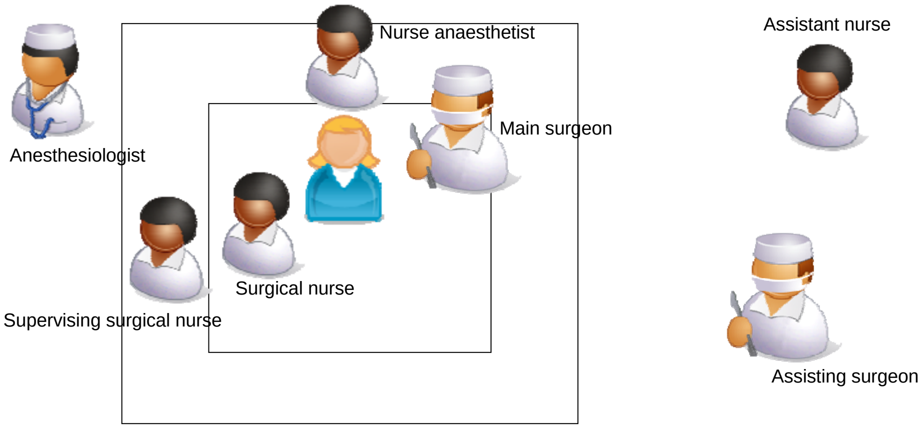
Patient safety – the case

The number of lethal injuries *received while being treated* in health care outnumber the lethal accidents in traffic (Kohn, 2000)



Patient safety – the case

The number of lethal injuries *received while being treated* in health care outnumber the lethal accidents in traffic (Kohn, 2000)



The case – material was left in the patient's abdomen

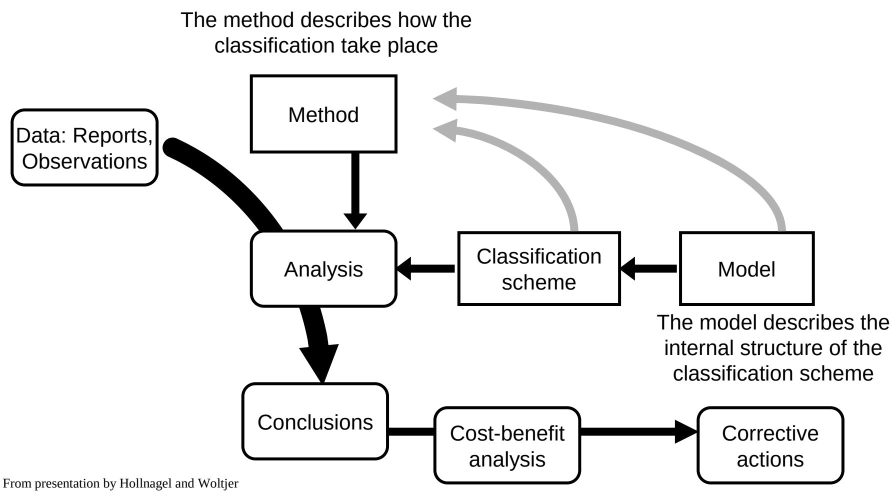
Abdominal gauze swab (cloth for haemostasis)

Disarp (disposable abdominal retracting pad)

Patient safety investigation through the lens of FRAM

- Purpose of the study
  - Accident models
  - Analysis method comparison
    - RCA-MTO (patient safety unit)
    - FRAM (this study)
  - Research questions
- Method
- Results
- Conclusions

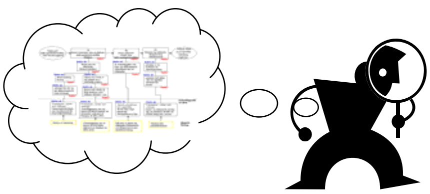
Model – classification - method



From presentation by Hollnagel and Woltjer

Complex, linear cause-effect model

Assumption: Accidents result from a combination of active failures (unsafe acts) and latent conditions (hazards).



Consequence:
Accidents are prevented by strengthening barriers and defences.
Safety is ensured by keeping track of performance indicators.

From presentation by Hollnagel

Systemic view on performance variability

Human performance is inherently variable!

Work conditions are inherently variable!

HUMAN ERROR!
Actions with a negative outcome.

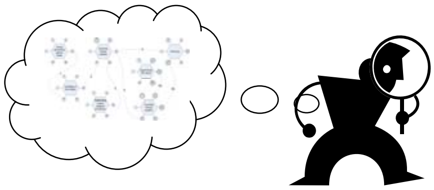
Actions with a beneficial outcome.
CREATIVITY, LEARNING

Both are due to performance variability, and may therefore have the same "causes"

From presentation by Hollnagel (2004)

Systemic accident model

Assumption: Accidents result from unexpected combinations (resonance) of the variability of normal performance.



Consequence:
Accidents are prevented by monitoring and damping variability. Safety requires constant ability to anticipate future events.

From presentation by Hollnagel

Research questions

- How can FRAM be applied to investigations of health care injuries?
- What are the differences between a health care investigation using the RCA-MTO-method (based on a complex, linear cause-effect model) compared to one using FRAM (based on a systemic accident model)?

Methods

- Participation in the County Council of Östergötland's education in patient safety
- Observations of the activities in an Operating Room (OR)
- Interviews with four experts
- Collecting data from the incident
- Collecting other documentation
- FRAM was applied at the same time as the patient safety unit (County Council) applied their RCA-MTO-method as the official investigation
- Focus group on analysis methods

FRAM – four steps

0 Define the purpose of modelling (accident investigation) and describe the target situation or scenario to be analysed

1 Identify essential system functions; characterise each function by six basic aspects

2 Characterise the (context dependent) potential variability using a checklist

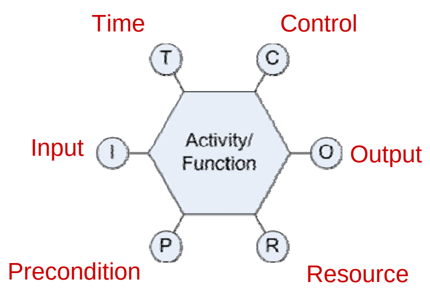
3 Define functional resonance based on possible dependencies (couplings) among functions

4 Identify barriers for variability (damping factors) and specify required performance monitoring

1. The 13 functions in this analysis

- Using abdominal gauze swab
- Excising tissue sample
- Injecting analgesic into the wound
- **Supervising the surgical nurse**
- Informing about the study
- Insetting the disarp
- **Counting (instruments and materials) during surgery**
- Re-counting after surgery
- **Suturing the wound**
- Re-anaesthetising and re-intubating the patient
- Performing urgent surgical procedure (Procedure 1 and Procedure 2)
- Waking and extubating the patient

1. The six basic aspects



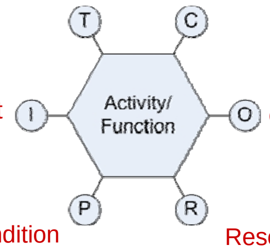
1. Function: *Counting during surgery*

Time

Control

List with unpacked material,
Check tags
Unpacked material

Input



Output

Counting during surgery finished,
The surgical nurse reports the result to the surgeon

Precondition

Resource

1. Function: *Counting during surgery*

When the main surgical procedure is done
Before suturing

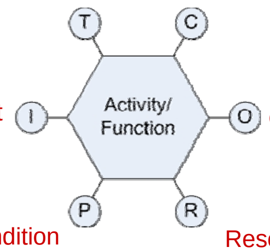
Surgical nurse (supervision if needed)
Guidelines

Time

Control

List with unpacked material,
Check tags
Unpacked material

Input



Output

Counting during surgery finished,
The surgical nurse reports the result to the surgeon

Precondition

The main surgical procedure is done

Resource

List with unpacked material
Check tags
Surgical nurse (supervision if needed)

FRAM – four steps

0 Define the purpose of modelling (accident investigation) and describe the target situation or scenario to be analysed

1 Identify essential system functions; characterise each function by six basic aspects

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2. Counting during surgery

Common performance conditions (CPCs):

1. Availability of personnel and equipment
2. Training, preparation, competence
3. **Communication quality** Lack of communication/communication about other issues
4. Human-machine interaction, operational support
5. **Availability of procedures** The surgical nurse was not familiar with the set of equipment and therefore had a great need of time and support
6. Work conditions
7. Goals, number and conflicts
8. **Available time** Hectic and stressful
9. Circadian rhythm, stress
10. Team collaboration
11. Organisational quality

FRAM – four steps

0 Define the purpose of modelling (accident investigation) and describe the target situation or scenario to be analysed

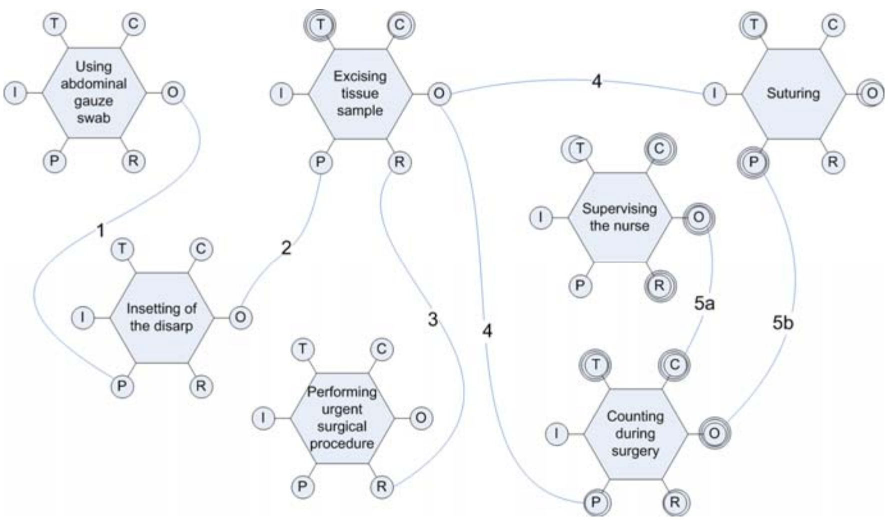
1 Identify essential system functions; characterise each function by six basic aspects

2 Characterise the (context dependent) potential variability using a checklist

3 Define functional resonance based on possible dependencies (couplings) among functions

4 Identify barriers for variability (damping factors) and specify required performance monitoring

3. Dependencies among functions



FRAM – four steps

0 Define the purpose of modelling (accident investigation) and describe the target situation or scenario to be analysed

1 Identify essential system functions; characterise each function by six basic aspects

2 Characterise the (context dependent) potential variability using a checklist

3 Define functional resonance based on possible dependencies (couplings) among functions

4 Identify barriers for variability (damping factors) and specify required performance monitoring

4. Recommendations – a comparison

Recommendations FRAM

1. Introduce supervisor training or forum to support the supervising nurses in establishing their role, and monitor their performance
2. Create a guideline making sure that the surgical nurse never should hand over the suture before the counting during surgery is accomplished, and monitor in which situations such a guideline is difficult to follow
3. Create a reliable way for the nurse anesthetist to contact the anesthesiologist
4. Introduce a procedure for how to handle the abdominal gauze swab when used
5. Make sure the information on patients taking part in studies reach staff treating the patient in the OR
6. Rearrange the staffing so that the surgeons do not have to interrupt planned surgical procedures in order to perform urgent surgeries
7. Make sure that one person in the OR have overall control
8. Work at the climate in the OR to make sure that all personnel dare to ask for help and also fells free to speak up if someone else makes a mistake

Recommendations RCA-MTO

1. Develop a procedure for how to handle gauze swabs and make sure that it is complied
2. Establish a work group to discuss how the telephones should be used in the OR
3. Improve the communication between the surgical nurse and the surgeon before the wound is sutured
4. As a supervising surgical nurse and as a nurse undergoing introduction - make sure to have a continuous dialogue to determine whether there is a need for extra support
5. Introduce a timeout before each surgical procedure starts where all personnel declare their function

Conclusions: How can FRAM be applied to investigations of health care injuries?

- FRAM can be applied to these kind of investigations
  - FRAM was great support in understanding the incident from different perspectives
    - By describing activities through the function aspects
    - By describing work conditions through the CPCs
    - By providing guidance in where to look beyond system boundaries
  - In less complex accidents in health care the complexity of FRAM is unnecessary

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Conclusions: Differences between the investigations

- FRAM resulted in measures → organisational context
- Most of the measures from RCA-MTO → procedures in the OR
- FRAM seems to give a profound understanding of the complex situation investigated. But it is still a new method
  - It must be clear how to connect step 1 (aspects) and step 2 (CPCs)
  - More guidance on each step is necessary for straightforward application of the method

The method has been developed further since this study was conducted.

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Thank you for the attention!

Questions?

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HFC

Organisasjonsmessige faktore - kvalitetstap over grensesnitt
L.Hansson

Mere informasjon:

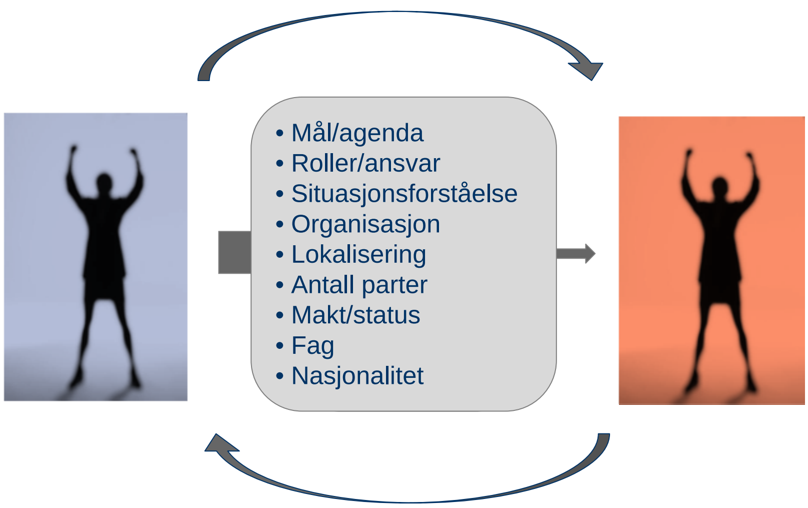
Vedlagte paper, "*Decision support tools for production optimisation - organisational challenges and implications*" Lisbeth Hansson, Morten Hatling, Bjørn-Emil Madsen; Presented at International Workshop of Advanced Manufacturing and Automation (IWAMA) 2010.

Organisasjonsmessige faktorer – kvalitetstap over grensesnitt

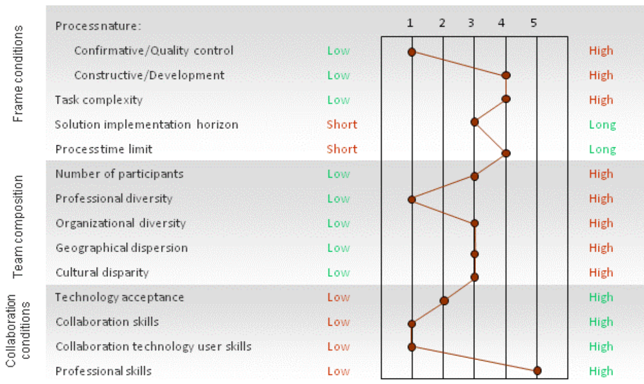
HFC forum 20 -21. oktober 2010

Lisbeth Hansson & Bjørn-Emil Madsen, SINTEF

Organisatoriske faktorer og kvalitetstap over grensesnitt

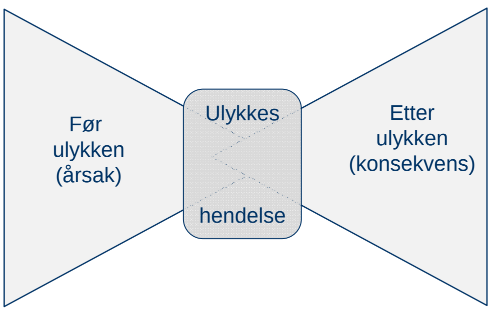


Analyse av samhandling – Collaboration Complexity Profile (CCP)



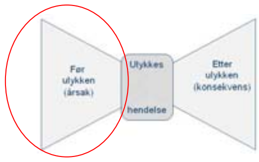
Erfaringer med CCP:
- analyse av samhandlingssituasjoner
- ikke benyttet i forbindelse med ulykkes- forebygging og granskning så langt

Kvalitetstap over grensesnitt gir dårlig samhandling og mulighet for misforståelser, feil og ulykker!



"Bow tie" modellen

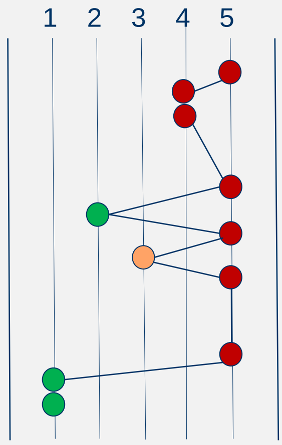
Samhandlingssituasjoner
før ulykken inntreffer



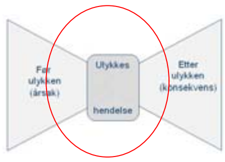
Samhandlingssituasjonen
- komplekse beslutninger
- begrenset tid
- stress

Organisering
- antall deltagere/organisasjoner
- spredt lokasjon
- forskjellige kulturer
- forskjellig fag
- forskjellige mål/agenda

Kompetansemangler
- samhandling inkl ledelse
- fag
- HMS



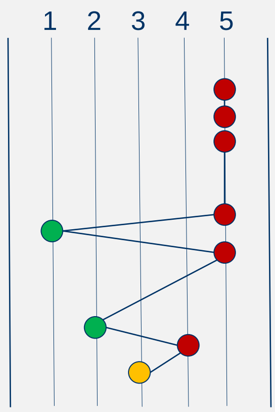
Samhandling i
ulykkessituasjonen



Samhandlingssituasjon
- komplekse beslutninger
- begrenset tid
- stress

Organisering
- antall deltagere/organisasjoner
- spredt lokasjon
- forskjellig fag

Kompetansemangler
- samhandling og ledelse
- lokal kunnskap
- helhetsforståelse



Oppsummering

- Kvalitetstap over grensesnitt gir dårlig samhandling og kan føre til misforståelser, feil og ulykker!
- God samhandling er viktig
  - for å unngå ulykker
  - for å begrense skadeomfanget når ulykken er et faktum
- Samhandling og kommunikasjon bør ha en sentral plass i granskning av ulykker
- I en robust organisasjon har man lagt forholdene til rette for god samhandling

Decision support tools for production optimisation - organisational challenges and implications

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Acknowledgement[1]

Abstract

More and more teams are the basic work unit in organizations. Teams of professionals with complementary skills can draw on a wider spectre of knowledge and experience, but research also show that collaboration and the decision making process can be quite complex. ICT supported decisions may be even more complex as additional challenges may arise in the man – technology interface. The challenges when it comes to implementation and use of new ICT tools in organisations are easily underestimated. This paper discusses the complexity of team work and organisational challenges related to implementation and use of new ICT tools. The case study is conducted at a company within the Norwegian oil and gas industry and the ICT tool is a decision support tool called RAMTool. The main objective of the RAMTool is to support decisions about modification projects for production optimisation. The challenges and implications of introducing new ICT tools in complex team work situations are analysed by two analytical frameworks for assessing the collaboration complexity and technology acceptance. Resulting recommendations for improvements are presented and these recommendations should have general application beyond production optimisation in the oil and gas industry.

Keywords: Organisational challenges, ICT tools, production optimisation

1. Team work and frameworks for organisational analysis

1.1 Team work

Teamwork has become a megatrend in organizational development. In the literature on knowledge management (Hasan & Crawford, 2009) it is stated that: A major shift, associated with the advent of information technologies, is a shift from individual notions of expertise and merit to shared information, knowledge and teamwork, i.e. from individualism to collectivism. Organisational knowledge creation occurs when people combine and exchange their personal knowledge with others. Teams can be used as a way to bridge boundaries within an organization and in dealing with inter-organizational issues. Cross-functional teams can bring different kinds of knowledge together for tasks like product development or process

[1] The work with this paper has been supported by SFI Norman and in collaboration with the research project NORM – The Norwegian Manufacturing Model.

improvement, but also to resolve other deep-rooted differences in perspectives (Jassawalla & Sashittal, 1999).

Focus on teamwork within organizations has increased remarkably over the last ten years. Teams are seen as a way to increase organization performance, flexibility and innovativeness, and simultaneously provide increased quality of work life. Concepts such as autonomy, multi skilling, continuous improvement, multidisciplinary problem solving and team leadership have received a lot of attention both in the consultant and the academic literature.

Despite the overall attention, the concept is still vague and ambiguous. Most of the research on teams focuses on social and psychological aspects within the team, and very few studies aim to clarify the structural arrangements, through which teams are integrated horizontally and vertically in an organization and just as important, the dynamic relation between how the team work and the complexity of the work process.

1.2 Collaboration Complexity Profile (CCP)

The Collaboration complexity profile (CCP) is a framework for evaluating and managing the variety of challenges implicit in team work.[2] CCP may also serve as platform for communicating about projects, and for designing actions to improve or ensure the quality of the team's output. The main dimensions in CCP are "Frame conditions", "Team composition" and "Collaboration conditions".

High scores in "Frame conditions" and "Team composition" show that the actual collaboration process is complex and must be approached accordingly. Low scores in "Collaboration conditions" indicates that the organization has needs to further develop their platform for collaboration. However, it is the total collaboration profile that determines the probability for success in these projects. The CCP profile gives project managers an analysis of a particular collaborative process in a way that produces a platform for organizational and technological decisions where they are mostly needed, i.e. teamwork training, reducing professional diversity in the team, or expand the process time limit.

Frame conditions

"Frame conditions", the first dimension in the CCP framework, measures the limitations and opportunities for the collaboration process. The dimension consists of five factors: *Process natur*e shows the nature of the main goals of the overall process. If the goal of the process is mainly to confirm the validity of data, information or prior decisions, that is significantly different from a process goal that aims at solving a novel problem by developing relevant actions. The main issue in this factor is to show the difference between deploying established knowledge vs. collectively creating new knowledge. However, sometimes a team will segue from one goal to another as the process moves forwards. *Task complexity* shows both the size of problem and solution space. Wide space requires different qualities and abilities within the team members than a narrow space. The same goes for handling the solution space. A problem that is so multi-facetted that it is not solvable within one single domain/profession is of high task complexity. *Solution implementation horizon* shows when the solution is to be utilized. Knowing that the solution is to be implemented tomorrow creates more stress for the team members, than knowing that there will be time available to

[2]CCP is developed within SINTEF, Department of Industrial Management.

hone and mature the solution before actual implementation. *Process time limit shows* the overall time frame available for producing a solution.

Team composition

"Team Composition", the second dimension, measures the organizational profile of the team. It consists of five factors: *Number of participants* – how large is the team. *Professional diversity* measures the degree of heterogeneity in the team. The degree of professional diversity influences how managers can establish shared situational awareness. Consequently, a large team of experts from many different professions faces different and greater challenges regarding communication and knowledge sharing than a small team with members that are professionally homogenous. However, both a very small team and a too homogenous team may also be counterproductive. *Organizational diversity shows* to what degree the team is composed across organizational borders within one company, as departments/business or shop floor units, or a mix of people from two or more companies. In both cases differences in mindsets, work practice and business goals may constipate the problem solving process within the team. However, according to the type of problem that is to be solved, the level of diversity could be both too low and too high. Nevertheless, a high level of organizational diversity is in most cases a greater risk factor when it comes to conducting productive team work. *Geographical dispersion* shows to what degree team members are located in the same place. This issue is now more and more managed by means of ICT/videoconferencing. However, even if the quality of the technology is good and documents are shared electronically, the communication within a virtual team can never be as rich as when people are in the same room. *Cultural disparity* is about differences in habits, attitudes, values, perceived status etc. due to what culture each team member reflects. Culture disparity is about nationality (Norwegians vs. Italians), but could also be about company size and type (large/dominant vs. small/submissive), or professions (engineers vs. psychologists). Team members' mindsets reflect their cultural roots, and thus affect both will and ability to communicate well across these differences, and how they act and play their roles in the overall team process. The necessity of ICT mediated communication may add to the impact of such differences. Cultural kindred experts may have small problems communication by ICT while cultural diverse team members may encounter great challenges communicating, even in the same room.

Collaboration conditions

The third main dimension of the CCP framework , measures what impact team members skills and knowledge have on the collaboration process. *Technological acceptance* is about the members' general attitudes and trust towards ICT and includes a review of the actual collaborative ICT solutions in use. For team members with low degree of technological acceptance, ICT will constitute "noise" and hence likely reduce their ability to truly contribute. *Collaboration technology skills* is the members' ability to utilize the ICT solution in use. This element also comprises the ability to behave appropriately when conducting mediated communication. *Professional skills* is about to what degree each team member represent expertise within his or hers domain. A closely related question deals with the relevance of the same expertise. *Collaboration process skills* is about the team members' ability to take fully part in the collaboration process and taking responsibility for the process of solving a problem.

1.3 Technology acceptance model (TAM)

The term "technology acceptance" is widely used within the organisational research literature and covers the Man, Technology and Organisational (MTO) aspects of implementing new ICT in organisations. The technology acceptance model (TAM) (Legris et al. 2003) is a framework that examines the mediating role of perceived ease of use and perceived usefulness in the relation between systems characteristics and the probability of system use. TAM has its main role in analysing ICT tools in relation to the team, but the work tasks are considered as well.

One key measure of implementation success for new ICT tools is achieving the intended level of usage. People's actual use of a technology depends on their perception of that technology. In the Technology Acceptance Model (TAM) this has been divided into the user's perceived usefulness and their perceived ease of use. These two aspects influence attitudes (intention to use) and finally the usage behaviour. The TAM model has been verified in numerous studies and external factors influencing perceived usefulness has been established as illustrated in Figure 1, the TAM2 model. Experience influence on the perceived usefulness and at the attitude as well. Voluntariness influences directly the attitude.

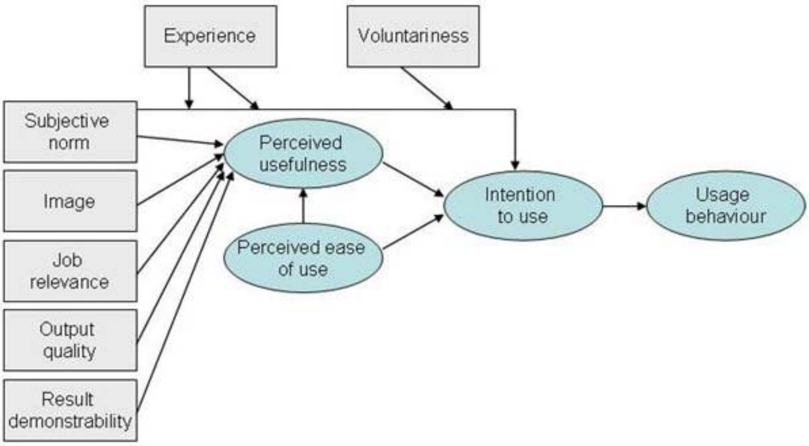

Figure 1. Technology Acceptance Model – TAM2 (Legris et al. 2003))

"Subjective norm" is defined as beliefs about other people's expectations. "Image" is the degree to which use of an information system is perceived to enhance ones image or status in ones social system. "Job relevance" is an individual's perception regarding the degree to which the target system is applicable to his or her job. "Output quality" refers to how well the system performs tasks matching the user's job goal while the "result demonstrability" is the tangibility of the results of using the system, including their observability and communicability.

2. Case study

2.1 Organisation and team

The organisation ((HUGO)) in the case study is a FPSO (Floating Production, Storage and Offloading Unit) contractor operating in the oil and gas business. The current operations for the HUGO fleet are in the tail end production for the respective fields. High oil prices have extended the fields' lifetimes significantly, contributing to increase in reserves recovery.

More than doubling the time of operation on a field beyond what was originally anticipated and planned involves particular challenges to integrity and maintenance management. Each FPSO is operated from an onshore operation centre located partly in Norway and partly in UK. The main office with administration, engineering and project departments are collocated with the operation centre in Norway. This geographically distributed organisation operates FPSOs in different parts of the North Sea. The company culture is characterized by a mix of nationalities (Norwegians and Englishmen) and a mix of cultures (offshore and maritime). Mostly the personnel from the offshore industry has an academic background for while most of the personnel from the shipping industry has worked their way up through more operational positions to leading positions. The work process to be analysed in this paper covers decisions about the availability and profitability of modification projects. Decisions concerning modification projects are team based and the team composition depends on the size and the nature of the modification project. For larger modification projects the operation manager will be the overall decision maker and the engineering department will be running the project. A dedicated project team will be doing the evaluation of the modification projects when entering new contracts and the overall decision maker will be the company manager.

2.2 Work tasks and processes

When an FPSO is about to enter a new contract, major modification may be needed to adapt to a new production profile. In ordinary operation, modification may be necessary due to maintenance intensive systems or ageing. Production regularity vs. modification cost is a key decision parameter. The specific case analysed in this paper is as follows: one of the units operating from UK has experienced problems over time with one of the main compressors. The operation manager in the UK office contacts the operation department in Norway and the discussion start. The engineering department is asked to evaluate the possible technical solution. The operation manager has concluded that it is no other choice than installing a new compressor and this should be done ASAP. The operation manager’s team must decide if other solutions are possible, and what is the most cost effective solution. An analytical tool based on RAM model methodology called RAMTool, has been developed to support operation manager teams in these decision processes.

2.3 RAMTool

RAM models are traditionally used mainly as design tools, the use of the RAM model as an operational support tool is rather innovative. Usually regularity modelling of such systems is conducted by using Monte Carlo methods. These methods have huge flexibility and are often treated as a “general modelling framework”, but it has a major weakness in the sense that it is almost impossible to verify that the model has been set up correctly. Another problem with the method is the computational time required for obtaining the results. In the case of maintenance optimization Monte Carlo methods seem inappropriate due to the combinatorial problem, i.e. the number of combinations of different maintenance intervals to consider. The FPSO production system is modelled by reliability block diagrams where each block represents a single component or a sub-system. Production availability figures of the sub-systems are estimated based on the system configuration. Finally, the total system availability is estimated. The component availabilities are calculated based on the component-failure rates and remaining lifetime distributions. Additionally, the estimated mobilization time for spare parts, ramp-up time and repair time are used to calculate the expected downtime.

3. Analyses of case

3.1 Analysis of case using the TAM framework

We have used the TAM framework to analyse the introduction and use of the RAMTool in the case of the faulty compressor.

Experience

None of the team members have experience with the RAMTool. The team members with an academic background are more used to analytical approaches in problem solving than team members with a practical background who tend to solve problems based on their operational experience. Introducing a decision support tool in an organisation may be a threat to the decision makers. Using decision support tools like the RAMTool also implies making tacit knowledge explicit and documenting the basis for the decisions. For some the process of revealing their personal knowledge may be giving away status and power.

Subjective norm and Image

The manager for the operation support department is an experienced and dedicated user of decision support tools such as the RAMTool. He has not, however, so far been propagating his view internally in the organisation. So far only researchers have used the RAMTool in the organisation. A RAM analyst is a new position and the status he gets depends to a high degree of the response and support from the department manager. How will the RAM analyst be met when he presents results from analysis within the organisation?

Job relevance

The company wants to become a learning organisation to be able to cope with the shortage of experienced personnel, a growing problem in a phase of expansion. The RAMTool has the potential of becoming part of an “organisational memory” and a tool for knowledge sharing. The RAM model describes the reliability network of the production plant and input data will be stored as a company memory. Decisions made about modification projects will also be documented for the future.

Output quality

During the development phase the RAMTool was used on several occasions. One particular FPSO used it to support negotiations for prolonging a contract. It was useful especially when they needed larger replacement of piping and valves. Experienced personnel registered failure data. Conservative input data for failure rates and lead times for critical spare parts, gave results that favorized replacement of given systems. At the same time these conservative estimates gave some surprisingly results for the total availability. As the availability was calculated to around 90% while the experienced reliability was between 95 – 98%, this result raised some scepticism towards the tool.

Result demonstrability and Perceived ease of use

The RAMTtool has provided useful results even in this initial phase, The company's internal RAM analyst has traditionally used a spreadsheet for calculating minor modification projects He has now started to use the RAMTool and realise that the tool will ease and improve these calculations. The RAMTool is developed as an analytical tool and is easier to use than Monte Carlo simulation based RAM models. It is essential that the decision makers trust the result from the analysis and accept the use of the new technology as a decision support tool.

3.2 Analysis of the case using the CCP framework

When we use CCP to analyse the complexity of the work tasks and the team situation, the overall impression is that this is a complex collaboration situation (see Figure 2).

The decision making consist to a low degree of confirmation activities and dependent on the modification project in question, it includes development work. The task complexity is high. Relatively high scores for solution implementation horizon and process time limit improves the conditions for a good decision as the team has more time available.

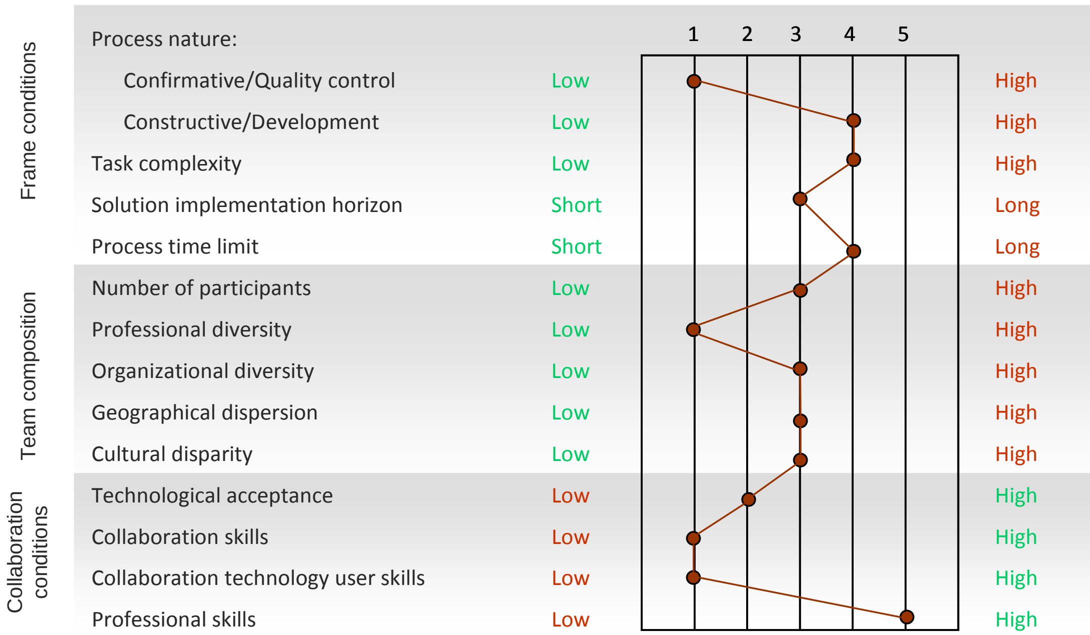

Figure 2 Collaboration Complex Profile for case

The team composition parameters are relatively high. The team members are from both UK and Norway. This represents a double challenge - the team must collaborate over distance, and the mebers represent different national cultures. In addition the team members belong to different departments within the company and the collaboration between the departments have traditionally been challenging.

The "collaboration conditions" scores are low, indicating low competence and skills for cooperation. An exception is the professional skills as the professional competence within this company is high in general. The team is supposed to collaborate partly by dated, well established tools such as telephone and e-mail but also using new collaboration technology such as video conferencing, which they are inexperienced in the use of. Technological acceptance related to the RAMTool is quite low as we have seen from the TAM analysis.

4. Discussion and concluding remarks

This paper has studied the organisational challenges and implications of implementation and use of decision support tools for production optimisation. We used the TAM framework to analyse the socio-technical interface between the ICT tool and the team organization. The CCP framework has been used to analyse the collaborative decision situation. The analyses show the organisational challenges that arise when new decision support tool are introduced with a particular focus on the team organisation. With the right stakeholders involved, such analysis can be used as input in organisational improvement or change processes. A stakeholder could be the team leader, the project leader or the company manager. Anyway, the stakeholders should be in position to decide on changes.

Examples on improvement input for the specific case in this paper, is that the managers should communicate their commitment and ownership towards the RAMTool throughout the organisation and sufficient resources should be allocated for implementation of RAMTool. The collaboration competence and the competence of using videoconferencing systems within the team should be improved; attending training courses are one way of doing this.

As described in this paper, teamwork is associated positively with descriptions like organisation knowledge creation, bringing different kind of knowledge together and an increased quality of work life. This study has contributed with tools and research related to the organisational challenges of realizing these positive effects from team work. This work is also relevant to collective work forms not necessarily defined as team work. The group of persons involved in the work process in the case will most probably not define themselves as a team. The “team” in our case is no organisational unit, they have no dedicated leader and this can partly explain their low scores on collaboration skills.

We have not applied TAM and CCP in real change processes until now. Future plans will be to apply these tools in industrial cases and follow up the change processes. Different types of teams should be analysed, a project group could be a relevant start. These analyses could be done in front of, during or after implementation of new ICT tools or for improvement of team work situations. This case study was related to the oil and gas business, in our opinion tools like TAM ad CCP are generic and could be used in all businesses on all levels of the organisation.

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HFC

Closing the loop between HF in accident investigation and implementing CRM: From Nature to Nurture

K. Mearns

Mere informasjon:

Vedlagte paper, R. Gordon, R. Flin, K. Mearns "Designing and evaluating a human factors investigation tool (HFIT) for accident analysis" Safety Science 43 (2005) 147–171

Closing the loop between HF in accident investigation and implementing CRM: From Nature to Nurture?

Kathryn Mearns

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Introduction

- To err is human…..
- Human performance problems dominate high hazard/ high reliability industries
- Need good diagnostic techniques
- Need to design interventions on the basis of diagnosis and understanding of the factors that influence human behaviour

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Data Collection Techniques

- Task analysis / Cognitive Task Analysis
- Accident analysis (non-technical /human factors e.g. HFIT, TRIPOD, SYNERGI)
- Crew interviews and surveys
- Worksite and simulator observations
- Confidential safety reporting systems
- Organisational - Safety climate surveys

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Closing the Loop

1. Diagnosis

2. Design Intervention

   Establish outcome goals/ measures

3. Evaluate impact (ROI)

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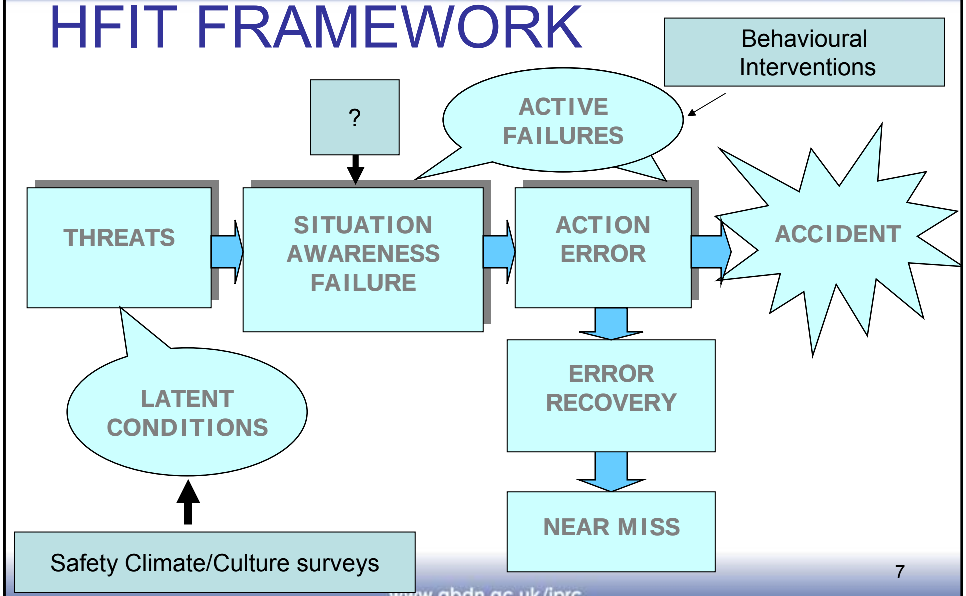
Designing and evaluating a human factors investigation tool (HFIT) for accident analysis

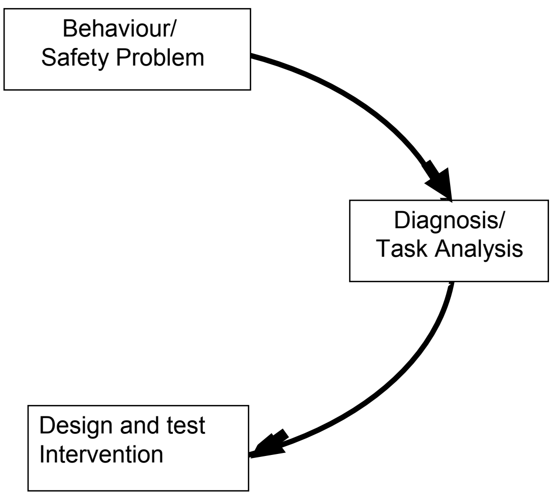
R. Gordon, R. Flin, K. Mearns Industrial Psychology Research Centre, University of Aberdeen, Scotland

Safety Science 43 (2005) 147–171

HFIT FRAMEWORK



Closing the Loop



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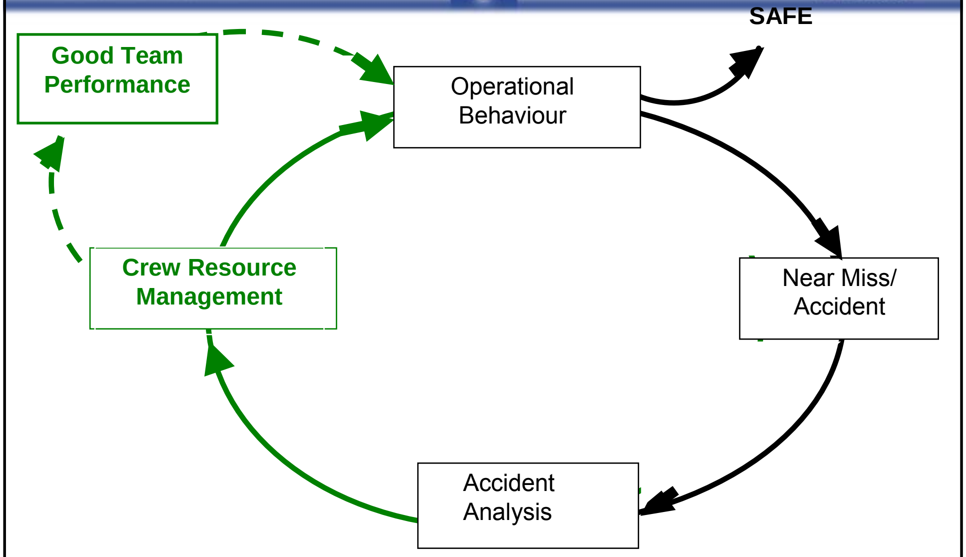


Aims of Crew Resource Management

- Reduce human error
- Reduce the effects of human error
- Enhance teamwork
- Increase situation awareness
- Increase effective communication
- Increase safety and productivity

'CRM training provides a set of countermeasures against human error; it is based on the premise that human error is ubiquitous and inevitable'. *Helmreich (1996)*

Pilots' Non- Technical Skills

- Term non-technical skills first used in European civil aviation (1990s).

Non-technical skills are the cognitive and social skills that complement technical skills, and contribute to safe and efficient task performance.

Aka: Crew Resource Management (CRM) skills

Formally trained and assessed in aviation and nuclear industries

Pilots' Non-Technical Skills

NOTECHS system (1998)

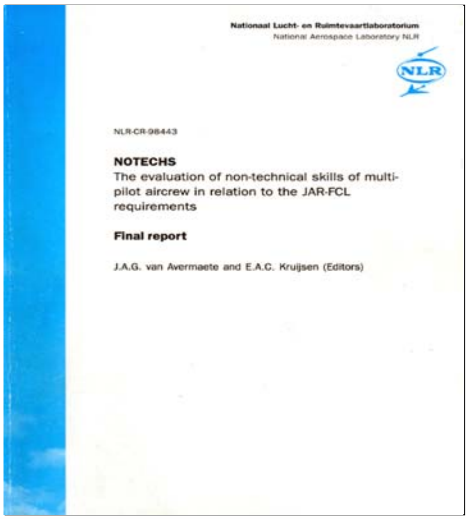
Pan-European

Behaviour rating method to assess a pilot's non-technical (CRM) skills.

Recommended by JAA/ CAA

Adopted by some airlines, adapted by others.

Flin et al. (2003) *Human Factors & Aerospace Safety, 3, 95-117*



Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

NLR

NLR-CR-98443

NOTECHS
The evaluation of non-technical skills of multi-pilot aircrew in relation to the JAR-FCL requirements

Final report

J.A.G. van Avermaete and E.A.C. Kruijsen (Editors)

The NOTECHS framework

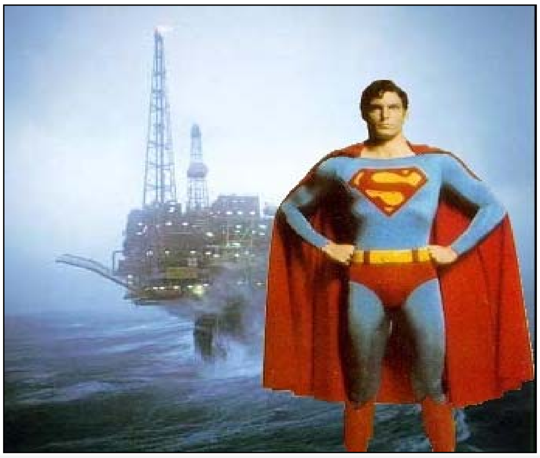
Non-technical skills
- Co-operation
  - Team building & maintaining
  - Considering others
  - Supporting others
    - Helps other crew members in demanding situations
    - Offers assistance
  - Conflict solving
- Leadership & management skills
- Situation awareness
- Decision making

Category

Element

Behaviour

Do people offshore make errors?



Evidence from the Offshore workforce

- In a survey of a sample of the workforce on six platforms (n= 622) carried out by Flin, Mearns, Fleming & Gordon (1996) 70% of the workers agree that "most accidents are due to human failure"
- In addition, over a third of the respondents cited "lack of care and attention" as the most common cause of accidents

Factoring the human into safety: Translating research into practice
Crew Resource Management Training for Offshore Operations
Volume 3 (of 3)

Prepared by the **University of Aberdeen** for the Health and Safety Executive 2003

RESEARCH REPORT 061

CRM topics identified from accident analysis

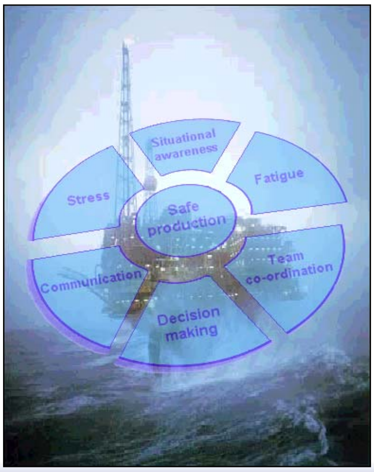
Data collected from 7 companies over a 2 year period (1268 incidents) using the ISRS system incidents were coded into 1123 codes.

CRM topic	Percentage
Team work	6
Leadership	2
Situational awareness	9
Decision making	11
Communication	5
Personal limitations	13
Total	**46**

Adapted from Flin, Mearns, Gordon, & Fleming (1998)

CRM training Offshore

1. Establish the required non-technical skills, e.g. decision making or situation awareness.
2. Design evidence based training.
3. Develop appropriate measures to assess the success of the training.



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CRM Training Modules

- Leadership
- Team Work / workload management
- Communication
- Situation Awareness
- Decision Making
- Personal Limitations - stress and fatigue

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Training Evaluation Measures

- Participant feedback (course content and delivery)
- ☺ ☻ I enjoyed this course! The trainers were brilliant!

But has training transferred to worksite?

- Skill tests
- Interviews / questionnaires (attitudes, behaviours)
- On the job/ simulator observations
- Safety climate assessment
- Accident rates

CRM training beyond the cockpit

Maersk: CRM for ships and rigs

Pre-CRM

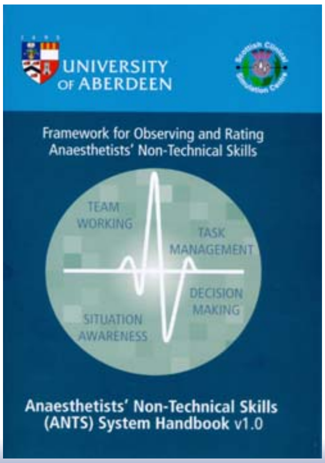
(1992) 1 Nautical casualty per 30 ship years
6.5 LTIs per million exposure hours per fleet

Post-CRM

(1996) 1 Nautical casualty per 90 ship years
3.7 LTIs per million exposure hours per fleet
(1998) Reduction of insurance premium by 15% for fleet and offshore installations

Anaesthetists' Non-Technical Skills

Flin, Fletcher, Glavin, Maran, Patey (2004)



Anaesthesia (2002)
British Journal of Anaesthesia (2003; 2004)
Cognition, Technology & Work (2004)

Available from www.abdn.ac.uk/iprc/ants

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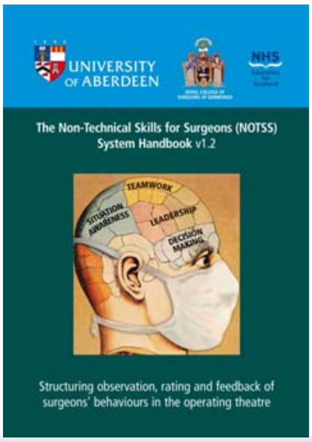
Non-Technical Skills for Surgeons (NOTSS)
Flin, Yule, Paterson-Brown, Rowley, Maran (2006)



Yule et al
(2006) *Surgery*
(2006) The Surgeon
(2008) *World Journal of Surgery*
(2009) ANZ J Surgery

Available from
www.abdn.ac.uk/iprc/notss

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NOTSS (surgeons) skills taxonomy

Categories	**Elements**
Situation Awareness	Gathering information Understanding information Projecting and anticipating future state
Decision Making	Considering options Selecting and communicating option Implementing and reviewing decisions
Communication and Teamwork	Exchanging information Establishing a shared understanding Co-ordinating team activities
Leadership	Setting and maintaining standards Coping with pressure Supporting others

Flin, Yule, Paterson-Brown, Rowley, Maran (2006)

NOTSS rating scale

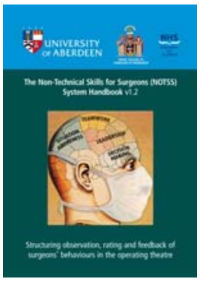
1 **Poor** Performance endangered or potentially endangered patient safety, serious remediation is required

2 Marginal Performance indicated cause for concern, considerable improvement is needed

3 Acceptable Performance was of a satisfactory standard but could be improved

4 Good Performance was of a consistently high standard, enhancing patient safety; it could be used as a positive example for others

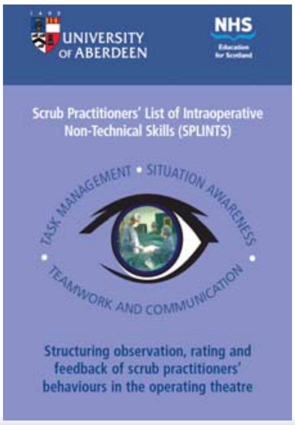
N/A Not Applicable. Skill was not required or not relevant in this case or scenario



NOTSS rating form

Category	Category rating*	Element	Element rating*	Feedback on performance and debriefing notes
Situation Awareness	3	Gathering information	2	
		Understanding information	4	
		Projecting and anticipating future state	3	
Decision Making	3	Considering options	2	Consider discussing the decision to convert with the anaesthetist next time
		Selecting and communicating option	3	
		Implementing and reviewing decisions	3	
Leadership	2	Setting and maintaining standards	3	
		Supporting others	2	Ensure you delegate tasks appropriately
		Coping with pressure	N/A	
Communication and Teamwork	1	Exchanging information	2	Be more precise when asking for instruments
		Establishing a shared understanding	1	Brief theatre personnel beforehand about the operation and your expectations
		Co-ordinating team activities	4	

Scrub Practitioners' Non-Technical Skills (SPLINTS)



Mitchell, Flin et al. (2010)

www.abdn.ac.uk/iprc/splints

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- www.abdn.ac.uk/iprc
  lists of projects and papers and reports

Scottish Patient Safety Research Network

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Designing and evaluating a human factors investigation tool (HFIT) for accident analysis

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Abstract

In an attempt to improve the investigation of the human factors causes of accidents in the UK offshore oil and gas industry, a Human Factors Investigation Tool (HFIT) was developed with the sponsorship of the UK Regulator, the Health and Safety Executive, and four exploration-related companies. The tool was developed on a theoretical basis with reference to existing tools and models and it collects four types of human factors information including (a) the action errors occurring immediately prior to the incident, (b) error recovery mechanisms, in the case of near misses, (c) the thought processes which lead to the action error and (d) the underlying causes. The investigation tool was evaluated on the basis of (i) an inter-rater reliability assessment, (ii) usability assessment, (iii) case studies and (iv) an evaluation system developed by Benner [Benner, L. 1985. Rating accident models and investigation methodologies. Journal of Safety Research 16, 105–126] Evaluation system. Although there is a need for further validation and analysis of HFIT using more realistic accident scenario exercises, some validation of the tool has been possible. In addition, it has been shown, in a small sample of accident investigations, that HFIT was found to be useful for the development of remedial actions, one of the main objectives of the tool.

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0925-7535/$ - see front matter
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1. Introduction

The collection and analysis of accurate accident data is essential for improving workplace safety, although is only one of several possible diagnostic sources (see Dekker, 2004 for a recent critique of over-reliance on accident and error data). Despite the importance of accident analysis, many industries still have accident reporting systems that are vulnerable to under reporting, have incomplete recordings and do not necessarily provide a complete picture of the conditions under which accidents take place (Stoop, 1997). For example in the offshore oil industry, there are currently no standard accident reporting systems in existence, instead companies tend to develop or purchase their own specific systems. Most of the oil companies operating on the UK Continental Shelf (UKCS) base their accident reporting systems on the International Safety Rating System (ISRS) developed by the International Loss Control Institute (ILCI; Bird and Germain, 1985), which (along with other systems in use) lacks a firm theoretical framework for psychological factors. Although information produced from these accident reporting forms can be extensive, the quality and quantity of data concerning human factors causes of accidents is generally poor; such as the sparse inclusion of human factors codes and the lack of understanding of these codes.

Accident investigation methods which are based on more robust human factors accident causation models allow safety managers to make a broader interpretation of their accident statistics in order to reduce the likelihood of future accidents. This paper describes the development and evaluation of a human factors incident investigation tool (HFIT), based on the dominant psychological theories of accident causation, which has the potential to improve the quality of human factors incident data.

1.1. Background research

Prior to the development of HFIT, two prototype human factors reporting forms were developed, tested and evaluated in the offshore oil industry, and provided part of the basis for HFIT (see Mearns et al., 1997; Gordon et al., 2000). One reporting form contained 11 open questions regarding the causes of an incident and the other reporting form contained 'yes'/'no'-choice questions. The forms were completed by the witnesses to the incident and the relevant line management. Both were found to extract additional and more specific information regarding the human factors causes of accidents than the company's original report. However, it was felt that in order to gather more comprehensive and accurate data, the human factors investigation of offshore incidents could be further improved.

A review of the theories of accident causation and an analysis of 18 incident reporting systems provided the basis for HFIT (Gordon, 2002) and are listed in Table 1.

The theoretical basis of HFIT includes the Model of Human Malfunction by Rasmussen et al. (1981), the Human Information Processing Model by Wickens (1992) and Kontogiannis (1999) system for measuring error recovery. Three of the incident

Table 1
List of incident reporting systems reviewed for the development of HFIT

	Reference
1. *Reactive Incident Reporting Systems*	
Management oversight risk tree (MORT)	Johnson (1980)
Nuclear regulatory commission (NRC)	West et al. (1991)
Maintenance error decision aid (MEDA)	Boeing (1995)
Maintenance error investigation (MEI)	Baachi et al. (1997)
TapRoot	Paradies et al. (1996)
Human performance investigation process (HPIP)	Paradies et al. (1993)
Incident reporting system (IRS)	IAEA (1998)
Human performance enhancement system (HPES)	Bishop and La Rette (1988)
Safety through organisational learning (SOL)	Fahlbruch and Wilpert (1997)
Human factors analysis and classification system (HFACS)	Wiegmann and Shappell (1999)
Technique for retrospective analysis of cognitive errors (TRACEr)	Kirwan et al. (1999)
IFE incident investigation system	Green et al. (2000)
2. *Combined pro-active and reactive investigation systems*	
Tripod (BETA and DELTA)	Hudson et al. (1994)
Aircraft dispatch and maintenance safety (ADAMS)	McDonald (1998)
3. *Confidential incident reporting systems*	
Aviation safety reporting system (ASRS)	Reynard et al. (1986)
British airways human factors reporting (HFR) programme	O'Leary (1999)
Confidential human factors incident reporting program (CHIRP)	CHIRP (2000)
Confidential incident reporting and analysis system (CIRAS)	Wright and Davies (2002)

reporting systems examined were found to be of particular relevance: the system for analysing aircraft dispatch and maintenance incidents (ADAMS, 1998), a taxonomy developed for Air Traffic Management incident analysis, called Technique for Retrospective Analysis of Cognitive Errors (TRACEr, Kirwan et al., 1999) and an incident investigation system developed for Phillips oil company (IFE, Green et al., 2000). Causal codes identified from a review of the human factors common to safety climate surveys and accident analysis studies (Gordon et al., under review) were used to check that relevant codes were included within the investigation tool. This stage of background research also identified the increasing use of psychological concepts relating to threat management (Helmreich et al., 1999) and situation awareness (Endsley and Garland, 2000) in human factors analysis systems for the aviation industry. Both of these constructs were relevant to the accidents occurring in the offshore oil industry and consequently these were also incorporated into the HFIT system.

2. Underlying model and structure of HFIT

On the basis of the above review and analysis, the structure of HFIT is developed on a sequential model of the incident trajectory where incidents (accidents and near

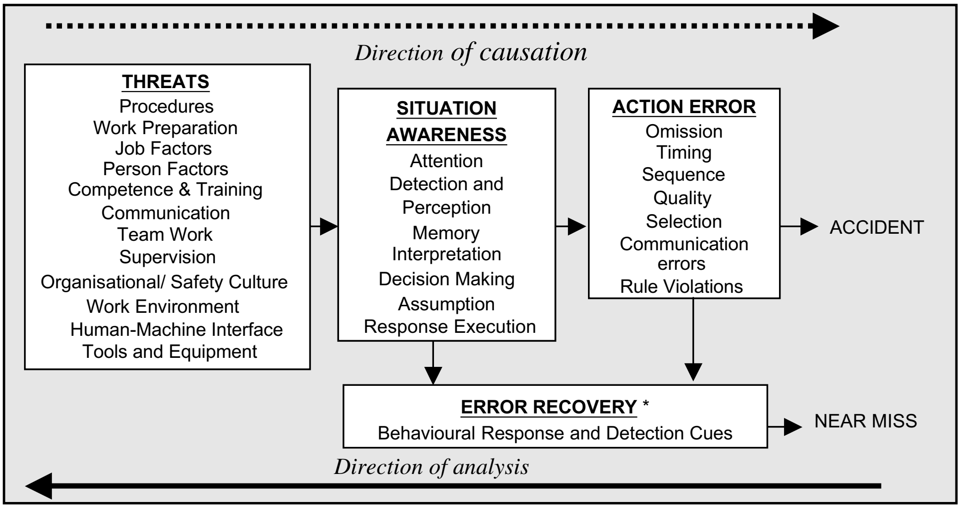

Fig. 1. HFIT model of incident causation and direction of analysis. (*) Can be analysed after the 'action error' or 'situation awareness' categories.

misses) are seen as the product of a number of different causes organised into four categories. As Fig. 1 illustrates, the behaviours immediately prior to the incident are described as the first category called 'Action Errors', which personnel at the sharp-end enact. These action errors are generally preceded and caused in part by a reduction in awareness of their situation, so Situation Awareness is the second category. The reduction in situation awareness is often related to 'Threats' to safety from the work environment or are conditions that may have been in the system for some time, but have not been identified nor rectified (third category). If the error, or reduced situation awareness is detected and recovered from before an accident occurs (error recovery), a near miss results. So a fourth category called Error Recovery is included that could occur during the action error or situation awareness stages.

The four categories, contain a total of 28 elements, listed in Fig. 1. Each of these elements are further described in Fig. 2, although only some examples are given at the 'sub-element' and 'item' levels. Action error elements are divided into 22 further 'items', situation awareness elements are described by 21 'items' and the error recovery elements contain 7 items. The 12 threat elements are divided into 'sub-elements' ($n = 43$) and 'items' ($n = 271$) and these are described in more detail in Gordon et al. (2002).

The following sections describe each of the four categories in more detail.

2.1. Action errors

This category is based on task-based taxonomies (such as Swain and Guttman, 1983) that describe the observable errors occurring immediately prior to the incident, but do not provide any causal information as to why or how the incident

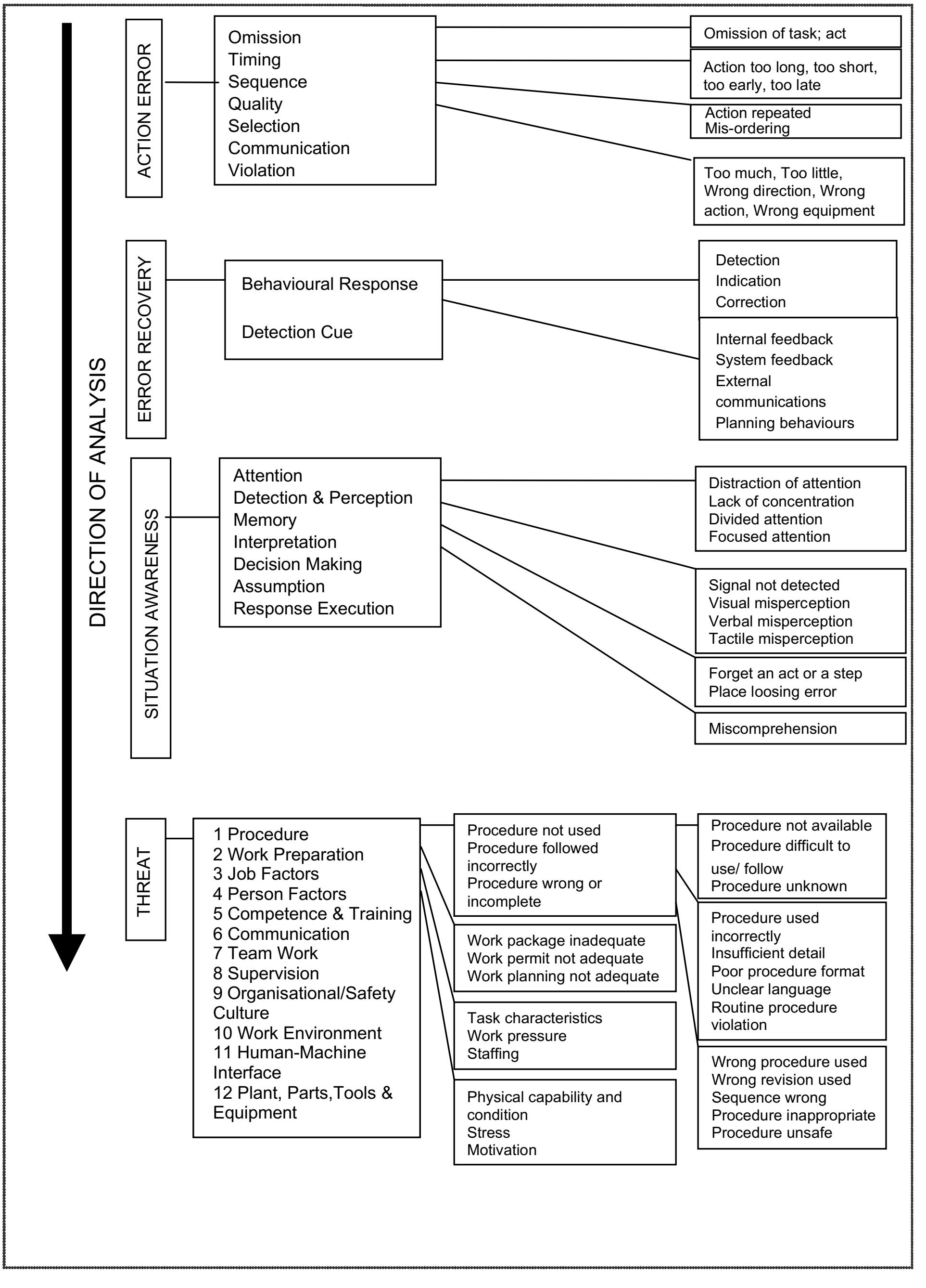

Fig. 2. Structure of HFIT.

happened. Such errors are referred to as External Error Modes in Rasmussen's (1981) taxonomy and as phenotypes by Hollnagel (1993). A taxonomy developed for Air Traffic Management incident analysis (TRACEr: Kirwan et al., 1999), contains a revised Swain and Guttman (1983) error mode taxonomy (consisting of: omissions; timing errors; sequence; quality; selection and communication errors). This has been revised slightly (at the item level) and used in HFIT. Action errors have been included in HFIT in order to understand the precise nature of the error before the causes for the error are investigated. It has been relabelled as 'action errors', as the original label (External Error Mode) uses jargon language (which is not user-friendly for non-human factors experts). It was thought that because the described errors are about errors of action, the term 'action errors' provides a clearer label. Despite this, some basic human factors training is required for potential users of the tool (see Section 3.2). This category contains six elements:

- Omissions—task or part of task not performed,
- Timing errors—action too short; too long; too early; too late,
- Sequence errors—action repeated; mis-ordering,
- Quality errors—action too much; too little; in wrong direction; wrong action right equipment,
- Selection errors—correct on wrong equipment/parts,
- Communication errors—information not transmitted/recorded; unclear information; incomplete information; incorrect,
- Violations—unintended; exceptional; routine; general.

2.2. Error recovery

Error recovery is thought to be an important supplementary safety goal since the 'zero accident policy' postulated by many oil companies (although remaining the ultimate safety goal) may be difficult to achieve in complex socio-technical systems (Kontogiannis, 1999). In some industries, systems are being developed which focus on preventing the consequences of human error by providing opportunities for error recovery (Helmreich et al., 1999).

A simplified version of the error recovery framework developed by Kontogiannis (1999) was used in HFIT. The first element, 'behavioural response', contains three questions regarding the possible recovery process of the error: (i) detect (i.e. realise or suspect that an error is about to occur), (ii) indicate (i.e. notify others in the team) and (iii) correct (i.e. modify an existing plan or develop a new one). The second element, 'detection cues', contained four questions regarding how the error was detected. This included 'internal feedback', 'system feedback' 'external communication' and 'planning behaviours'. This stage of the incident analysis would normally be undertaken after the action errors have been identified, although it could also be undertaken after the 'situation awareness' section.

2.3. Situation awareness

Information processing theory is one of the most widely used models in human error research and is perhaps the most useful cognitive error model for industrial applications. It states that people perceive information via their senses, interpret this information and make decisions concerning its meaning and relevance based on their previous understanding and current interpretation. (Wickens and Hollands, 2000). Both ADAMS (1998) and Kirwan et al. (1999) used Wickens (1992) Human Information Processing Model to collect data on cognitive failures. This approach has been included in HFIT, although it has been relabelled as 'situation awareness' (Banbury and Tremblay, 2004) since many of the items under this heading refer to the cognitive awareness of the individual. Situation Awareness has been defined as "the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status in the near future" (Endsley and Garland, 2000, p. 5). Situation awareness issues (e.g. loss of concentration, distraction) are frequently mentioned in accident reports from the offshore drilling industry (Sneddon et al., 2005). The category within HFIT is divided into seven elements that are based on the systems used by ADAMS (1998), Kirwan et al. (1999) and Wickens (1992):

- attention—distraction; lack of concentration; divided attention; focussed attention,
- detection/perception—signal not detected; visual, verbal, tactile misperception,
- memory—forget or miss a step; failure to consider all factors; place losing error,
- interpretation—miscomprehension,
- decision making—apply incorrect/inappropriate/partial solution,
- assumption—relating to task, equipment, parts, systems, procedures,
- response execution—stereotype take-over, motor variability.

2.4. Threats

Threats are defined as situations that can encourage the occurrence of errors. This label has been taken from the work of Helmreich et al. (1999) from their research into threat and error management in the aviation industry. The 12 elements of threat are based on the content of the two human factors reporting forms briefly described previously (Mearns et al., 1997) and are described below.

Policies, standards and procedures—refers to the formal instructions or guidance that personnel need to carry out a task or job, such as work-cards, checklists, maintenance manuals, operating procedures, emergency operating procedures. This also includes the content and use of the company's management documents (e.g. general guidelines for planning and carrying out of training, maintenance, production, construction and development of plant/systems, planning systems and the company's goals).

Work preparation—This category includes problems associated with granting work permits, preparation of the plant before starting work (e.g. isolations, pressure testing), as well as planning of time and resources that could have contributed to the incident.

Job factors—This section deals with problems in actually carrying out the task, such as the nature of the task itself, the pressure to carry out the job and the level of staffing.

Person factors—This section deals with problems related to the individuals carrying out the task, such as the individual's physical capability or condition, stress or their motivation to carry it out.

Competence and training—Competence is the combination of skills and knowledge of a job or task. Lack of training can be a contributory factor to an undesired incident because a task that had consequences for the incident was not being correctly carried out.

Communication—Problems with communication can occur between individuals, work teams and managers. This category covers both technical methods (radio, telephone etc.) as well as building up communication to secure clear and distinct information.

Team work—This category includes shared situational awareness (do they have the same common goals/expectations for the job?), team decision-making, and the issue of roles and responsibilities.

Supervision—This category includes supervision during completion of the task, such as the level of work supervision, the roles and responsibilities, the supervisor's instruction and their leadership.

Organisational and safety culture—This includes the level of management commitment, whether or not there is a learning organisation, the reporting culture of the organisation, as well as the use of incentives (see Reason, 1997).

Work environment—This category examines the external & internal environments (e.g. extremes in temperatures) that can lead to incidents such as, problems with the manual handling of the task.

System-equipment interface—This section includes the legibility, labelling, user-friendliness and accessibility of equipment as well as increasing levels of automation.

Tools and equipment—This section involves the design and use of tools and equipment, the plant and parts design, the systems in place for design, maintenance and testing, and protective systems.

3. Procedure

3.1. Process of using HFIT

The Human Factors Investigation Tool, HFIT, was developed in a flowchart paper-based format, and after initial testing by potential users, it was developed as a computer-based tool (see Gordon et al., 2002). The paper version of HFIT is 54 pages long. It was designed for use by investigators of incidents. Fig. 3 illustrates

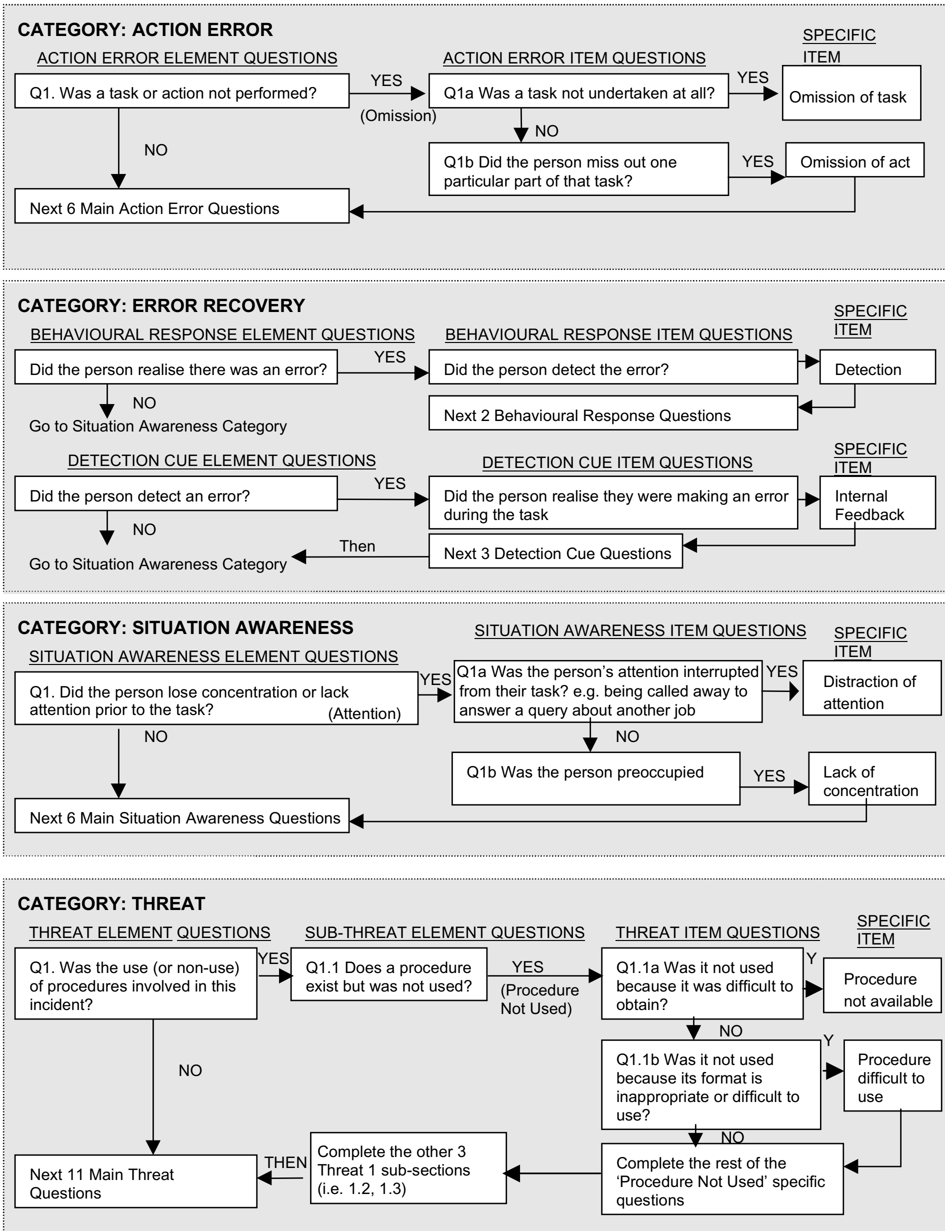

Fig. 3. HFIT process.

the process of investigating each category. The tool can be used in a number of different ways, first as an interview tool, where the investigator goes through the questions with each witness in turn. Secondly, the tool can be used after the witness interviews have taken place and the investigator/s use the tool themselves, keeping in mind what they found from the interviews. Finally, it can be used retrospectively on incidents that have been previously investigated using other investigation tools. The tool has not yet been tested to see which of the first two systems would be most effective for investigating incidents.

Before the investigator uses HFIT to investigate the causes of the incident, as with other investigation methods, information regarding the incident needs to be gathered, such as the people, objects and equipment involved in the incident and their actions. These actions can be plotted on a time line, which can help to establish whether or not there are gaps in the understanding of the accident sequence. The critical events (i.e. those which could have prevented the incident from occurring had they taken place) are identified and these are targeted using the investigation questionnaire. The causes of the critical events are analysed and appropriate remedial actions are implemented to prevent reoccurrence.

The process begins with the action error category, where the investigator asks a series of yes/no questions. The process is illustrated in Fig. 3, where the investigator begins at the element level and if they answer in the affirmative, they go to the item level. If they answer in the negative, they go to the next element question. Once they finish answering all the action error questions, they go onto the situation awareness element questions and follow the same procedure. After the situation awareness section has been completed, the investigator completes both the threat and error recovery sections, where the threat section contains an additional step (sub-elements).

3.2. Training the users

A one-day training course was developed to provide accident investigators ($n = 35$) with information about general human factors principles, instruction on how to use HFIT and scenario exercises to practise using HFIT. The participants generally had engineering backgrounds and previous training and experience in accident investigation. Some of the participants had some previous human factors training (such as Crew Resource Management). They were recruited from the four participating companies and the Health and Safety Executive (UK regulator) (HSE).

A total of five training courses were held, consisting of an introductory section and 10 modules: action errors; error recovery; situation awareness; job threats; person threats; competence and training; communication; team work; supervision; organisational and safety culture. Some of the Threat elements were not included, due in part to time constraints, hence the topics which engineers generally find more difficult to understand were the focus. After each section, respondents were asked to use HFIT to investigate the potential causes of an accident scenario. This allowed participants to practise using HFIT and become more familiar with it. In addition, the responses given by participants to the accident scenario were used to evaluate rater consistency.

The course could be deemed a success if the participants came away from the course with a better awareness and knowledge of the human factors causes of incidents and a good understanding of how to use HFIT to investigate incidents. An evaluation questionnaire was distributed to the participants, which is a standard measure for training evaluation (Goldstein and Ford, 2002) and results from this survey are described in more detail in Gordon et al. (2002). In total, 27 evaluation forms were completed, and overall, training was rated as either satisfactory or good on a 5-point scale (1 = very poor, 2 = poor, 3 = satisfactory; 4 = good; 5 = excellent) regarding their satisfaction with the following five indicators: their level of interest in the topic (mean = 3.7); the presentation of the materials ($m = 3.6$), the structure of the teaching ($m = 3.6$), the standard of the course materials ($m = 3.7$) and the relevance of the topic to their job ($m = 3.9$). Over the five training courses, small modifications to the course were made, where more time was spent using HFIT and less time was spent lecturing about the human factors principles and theories, which helped to improve the course ratings.

3.3. Implementing the human factors investigation tool

Data from accidents and incidents were collected from one of the four participating companies over a 5 month period between July and December 2001 in order to evaluate the effectiveness of the HFIT reporting system for collecting human factors information. Two of the companies did not use HFIT to investigate incidents because they had not taken part in the HFIT training and one company reported that they had no incidents since the training. For the company that collected incident data using HFIT, their investigators were asked to use the paper version of HFIT whenever they felt it could support any incident investigations they were involved in. Initially, the participating company used HFIT after an investigation had been completed using traditional techniques. This was intended to test the HFIT method and demonstrate the integrity of the process and outcomes from HFIT to the users.

3.4. Computer interface and database development

A computer programme was developed in Microsoft Access (1998 and 2000 versions) for HFIT. This tool can guide accident investigators through the relevant questions ultimately leading them to the causes of the incident. The user is given the option of answering either 'yes' (that it is a possible cause) or 'no' (that is not a cause) to each question that appears on the screen. Each cause is recorded on the screen as the user proceeds through the investigation, which allows them to follow their line of investigation. The computer-based version of HFIT can be used by investigators during the interview process with the witnesses, or after they had interviewed the witnesses (see implementation for further details). After the HFIT questionnaire has been completed, investigators are invited to write comments or 'evidence' to support each of the causes they found by describing why they thought that cause contributed to the incident. In addition, the investigation team can include possible 'remedial actions' beside each of the causes. Finally, the data from the investigation can be exported to either Word (in the form of individual reports) or Excel (for analysis with other incidents).

4. Evaluation

In order to evaluate the effectiveness of HFIT for collecting human factors information, the following four evaluation methods were used to assess HFIT and are discussed in turn in this section.

4.1. Accident scenario exercise

Accident investigators ($n = 25$) from the four participating companies (described above in Section 3.2) coded the causes of a specified incident (an actual incident) using HFIT during the HFIT training course. This was undertaken in order to determine the level of agreement between the investigators with regard to the causes of incidents, to determine the inter-rater reliability of the tool.

The incident scenario exercise comprised a one-page offshore accident scenario that the investigators were asked to read. After each section of HFIT was described in the training course, investigators used HFIT to determine which elements, sub-elements and items contributed to the incident from the Action Error, Situation Awareness, Error Recovery and Threat categories. These responses were recorded on a Response Sheet. Investigators were able to choose as many of the causes they thought may have contributed to the incident. The investigators' responses from the Scenario exercise were recoded as 'yes, a cause' = 1 and 'no, not a cause' = 0, and entered into Excel (97) and SPSS (Statistical Package for Social Sciences). These responses were compared to the 'investigation findings' which were a combination of the original investigation findings and a re-analysis of the incident by the HFIT developer and an original member of the investigation team using HFIT. Inter-rater reliability scores for each item, and the 'investigation findings' are described below.

4.1.1. Inter-rater reliability

Inter-rater reliability is the extent to which different raters give the same response for the same observed performance (Howell, 2002). In this case, the test was to find out the extent to which 25 investigators attribute the same causes (by responding 'yes' or 'no') to an accident scenario. Inter-rater reliability scores were calculated for the HFIT Action Error Items ($n = 22$), the Situation Awareness Items ($n = 21$), the Error Recovery Items ($n = 7$) and the Threat Sub-Elements ($n = 42$) in order to determine the consistency of the 25 investigators' responses in terms of which categories, elements and items they selected. Threat Items ($n = 271$) were not included in the analysis due to insufficient time in the training course. It is hypothesised that if the investigators' responses are consistent with each other, this may indicate a shared understanding of the questions, suggesting that the questions may be comprehensible to the investigators. An index developed by James et al. (1984) called the within group inter-rater reliability measure (r_{wg}) was used to test this hypothesis. The scores

Table 2
Inter-rater reliabilities for the main HFIT sections

Action errors	Number of items in scale[a]	% of investigators who found this item to be a cause of the incident	Inter-rater reliability (r_{wg}) of individual element
Omission	3	100	1
Timing	5	44	0
Sequence	3	24	0.24
Quality	5	68	0.09
Selection	2	0	1
Communication	6	100	1
Violation	5	68	0.09
Situation awareness			
Attention	5	76	0.24
Detection and perception	5	40	0
Memory	3	24	0.24
Interpretation	2	28	0.16
Decision making	5	52	0
Assumption	5	92	0.69
Response execution	3	20	0.33
Error recovery			
Behavioural response	4	76	0.24
Recovery cue	5	60	0
Threats	*Number of sub-elements in scale*[a]		
Procedures	6	72	0.16
Work preparation	4	56	0
Job factors	4	44	0
Person factors	4	20	0.33
Competence and training	4	12	0.56
Communication	4	80	0.33
Team work	6	72	0.16
Supervision	4	76	0.24
Organisational/safety culture	5	16	0.44
Work environment	4	8	0.69
Human–machine interface	4	16	0.44
Plant, parts, tools and equipment	6	0	1

[a] Including element.

for the elements are displayed in Table 2 (Column 4). This index is defined as the proportional reduction in error variance of a distribution of obtained responses compared to a distribution representing a random response pattern in which the frequency of the responses is equal for each possible point on the scale ($n = 2$). In this case, there were 2 possible responses: 'yes' and 'no'. The equation for r_{wg} is: $r_{wg} = 1 - (S_x^2/\sigma EU^2)$ where S_x^2 equals the variance of the observed and σEU^2 equals the population variance of a discrete rectangular distribution of the responses. The equation for this is: $\sigma EU^2 = (A^2 - 1)/12$, where A is the number of possible alternatives in the rating scale. Values of r_{wg} can vary from 0 to 1, where a score of 1 denotes perfect reliability between investigators. When the variance of the obtained ratings is random, then $r_{wg} = 0$, reflecting no agreement between investigators.

Overall, the results indicate the overall level of agreement between investigators was low. The causal codes that were selected by over three-quarters of the investigators were omissions (action error); communication (action error); attention (situation awareness); assumption (situation awareness); behavioural response (error recovery); communication (threat) and supervision (threat) indicating the highest consistency between investigators. Additionally, a high number of investigators (68%–72%) agreed on the following causes: quality (action error); violation (action error); procedures (threat) and teamwork (threat).

4.1.2. Agreement between investigators responses and 'investigation findings'

In order to measure how "accurate" the investigators were in coding the causes of the incident, their responses were compared to the 'investigation findings' (See Table 2, Column 1). They selected 33 codes, 19 of which were also selected by more than 50% of investigators. For 10 out of the 33 of codes, more than 75% of investigators chose the same codes (see Table 2, Column 2).

The most common elements that were chosen by investigators were omissions (where 100% of investigators chose this category), communication errors (100%); behavioural response (76%), attention (76%), assumptions (92%), as well as procedural (72%), communication (80%), team work (72%) and supervision threats (76%). At the item level, the most common responses were omission: task not performed (76%), communication: information not transmitted (76%); error recovery: detection (76%); lack of concentration (56%), divided attention (56%) and assumption relating to previous task (56%). The percentages of investigators who agreed with the causes in the threat section were smaller, indicating less agreement between investigators (the best agreement between the investigators' responses and the 'investigation findings' at the sub-element level of the 'threat' category, was 'location of communication threat', 48%).

The relationship between the inter-rater-reliabilities and the percentage of investigators who found the items to be causal indicates that there was high correlation between the investigators when the majority of them either agreed that the item was a cause or when the majority disagreed that that the item was a cause. Furthermore, inter-rater-reliabilities were very small (about 0) when around only about 33%–66% of investigators agreed (or disagreed) that the item was a cause.

Out of the 33 elements, sub-elements and items described in the 'investigation findings' to be the cause of the scenario, 10 were chosen by less than 33% of investigators: only 24% of investigators chose memory: forget an act or a step (16%); work planning not adequate (32%), task characteristics (16%); staffing (28%); communication misunderstood (20%); shared situation awareness-specific event (16%); shared situation awareness-in general (16%); co-operation (28%) and instruction (32%). The results from each category are described in Table 3.

Overall, the majority of investigators chose at least 50% of the codes described in the 'investigation findings'. The average number of codes attributed to the accident scenario by the 25 investigators was 30.6 (range 8–56), where the 'investigation findings' attributed 33 codes to the accident scenario. Some of these codes attributed by the investigators were not identified in the 'investigation findings' ($n = 12.2$ codes;

Table 3
'Human factors investigation findings' and common responses

Human factors investigation findings	% of investigators who found this item to be a cause of the incident
Action errors	
Omission	100
Task not performed	76
Communication	100
Information not transmitted	76
Error recovery	
Behavioural Response	76
Detection	76
Indication	52
Recovery cue	60
System feedback	48
Situation awareness	
Attention	76
Distraction of attention	52
Lack of concentration	56
Divided attention	56
Memory	24
Forget an act or step	16
Assumption	92
Assumption relating to previous task	56
Threats	
Procedures	72
Procedure followed incorrectly	40
Work preparation	56
Work planning not adequate	32
Job factors	44
Task characteristics	16
Staffing	28
Communication	80
Location of communication threat	48
Communication misunderstood	20
Team work	72
Shared situation awareness (event specific)	16
Shared situation awareness (in general)	20
Co-operation	28
Supervision	76
Level of supervision	44
Instruction	32

Labels in bold refer to the categories; in *italics* refer to the elements; indented in italics refer to the items/sub-elements.

range 2–33), indicating that on average, 40% of the codes attributed by investigators were not in the 'investigation findings'.

In conclusion, it would seem the level of agreement between investigators responses and the 'investigation findings' is generally fairly low when using HFIT to code an accident scenario. However, this is not unexpected, since the investigators had only minimal training and practice using the tool. In addition, the accident scenarios were very simple with regard to the amount of detail given and the inability of the investigators to ask further questions of the people involved in the incident.

4.2. Evaluations by the users

Participants were asked for their opinions on the operation and value of the system at the end of the trial period using three methods of data collection: (i) user evaluation form; (ii) written feedback after investigators completed an investigation and (iii) information from informal discussions with HFIT users. The findings below are in reference to the paper version for HFIT. Out of the 35 investigators on the HFIT training course, 15 provided evaluations at the end of the HFIT training course. The user evaluation form was divided into four main sections with a total of 37 questions. The four sections included: (i) ease of use (13 questions); (ii) validity of results (4 questions); (iii) identification of causes of the incident (17 questions), and (iv) comparison with traditional accident analysis techniques (3 questions). This was developed as an Excel spreadsheet.

4.2.1. Ease of use

Overall, the comments indicate that users found HFIT useful for investigating incidents. Some investigators commented that they found it difficult to use at first, but after some practice with the tool they found it much easier to navigate through the flow charts. Investigators felt that they received sufficient training to be able to use HFIT. Some comments from the investigators include: "*Easy to use in paper form but I got the impression it was leading round and round at one point .... until I came to the root cause*"; "*I found the investigation part quite easy as you are just following the flowcharts going from step to step*" and "*HFIT in this scenario proved to be very successful and lent itself to the investigation process. Only took 1 h and 20 min*" Although another investigator felt that "*If there are a lot of people involved in the investigation it would be very time consuming*."

There were some comments for improving the comprehension of the questions within HFIT: "*Some of the terminology is above some of the general users, and needs to be understood by all users*". However, other investigators felt there were hardly any questions which were difficult to answer. Some investigators felt that it was difficult to monitor their progress using HFIT. In order to aid the monitoring during use of the paper version, a progress sheet was developed to help investigators track their progress.

4.2.2. Identification of causes and validity of results

The majority of investigators reported that HFIT addresses the key causes of incidents, although this will require further testing to verify. "*Use of the tool provided greater and more detailed questions along any threads identified that could contribute to the corrective action*".

"*Although the investigation can be very time consuming, if you go through all the steps there is nothing that would be missed*". "*The HFIT did lead us to some aspects of the operation that would not normally have been considered*". Another investigator felt that the investigation technique was "*very non-confrontational*".

4.3. Individual case studies

The causal analysis of individual incidents were evaluated in terms of the causes attributed to incidents using the company's original reporting system compared to the causes attributed using HFIT. Furthermore, in order to investigate whether HFIT aided in the development of remedial actions, the remedial actions and the incident causes have been compared.

In total six case studies were provided, although only three of the incidents could be used as individual case studies as the others had incomplete recordings of the causes identified using HFIT. These are described in Gordon et al. (2002) and only summary results are described in this paper. Each case study was analysed with respect to the following information:

(i) Brief description of the event.
(ii) Immediate and underlying causes from the original report.
(iii) Findings from HFIT (action errors, situation awareness and threats).
(iv) Remedial actions for the original report.
(v) Links between the original report and HFIT causes.
(vi) Link between the original report and HFIT causes and the remedial actions.

Three case studies were collected in order to assess HFIT in terms of its ability to generate further human factors data and remedial actions for incident investigation.

The results indicate that HFIT may have helped to improve the analysis of the incidents. Additional codes were identified from the HFIT analysis that could not be coded using the company's original coding system. A total of eight, nine and four additional causes were identified from the three case studies over and above the company's own reporting system. The HFIT analysis (in addition to using their own analysis) was used by the company to help develop the remedial actions in each of the case studies. This was noticeable from the comparison of the results in the final investigation report with the HFIT results, where the causes reported in the investigation report did not always directly link to the remedial actions, whereas they did link to the HFIT results. However, it was not possible to identify precisely which remedial actions had been developed based on the HFIT analysis. It was clear, however, that not all of the causes identified by HFIT were developed into remedial actions.

The incidents that were analysed using HFIT ($n = 6$) provide useful information regarding how effectively the tool was used. In the main, the tool appears to be used effectively, although the method of recording the results was not always complete. For example in one case study, communication was found to be a threat (Communication not effective). Using HFIT correctly, further analysis should have taken the investigator to the point where they understood why the communication was not effective. In addition, the sub-element: team situation awareness was not recorded accurately by the investigator, as they missed out the term: 'situation awareness', although this was deemed to be the cause of the incident. A reason for this maybe that the term 'situation awareness' is not familiar to the other users of the system (who have either not had the human factors training), or the term is not apparent or 'user-friendly' to the investigators. This information may not have been available to the investigator, or they neglected to record the data at the item stage. It is important that the data are recorded, so that if the incidents are ever reviewed, the findings and the evidence for the findings are documented. It is also important to record the data if they are to be used to analyse trends of the causes of accidents. The computer version of HFIT automatically records the causes, and hence the progression of the analysis is recorded as well as evidence for the causes (i.e. the reasons why they came to the conclusions they did).

4.4. Benner's evaluation system

Benner's (1985) model and method evaluation system was used to evaluate HFIT using 10 criteria (e.g. comprehensiveness and ability to define remedial actions, the criteria are provided in Tables 3 and 4). The two human factors reporting forms (described briefly in the background section) were also evaluated using these criteria, and have been included in the tables. Benner's (1985) evaluation scheme used a three-point rating scale (where a rating of 2 = would satisfy; 1 = might satisfy; 0 = cannot satisfy) and the maximum score for any model or method was 20. The two human factors reporting forms and HFIT were assessed on each of the 10 criteria by deciding whether the models could satisfy the criteria. The ratings of the methods were derived by deciding whether the methods could satisfy the criteria, both conceptually and in their application within the company. It must be noted that the developer of the three reporting tools also undertook the Benner evaluation, which could have introduced a bias (Table 5).

The overall evaluation score for HFIT was 33 out of a possible 40 points (which compared favourably to the two forms which scored 21 and 25 respectively).

Although the number of the questions about the HFIT method (Table 4) have not scored full points (14/20), Forms 1 and 2 scored even lower (11 and 12 respectively). This may be in part because the measure is very stringent, and very few investigation systems would be able to score highly on their ability to support personal initiatives (q.3) or 'truth-test' the data (q.9). The other three questions that scored poorly were about providing information about duties under a standard with regard to the enforcement programme (Table 4, q.7); about the compatibility of HFIT with 'pre-investigations' (or safety analyses) of potential accidents (Table 4, q.10); and about the theoretical consistency of HFIT with the company's safety programme concepts (Table 3, q.6). These three aspects could be improved by further refinement by closely liasing with individual companies.

Table 4
Evaluation of the HFIT model (and Form1 and Form2 models) according to Benner's evaluation system

	Score (HFIT)	Score (Form1)	Score (Form2)
1. How realistically is the accident described? *The causes of the accident include the proximal (action errors, situation awareness) and distal factors (threats). In the database version, investigators are asked to write a brief summary of the events leading up to the incident. In addition, there is section for witnesses to write statements*	2	1	1
2. How well does the model define the aspects of an incident? *HFIT includes 271 item-level codes, providing the investigator with a very detailed and specific set of causes*	2	1	1
3. How well does the model demonstrate the company's safety mission? *The company's safety mission is to gather more data regarding the human factors causes*	2	2	2
4. How comprehensive is the model at encompassing the development and consequences of an accident? *HFIT is designed to take the investigator through the causes of the incident, beginning with what happened immediately prior to the incident through to the threats that exist at the work site and in the system*	2	1	1
5. Is the model a technically sound framework that can test the quality, validity and relationships of data developed during an investigation? *With sufficient data, it would be possible to test the quality and validity of the data found using HFIT. The database version could allow for relationships to be tested within Excel*	2	1	1
6. Is the model theoretically consistent with or provide consistency for the company's safety programme concepts? *The company includes human factors into their safety programme—this form helps to enhance it*	1	1	1
7. Does the model provide for direct identification of safety problems so that prompt correction can be made? *HFIT provides a systematic method for investigators to source the causes of the incident, and with the specific 'item' questions, identification of safety problems are readily identified*	2	1	2
8. Does the model make it possible to link accident descriptions to the work process in which the accident occurred? *In the database version, after each cause has been identified, investigators are encouraged to provide explanations for the causes chosen. Here, the investigators would identify the work process and accident link. This may also be described in the narrative description*	2	1	1
9. Does the model show interactions among all parties and things, rather than oversimplification? *HFIT captures a large set of human factors issues, which could be used to show interactions*	2	0	1
10. Does the model enable investigators and others to see the relevance of the model to any accident under investigation easily and credibly? *Yes, the human factors issues covered in this model could be applied to many accidents*	2	1	2
Total score	19/20	10/20	13/20

Table 5
Evaluation of the HFIT method according to Benner's evaluation system

	Score (HFIT)	Score (Form1)	Score (Form2)
1. Does the method encourage employees to participate in investigations and to have their views heard? *HFIT can be used to interview witnesses directly, thereby encouraging people to have their views heard*	2	2	2
2. Does the method produce blameless outputs and identify the full scope of the accident, including the role of management and supervisors? *HFIT starts with the errors that occurred immediately prior to the incidents, although the main part of the investigation is taken up with the threats further back in the system*	2	1	1
3. Does the method support personal initiatives?	0	0	0
4. Does the method support timely discovery process? *The process is very thorough and has been found to really get to the underlying causes of the incident between 1.5 and 2 h—the systematic and thoroughness of the process supports timely discovery*	2	2	2
5. Does the method increase the competence and safety effectiveness of personnel, such as used in training? *Yes, there is a section that identifies training issues*	2	2	2
6. Does the method show definitive corrections so that remedial actions can be defined, evaluated and selected? *Yes, the specific questions provide the investigator with more detailed accounts of possible causal factors. The database version encourages investigators to provide preliminary remedial actions*	2	1	2
7. Does the method provide information about duties under a standard with regard to the enforcement programme? *No*	0	0	0
8. Does the method provide a practical way to produce consistent, reliable accident reports, hence encouraging the company to take responsibility, to fulfill their occupational safety and health mandates? *The systematic process encourages consistent, reliable reports*	2	1	1
9. Does the method allow for accidents to be technically "truth-tested" to assure the quality of the information? *Yes, other witnesses who are asked for their version using HFIT will provide more information as well as the possibility for 'truth-testing' the data*	1	1	1
10. Is the method compatible with 'pre-investigations' (or safety analyses) of potential accidents? *There is a set of questions in the HFIT that ask about the planning of the job that includes risk assessments. Although this may not be compatible with the system used in the companies*	1	1	1
Total score	14/20	11/20	12/20

5. Conclusions

The Human Factors Investigation Tool has been subjected to a preliminarily evaluation in order to determine its effectiveness for analysing the causes of incidents in the offshore oil industry using an accident scenario exercise, three case studies, user evaluations and Benner's (1995) evaluation system.

The accident scenario exercise provided information regarding only a very small proportion of the causal codes in HFIT. Overall, the results indicated that the overall level of agreement between investigators was low, perhaps due to them having received minimal training and not being very familiar with the tool. However, the following six elements were thought to be causes of the incident scenario by over three-quarters of investigators possibly indicating that these elements are better understood and usable by the participating investigators: two action error elements: 'omission' and 'communication'; two situation awareness elements: 'attention' and 'assumption', one error recovery element (response behaviour) and two threat elements: 'communication' and 'supervision'.

Using the accident scenario data, the investigators' responses were compared to those of the human factors investigation findings. The scores were found to differ greatly across investigators, with some investigators being very close to 'the investigation' findings while others were very different. The level of agreement between investigators and 'the investigation' findings using HFIT to code an incident is generally low (overall mean = 0.38). This result could be due to the very large number of possible causal codes, investigators minimal training and practice with HFIT. In addition, the amount of information contained within a paper-based incident scenario is very limited, therefore making the exercise quite different from an actual investigation.

The inter-rater reliability tests indicated that investigators were more likely to agree with each other at the more general level (i.e. element level) rather than with regard to the specifics (i.e. the item or sub-element levels). At the sub-element, element and category levels, investigators were in least agreement with the 'investigation findings' regarding threats, situation awareness and error recovery respectively. This may indicate that threats and situation awareness problems are better understood at the more general level and error recovery is better understood at the more specific level.

The results from the three case studies have provided some initial evidence that HFIT improved the analysis of the incidents, where additional codes were identified from the HFIT analysis that could not be coded by the company's original coding system and the company used the findings from HFIT to develop the remedial actions. It must be noted that this is a prototype with some encouraging preliminary findings.

In order to improve the reliability of the tool (i.e. the agreement between investigators) it would be necessary for the investigators to share the same understanding of the categories, elements, sub-elements and items. In order for this, investigators may require more on-the-job training with the tool, and perhaps some sort of calibration between investigators during training. The question format of HFIT should in fact enhance the reliability as detailed questions explain the meaning of each label. Due to the nature of accident investigations (many possible contributing factors) it is very difficult to obtain "clean" reliable data from incident investigations. Reliability could be enhanced by 'team' investigations, rather than individual investigations (individual investigations were undertaken in this experiment); and investigators having more familiarity with the tool. In order to assess the reliability and validity of HFIT more fully, more incident data needs to be collected using HFIT. In addition, interventions could be designed and implemented on the basis of recommendations that come from using the tool and these interventions could then be evaluated to see if they reduce accident and incident rates (or certain types of incidents). Although these tests were out of the scope of this study, they are planned for future work.

Some problems with the method of recording the results were experienced, making it difficult to retrace where the results could have originated. It is important that the data are recorded, so that if the incidents are ever reviewed, the findings and the evidence for the findings are documented. It is also important to record the data if they are to be used to analyse trends of the causes of accidents. This problem could be eliminated using the computer version, which automatically collects and records each level of the data.

The case studies provided examples of where the investigator stopped at the sub-element level (at least when recording the data), and when further analysis should have taken the investigator to the 'endpoint' where they understood more about the threat, which could have aided them in the development of the remedial actions. Furthermore, the case studies revealed that a possible reason why investigators were sometimes not recording the complete findings from the HFIT analysis was that they felt others reading the findings may not understand some of the labels used to describe the causes. In order to evaluate the reliability and validity of HFIT more fully, more incidents need to be investigated using HFIT. The tool is currently being used by one of the participating companies in Alaska and Brazil and it is hoped that after a longer period of data gathering, statistical comparisons between the HFIT and pre-HFIT incident data could be undertaken.

The Human Factors Investigation Tool was developed with the intention of it being used by engineers not necessarily expert in human factors. However, in order for investigators to feel confident using the tool, investigators were first given basic human factors training and training to understand the structure of the tool and to practice using it. Overall, the investigators indicated that the training was either 'satisfactory' or 'good' and as the trainers became more practised, the participants' satisfaction ratings improved. Although participants indicated that the training was good or satisfactory, the human factors training should be further evaluated to ensure that it is providing participants with information that will help them to investigate incidents with regard to the human and organisational causes.

The implementation of HFIT into the incident investigation procedures of the participating companies indicated a very poor result, where only one out of the four participating companies collected data using HFIT. Lack of time and resources and no incidents to report were the reasons given for this poor response. In order for companies to implement HFIT, management support for the tool needs to be expressed to the potential users, encouraging them to make use of the tool and presenting potential users with examples of how this tool can aid their investigations. One of the main issues seems to be the cost and resources implications for implementing new tools especially for large, international organisations. In addition, keeping track of the use of the tools has proved difficult, as personnel in these companies often move positions and many of the companies have merged.

The evaluation of HFIT using Benner's (1985) system indicated an improvement over the previous two reporting forms, although further refinement of the tool would be necessary in order for it to be compatible with individual company's safety management systems.

Although this tool was developed specifically for the oil industry, many of the elements could be used in other industries. The specific questions relating to the sub-elements and items may need to be customised for the particular industry, as examples from the oil industry are provided. Each of the categories: 'action errors', 'situation awareness', 'error recovery' and 'threats' could be applied to other industries. HFIT has been used in the shipping industry where it was recently trialed on 3 accidents. The four main HFIT categories were found to be transferable within this domain as were the majority of items within them.

Although this paper has highlighted the need for further validation and analysis of HFIT either using more realistic accident scenario exercises or gathering more data from incident analysis, it has been possible to gain a better understanding of the clarity of some elements. In particular, it has shown in a small sample of accident investigations, that HFIT has helped to identify additional human factors causes from the traditional incident investigations.

Acknowledgement

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Læring av ulykker

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Læring av ulykker

HFC-forum,
Stavanger, 20. – 21. oktober 2010

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Dette vil jeg snakke om …

- Litt om AcciLearn – prosjektet
- Åsta- og Sleipner-ulykken som case
- Begrepet ”læring”
- Hva har vi lært etter Åsta- og Sleipner-ulykken?
- Hva har vi lært om læring etter ulykker?
- Hva som fremmer og hemmer læring etter ulykker
- Avslutningsvis: Fire momenter som fremmer læring

Forskningsrådet

ACCILEARN –
Accident investigation and learning effects within transport organizations and across societal sectors

Et samarbeid mellom:

Univ. i Stavanger, Univ. i Lund, SINTEF/NTNU

Statens havarikommisjon for transport (SHT), Statens helsetilsyn

NTNU Det skapende universitet · SINTEF · Universitetet i Stavanger · sht Statens Havarikommisjon for Transport · HELSETILSYNET · Lunds universitet

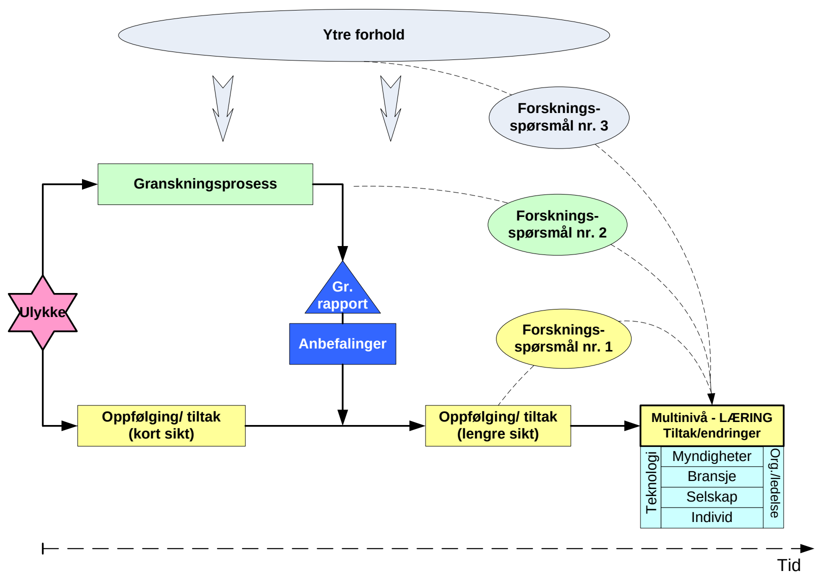
Delprosjekt:
Læring etter ulykker på ulike beslutningsnivåer

Målsetning:

Utvikle kunnskap om hvilke forhold knyttet til ulykkesgransking og oppfølging i etterkant som har størst betydning for læring etter ulykker.

- hvilke forhold fremmer/hemmer læring på de ulike nivåene (selskap/ bransje/ myndigheter)?

Analytisk rammeverk



Tilnærming

- **Strategi:**
  Velge ut noen alvorlige ulykker som har skjedd litt tilbake i tid; én ulykke fra hver av sektorene jernbane og sjøfart. *Hvilke "spor" har ulykkene etterlatt seg på selskapsnivå, bransjenivå og myndighets/-tilsynsnivå?*

- **Utvalgte case:**
  "Åsta-ulykken" (2000) og *"Sleipner-ulykken"* (1999)

- **Datagrunnlag:**
  Dokumentgjennomgang, workshop og intervju med 30 personer innen jernbane og sjøfart

Vi vil finne svar på følgende spørsmål:

Hva har vi lært?

Hvordan kunne vi ha lært mer?

Hva mener vi med læring?

- Læring:
  - *Identifiserte endringer i atferd, organisasjon/ ledelse eller teknologi som kan spores tilbake til ulykken*
- Multinivå læring:
  1. Læring på ulike beslutningsnivåer (individ, selskap, bransje, myndigheter)
  2. Læring av ulike typer og innhold (fra avvikskorreksjon til forbedring/ ”standardheving”)

Åsta-ulykken 4. januar 2000 (NOU 2000:30)

- **Hendelsesforløp:** Sørgående tog fra Trondheim kolliderer med nordgående fra Hamar mellom Rustad og Rena
- **Konsekvenser:** 19 omkomne + materielle tap
- **Direkte årsak:** Uklart (menneskelig feilhandling eller signalfeil?)
- **Bakenforliggende hovedårsak:** Grunnleggende mangler ved sikkerhetstenkning og sikkerhetsstyring i deler av jernbanevirksomheten

Sleipner-ulykken 26. november 1999 (NOU 2000:31)

- **Hendelsesforløp:** Hurtigbåten gikk på et skjær (Store Bloksen) i høy fart (ca. 35 knop). Skroget brakk i to og forparten drev vekk. Etter ca. 20 minutter skled også bakparten av skjæret, drev vekk og sank.
- **Konsekvenser:** 16 omkomne + tap av fartøy
- **Direkte årsak:** Feilnavigering
- **Bakenforliggende årsaker:**
  - Manglende kommunikasjon på broa
  - Ufullstendig opplæring og trening av besetningen
  - Mangler ved myndighetenes regelverk og godkjenning (av evakueringsutstyr, redningsvester)

De viktigste lærdommene

Tema	Beskrivelse
Sikkerhets-bevissthet	Massive endringer, økt sikkerhetsbevissthet. En vekker, sikkerhet angår hele organisasjonen.
Sikkerhetsstyring	Mer risikobasert sikkerhetsstyring, barrieretenkning.
Kommunikasjon	Kommunikasjon og kommunikasjonsutstyr ble et viktig tema.
Teknologi	En rekke tekniske tiltak ble implementert, inkl. tiltak for å forbedre kommunikasjon mellom ulike aktører.
Ledelse	Nytt ledelsesregime; sikkerhet ble et tydeligere linjeansvar.
Opplæring	Mer struktur på opplæringen (inkl. simulatortrening), og mer fokus på kriseberedskap, kommunikasjon.
Dokumentasjons-kultur	En dreining fra en “verbal kultur” til en ”dokumentasjonskultur”. Prinsipper og metoder for sikkerhetsstyring ble adoptert fra oljeindustrien.
Prosedyrer	Prosedyrer og styringssystemer er blitt overveldende; for mange, for store, for rigide.

Hva har vi lært om læring etter ulykker? – I

- Komplekst mønster og samspill mellom mange påvirkninger bidrar til læring/ endring etter en ulykke
- Vanskelig å spore læring/ endringer tilbake til én enkelt hendelse/ ulykke
- Samspill/ påvirkning fra:
  - Tidligere hendelser
  - Generell utvikling i bransjen
  - Nye forskrifter og fokus fra tilsynsmyndigheten
  - Medienes fokus
  - Eksterne rammebetingelser

Hva har vi lært om læring etter ulykker? – II

- Ulike mekanismer i forhold til læring
  - Oppvåkning
  - Forsterkning og fremskynding av planer og prosesser
  - Moderering av tiltak over tid
- Læring på tre nivåer/stadier:
  - Læring i forhold til det som faktisk skjedde
  - Læring i forhold til håndtering
  - Læring på det mentale plan
- Akseptabel standard for sikkerhet flyttet seg som en effekt av ulykken

"Var ikke inne på tanken at det kunne komme et tog i mot"

Aftenbladet.no 07.11.2000:

Skjerpet sikkerhet etter «Sleipner»-forlis

«Sleipner»-ulykken har skjerpet kravene til sikkerhet på hurtigbåtene. Akseptabel standard for ett år siden holder ikke i dag. Reisende aksepterer ikke noen risiko knyttet til et offentlig kommunikasjonsmiddel.
(adm.dir. P. A. Tellnes i HSD Sjø AS)

Hva har vi lært om læring etter ulykker? – III

- Akuttfasen etter ulykker:
  - Forventninger om å demonstrere handlekraft
  - Det ble satt i gang prosjekter som var lite styrt og koordinert
  - Mange eksterne konsulenter; det ble fragmentert og lite eierskap
- To sikkerhetskulturer møtes i læring etter ulykker: *Praksiskulturen* og *teorikulturen*
- Virksomhetene etterlyser mer dialog og mindre pålegg fra myndighetene
- Generelt dårlig til å bruke hendelser og å lære av dem; ulykkene blir fort historie

”Vi som jobbet operativt,
.. vi passet på å kjøre tog, så fikk de andre holde på med sitt”

Hva som hemmer læring etter ulykker

- ”Fjernstyring”
- Grafsende katastrofejournalistikk
- Teater og dukkespill
- Sikkerhetsfiffen
- Prosedyrealibiet

Hva som fremmer læring etter ulykker - I

Granskningsprosessen:

- Ekskludere skyldspørsmål
- Vidt perspektiv på årsaksforhold

Granskningsrapporten:

- Konkrete, men ikke for detaljerte tilrådninger/anbefalinger
- Detaljert beskrivelse av hendelsesforløpet og årsaksfaktorer
- Ikke for generell og teoretisk

Hva som fremmer læring etter ulykker - II

Oppfølgingsfasen etter ulykker:

- Forankring av forbedringsprosesser
- Medvirkning
- Realisme (i forhold til frister og tiltak)
- Vilje til læring
- Åpenhet

" For oss handlet det om å overleve som organisasjon"

Avslutningsvis: Fire momenter som fremmer læring

1. Parkér skyldspørsmål, søk forståelse
2. Ikke glem; historien må leve
3. Aksepter læring som en ferdighet – den må vedlikeholdes
4. Demp prosedyretrangen

Vær var for paradokser:

- Alle vil lære av ulykken – men det er mange interesser
- Alle vil ha åpenhet – åpenheten medfører at noen ”sikrer seg”
- Myndighetene er pådrivere – myndighetene fragmenterer/ pulveriserer
- Media bidrar til fokus – media ødelegger fokus

”I noen sammenhenger kan det være greit å miste selvtilliten… om du ikke mister den helt”

Takk for oppmerksomheten!

HFC

Menneskelige og organisatoriske faktorer i ulykkesgranskingen
H.Heber

Mere informasjon:

Se http://www.ptil.no/nyheter/ulykkesgranskinger-er-grunnlag-for-laering-article6858-24.html

Organisatoriske faktorer i ulykkesgranskning

Orientering om Petroleumstilsynets arbeid

Hilde Heber
21.10.2010

Bakgrunn

- Ptil har erfart at selskapenes granskninger identifiserer menneskelige og teknologiske faktorer.
- Selskapenes granskningsrapporter belyser ikke i tilstrekkelig grad organisatoriske faktorer i sin fulle bredde.
- Organisatoriske faktorer som relaterer seg til strukturelle forhold f.eks. roller, ansvar, prosedyrer og opplæringsprogram blir inkludert.
- Faktorer som knytter seg til f.eks. kulturelle forhold, ledelsesmessige betingelser, maktrelasjoner og rammebetingelser på ulike nivå blir i mindre grad blir tydeliggjort.

Oversikt over arbeidet så langt

- Vurdering av selskapenes granskingsrapporter – **rapport** utført av IFE (Institutt for energiteknikk).
- **Seminar**: Organisatoriske forhold i ulykkesgranskning 27.04.2010
- **Tilsyn** med tre selskap og deres vurdering av seg selv opp mot IFE-rapport (april – desember 2010)
- **Seminar** om ledelse og storulykkesrisiko 31.08.2010 (samarbeid mellom OLF, UiS og Ptil.)

Rapport fra IFE

Rapporttittel:

”*Vurdering av organisatoriske faktorer og tiltak i ulykkesgranskning*” (IFE, 2009) *(Lenke)*

Forfattere:

- Atoosa P-J Thunem (Prosjektleder, IFE)
- Magnhild Kaarstad (IFE)
- Harald P-J Thunem (IFE)

Målsetning

Utvikle dybdekunnskap om følgende forhold:

1. Hvordan ulike **kategorier av organisatoriske faktorer** blir vurdert i selskapenes granskningsrapporter.
2. Hvilke organisatoriske faktorer som **ikke** blir belyst, men som ut fra organisasjonsteoretiske perspektiv **kunne vært** trukket frem.
3. Hvilke **tiltak** relatert til ulike kategorier av organisatoriske faktorer som foreslås i granskingsrapporter.
4. I hvilken grad det er mulig i praksis å vurdere **effekter av tiltak**, relatert til organisatoriske faktorer som selskapene foreslår i granskningene.

Granskningsmetoders bruk av teori og fokus på årsaksmodeller

- Det finnes en gjensidig avhengighet mellom årsaksmodeller og granskningsmetoder.
- En ulykke kan forklares på ulike måter avhengig av den ulykkesmodellen som benyttes i hendelsesanalysen.
- Ulike ulykkesmodeller fokuserer på ulike aspekter og assosieres med ulike anbefalinger for forbedring.
- Modeller gir kunnskap om grunnleggende mekanismer som er til stede i ulykkesscenariet.
- Metoder gir nødvendig informasjon for å analysere ulykken i en spesifikk setting.

IFE, 2009

Granskningsmetoders bruk av teori og fokus på årsaksmodeller

- En hovedutfordring for granskingsmetodene er å fange opp organisasjonenes komplekse og dynamiske natur inn i en enkelt integrert metode.
- Ulike modeller former:
  - måten spørsmålene blir stilt på
  - valg av svar som tas med videre i analysen
  - konklusjoner som trekkes relatert til årsaksforhold
  - hvilke etterfølgende tiltak som foreslås.

IFE, 2009

"What-you-look-for-is-what-you-find"- prinsippet
"What-you-find-is-what-you-fix"- prinsippet

Lundberg et al, 2009

What you look for is what you find

Metode – utvalg

- Selskapene har sendt inn 91 granskningsrapporter til Ptil i 2007 og 2008.
- Hendelsene er i kategori 4 (alvorlig) og 5 (høyt potensial/storulykke) i forhold til Ptils alvorlighetsgradering.
- Rapportene ble oversendt til IFE som i samarbeid med Ptil valgte ut 20 rapporter som grunnlag for dokumentanalyse.

Fellestrekk rapportutvalg

- Grundige hendelsesbeskrivelser
  - Hovedfokus på tekniske faktorer, også der menneskelige og organisatoriske faktorer har hatt stor betydning
- Varierende struktur og detaljeringsgrad
- Mange rapportene inneholder MTO-gjennomganger
  - Kronologisk beskrivelse (tidslinjer)
  - Varierende detaljeringsgrad
- Strukturelle faktorer eksplisitt nevnt
- Kulturelle faktorer implisitt beskrevet/antydet
- Barrierer (fysiske og organisatoriske) ofte godt dekket
- Faktiske og potensielle konsekvenser ofte inkludert

IFE, 2009

Fellestrekk ved organisatoriske faktorer og tiltak

De organisatoriske faktorene som oftest nevnes i granskningsrapportene er kategorisert i følgende kategorier:

- **Kompetanse, erfaring og kunnskap**
- **Sikkerhet og risikovurdering: Forståelse og etterlevelse**
- **Prosedyrer og styrende dokumenter**
- Kommunikasjon
- **Målkonflikt**
- Arbeidsrutiner
- Vedlikehold
- Ansvar og roller
- Ledelsesfunksjoner
- **Design**

IFE, 2009

Kompetanse, erfaring og kunnskap

I kategorien inngår:

kompetanse, erfaring, kunnskap, kjennskap til utstyr, opplæring i arbeidsprosesser, kunnskap om risiko og erfaringsoverføring.

- I mange rapporter kategoriseres mangelfull erfaring og kompetanse som en individfaktor ikke en organisatorisk faktor.
- I flere av hendelsene var ikke nødvendig opplæring gitt, noe som er et ledelsesansvar.
- Det er organisasjonens ansvar å legge til rette for gode rutiner for kompetanseoppbygging, opplæring og rutiner for erfaringsoverføring.
- **Tiltak** er ikke konkrete i forhold til hva som forventes av kompetanse, og hvordan denne skal bygges opp.
- Tiltakene blir ofte for lite spesifisert i forhold til gjennomføring, noe som vanskeliggjør gjennomføring av tiltakene.

IFE, 2009

Sikkerhet og risikovurdering: Forståelse og etterlevelse

I kategorien inngår:

gjennomføring og bruk av risikoanalyse og risikovurdering, kunnskap og forståelse om sikkerhet, risiko og barrierer.

- Rapportene viser et spenn fra mangelfull risikoanalyse i designfasen, til mangelfull risikovurdering i planleggingen og til mangelfull forståelse ift risiko og sikkerhet i "den skarpe enden".
- Rapportene peker ofte på at individene ikke har tilstrekkelig forståelse av sikkerhet og risiko.
- Rapportene sier lite om årsakene til mangelfull gjennomføring og bruk av risikoanalyse og risikovurdering.
- **Tiltakene** varierer i konkretiseringsgrad og nivå – fra holdningskampanjer til økt systematikk i risikovurderinger

IFE, 2009

Prosedyrer og styrende dokumenter

I kategorien inngår:

etterlevelse av/ respekt for prosedyrer, opplæring om og kjennskap til prosedyrer, klarhet og innhold i styrende dokumenter, prosedyrer og sjekklister, samt bruk av prosedyrer.

- Rapportene benytter uttrykk som "prosedyrebrudd" og "manglende respekt for prosedyrer". Dette medfører individ- og ikke organisasjonsfokus.
- Ved "prosedyrebrudd" må granskningen gå mer i dybden for å finne de virkelige årsakene.
- Uuttalte, kulturelle aspekter er vanskelige å oppdage og gjøre noe med hvis granskningen slår seg til ro med at årsaken var "prosedyrebrudd".
- Rapportene foreslår konkrete **tiltak** som er gjennomførbare, men gjelder ofte oppdatering av én prosedyre.

IFE, 2009

Målkonflikt

I granskningsrapportene kommer det fram målkonflikt mellom:

- tidspress og grundighet,
- sikkerhet og produktivitet
- ulike involverte parter

- Målkonflikt er nevnt noen ganger i rapportene, men kan ha forekommet i flere av hendelsene.
- I hendelser der en har mistanke om målkonflikt som medvirkende årsak, kan granskningsteamet med fordel forsøke å gå litt grundigere inn på dette temaet.
- **Tiltakene** som foreslås er generelt vage.
- Ved målkonflikter mellom sikkerhet og produktivitet var det ingen forslag til tiltak.

IFE, 2009

Design

I kategorien inngår:
gjennomføring av og kvalitet på risikovurderinger, kvalitet på barrierene i systemdesignet og hvordan dette er implementert i design.

- Kulturelle faktorer og etablerte rammebetingelser er av betydning for design.
- Det er nødvendig å gå tilstrekkelig tilbake i tid for å avdekke forhold i designfasen som kan ha hatt betydning.
- I flere hendelser kommer det fram at mangler i design har vært til stede i lang tid. Mangler har også vært kjent uten at de har blitt utbedret.
- Få rapporter tar for seg bakenforliggende årsaker til mangelfullt design.
- **Tiltak** går direkte på tekniske og strukturelle forhold og vil derfor ha liten effekt på andre designforhold.

IFE, 2009

Utfordringer med organisatoriske faktorer i granskning

- Vesentlig at granskninger bruker metodikk der både menneske, teknologi og organisasjon blir behandlet.
- Det er aksept for at alle tre faktorene bidrar, men rapporter fokuserer til dels ensidig på tekniske faktorer.
- Hevdes at MTO-analyse benyttes, men de har til dels mangelfull kvalitet.
- MTO-diagram først og fremst benyttes for å gi oversikt og følge en trend – ikke for å se MTO i et systemperspektiv.
- **Gjennomgående individperspektiv**. Menneskelige feilhandlinger og oppmerksomhet på individet får større plass enn organisatoriske faktorer i granskningene.

IFE, 2009

Utfordringer med organisatoriske faktorer i granskning

- Granskning berører multidisiplinære forhold og bemanning av granskningsgruppene bør gjenspeile dette.
- Behov for et mer utfyllende begrepsapparat for å analysere organisatoriske faktorer
  - Direkte arbeidsplassbetingelser inkluderes, men ytre faktorer som rammebetingelser tas ikke opp i tilstrekkelig grad
- Tidsaspektet i analysene er til dels for snevert til å identifisere organisatoriske og kulturelle faktorer
- Søken etter direkte årsak kan gi et upresist bilde av en kompleks situasjon med sammensatte årsaker.
- Mer opptatt av *hva* som har skjedd enn *hvorfor*!

IFE, 2009

Utfordringer med organisatoriske faktorer i granskning - tiltak

- Det er ofte manglende samsvar mellom identifisert årsaker og tiltak.
- Årsakene synes reelle, men det er vanskelig å foreslå konkrete tiltak for å unngå tilsvarende hendelser.
- Selv om en årsak framkommer som en organisatorisk faktor i analysen, ser man ofte at foreslåtte tiltak er av individuell eller teknisk art.
- En kan søke et bredere spekter av tiltak i samsvar med analysen og rette tiltakene mot ulike nivåer i organisasjonen
  - det operative, ledelsen, selskapet og andre enheter som inngår i forhold til organisasjonen eller rammebetingelsene rundt den.

IFE, 2009

Utfordringer med organisatoriske faktorer i granskning

- De fleste granskningene forsøker å identifisere direkte årsaker.
- Hendelsesanalyser betrakter organisasjoner som lukkede systemer, der årsaksforhold er enkle å oppdage. Slik tapes oversikt og forståelse av organisasjoner.
- Organisasjoner er kjennetegnet ved komplekse vekselvirkninger gjennom blant annet sosial samhandling mellom mennesker som får sitt uttrykk i maktrelasjoner, strategier, kultur og sosiale konstruksjoner av virkeligheten.
- Granskningene ser ofte på den enkelte organisasjonen uten å se på samspillet mellom organisasjonsenheter og på tvers av organisasjoner i et utvidet perspektiv.

IFE, 2009

Bruk av IFE-rapporten i tilsyn - del 1

4.2. Fellestrekk ved organisatoriske faktorer og tiltak.

- Ledelsen presenterer funn fra rapporten
- Funnene diskuteres offshore på alle skift, blant egne ansatte og entreprenører
- Organisasjonen velger ut 3-5 organisatoriske faktorer de ser som utfordringer og/ eller interessante forhold i egen organisasjon
- Forholdene diskuteres med tanke på evt forbedringer
- Prosessen, utvelgelse av organisatoriske faktorer og evt forslag til forbedringer presenteres for Ptil.

God tid til diskusjon og spørsmål.

Foreløpig tilbakemelding etter tilsyn – del 1

Selskapenes egen vurdering:

- Tilbakemeldinger fra offshoreorganisasjonen var at dette var et interessant tema som engasjerte og igangsatte gode diskusjoner.
- Det ble sett på som vanskelig å peke på spesifikke organisatoriske faktorer man anså som utfordringer. Problemområder ble diskutert og deretter kategorisert under de ulike typene organisatoriske faktorer.
- Diskusjonene medførte en økt bevissthet offshore - ikke så mange konkrete forslag til forbedringer.

Bruk av rapporten i tilsyn – del 2

- 5.1. Kategorisering av organisatoriske faktorer med en kulturorientert synsvinkel.
- Selskapet samler personell offshore og på land som er involvert i egne granskninger (rapporten kjent på forhånd).
- Gruppen vurderer selskapets praksis i lys av de forholdene som framkommer i kapittelet.
- Gruppen velger ut 2-3 hendelser med alvorlig potensial og en viss grad av kompleksitet som selskapet har gransket de siste 2 årene (evt internasjonale hendelser i selskapet).
- Hvilke forhold er relevante og hvilke utfordringer ser dere i forhold til egen praksis? Evt forbedringsforslag.

God tid til diskusjon og spørsmål.

Foreløpig tilbakemelding etter tilsyn – del 2

Selskapenes egen vurdering:

- De organisatoriske faktorer som ble belyst i de utvalgte rapportene var hovedsakelig av strukturell art.
- Gjennom prosessen så spesielt ett av selskapene at enkelte av årsakene burde vært analysert mer i dybden, og at de da trolig ville funnet kultur-orienterte aspekter som bidro til hendelsene.
- Granskingsverktøy som brukes kan fange opp strukturelle organisatoriske faktorer, men ikke identifisere kulturelle aspekter.
- Viktig å sikre organisatorisk kompetanse i granskningsteamet.

Tilbakemeldingen fra selskap 1

- Måten tilsynet har blitt gjennomført på har ført til aktiv læring fra IFE-rapporten
- IFE rapporten var nok noe "høyttravende" for de som ikke er eksperter innen granskningsfeltet
- Har gitt grunnlag for videreutvikling av vår metode for gjennomføring av granskninger

Tilbakemeldingen fra selskap 2

En engasjerende og interessant tilsynsmåte, som samtidig ga utfordringer.

PTIL/PSA

Videre arbeid

- Bruk av rapporten og resultatene i ulike tilsynsaktiviteter for få fram selskapenes erfaringer og forbedringspunkter på området.
- Bruk av resultatene i Ptils interne forbedringsarbeid knyttet til ulykkesgranskning.

????

Takk for oppmerksomheten!

HFC

Säkerhetskultur, organisation och ledarskap - mänskliga och organisatoriska faktorer i haveriutredningar

C. Weikert og L. Kecklund

Mere informasjon:

Se http://www.mto.se/publikationer/flyg/ og vedlagte paper:
Clemens Weikert, Marcus Arvidsson, og Lena Kecklund "*Safety culture work in other high risk organizations*", IAEA, 2010.

Säkerhetskultur, organisation och ledarskap – mänskliga och organisatoriska faktorer i haveriutredningar

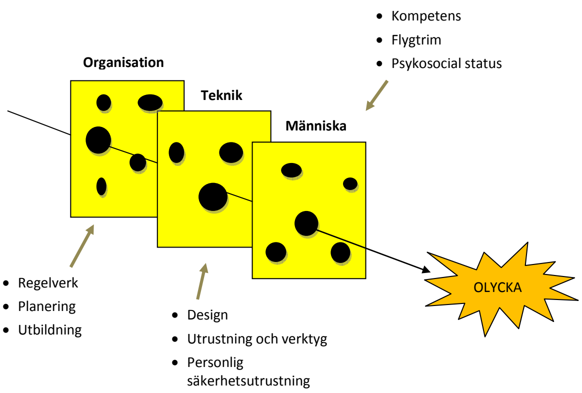
Lena Kecklund, MTO Säkerhet

Clemens Weikert, Lunds universitet

Säkerhetskulturbegreppet - bakgrund

Begreppet ”Säkerhetskultur” introducerades av IAEA 1986 efter Chernobyl-olyckan för att markera att organisatoriska faktorer och ledarskapsfaktorer är viktiga för säkerheten.

Flera utredningar om olyckan konstaterar brister i säkerhetstänkande och lednings-/kommando-strukturer

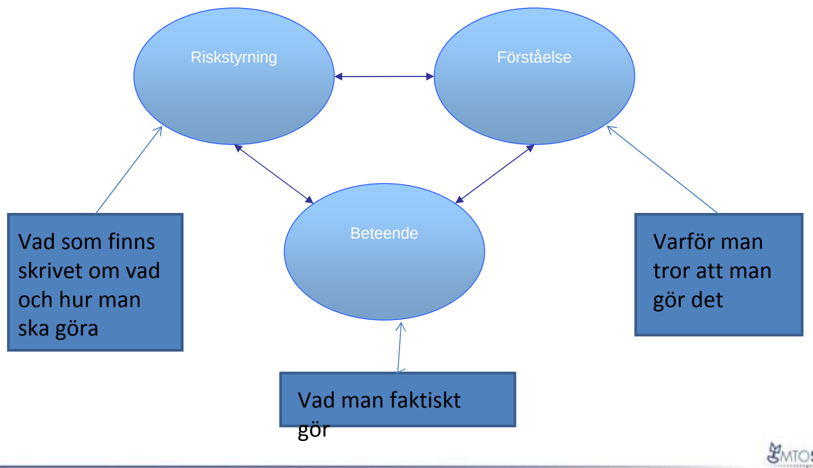


Reason's s k schweizerostmodell

Definition av säkerhetskultur (HSE; Health and Safety Executive, UK)

- En organisations säkerhetskultur är produkten av individers och gruppers värderingar, attityder, perceptioner, kompetenser och beteendemönster som bestämmer engagemanget för och effektiviteten hos en organisations säkerhetsledning. Organisationer med en positiv säkerhetskultur karaktäriseras av kommunikation baserad på ömsesidigt förtroende, av en gemensam uppfattning om säkerhetens betydelse och av förtroende för effektiviteten hos preventiva åtgärder.

Modell för säkerhetskultur (Skriver, 2004)



Riskstyrning

- **Hårdvara, bestående av regler, rutiner, ledningssystem, checklistor och dokumentation**
- **Externa krav från lagstiftningen och interna krav tillsammans ställer krav på verksamhetens riskstyrning**
- **Styrande dokument och riktlinjer för hur organisationen medarbetarna ska agera angående säkerhet**
- **Riskstyrningen ska se till att organisationen lever upp till externa och interna krav (t ex instruktioner)**

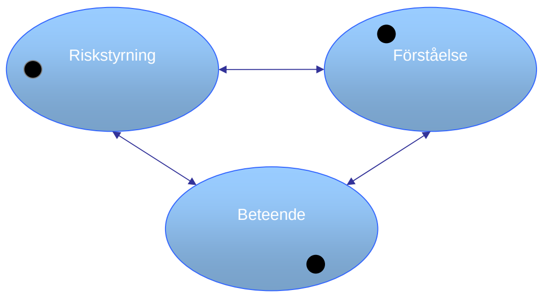
Förståelse

- Inställning till och kunskap om riskstyrningen i organisationen och hos medarbetarna på alla nivåer (dvs till de regler och rutiner som finns i verksamheten)
- Det finns kunskap och motivation för att följa uppsatta regler och rutiner
- Förståelse för att säkerhet är ett kärnvärde med högsta prioritet i verksamheten
- Att förståelse och prioritering vad gäller säkerhet finns hos högsta ledningen är en förutsättning för att den ska finnas hos medarbetarna

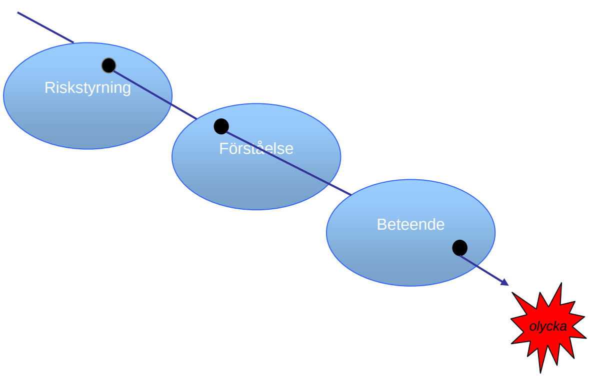
Beteende

- Det faktiska handlandet och hur man i det förhåller sig till säkerhet
- Hur ledningen och de anställda tar hand om säkerhetsfrågorna i det dagliga arbetet, i beslut som fattas och prioriteringar som görs
- Högsta ledningen måste i sitt eget agerande visa att säkerhetsfrågor är viktiga och att det är viktigt att rapportera avvikelser och ge återkoppling
- Det riktiga beteendet är nyckeln till en bra säkerhet

Systemsvikt I, (Kecklund, Skriver, m fl 2008)



Systemsvikt II, (Kecklund, Skriver, m fl 2008)



Element	Vad?	Exempel
Styrning - ***Vad finns skrivet om vad och hur man ska göra***		Policy Ledningssystem **Rapportera händelser och tillbud**
Förståelse/ Kompetens - ***Varför man tror att man gör det***		Attityder, tankar, känslor **Förståelse för att problem ska anmälas och måste hanteras/lösas** inom rimlig tider för att undvika/minska denna risk
Beteende - ***Vad man faktiskt gör***		Observerbara handlingar Normer, Beslut **Rapporteringsvilja – Återkoppling** Fixarkultur/Acceptans för avvikelser *"Det finns mkt initiativkraft o vilja att lösa problem som vi ställs inför. Risken är att "fixarfrasse" kommer o hälsar på. "*

Organisatoriska faktorer

Tydliga säkerhetsmål och säkerhetsstyrning centrala för säkerhetsklimatet och påverkar kommunikation, engagemang och ansvarstagande.

Tillit och öppenhet viktiga förutsättningar för god säkerhetskultur.

Organisationens struktur påverkar säkerhet och säkerhetsbeteende.

Aktiva tillsynsmyndigheter viktiga för hög säkerhet.

Ledning/ledarskap

Ledningens engagemang påverkar säkerheten. Bristande ledarskap är ofta en bidragande faktor vid olyckor. Viktigt att ledningen har begreppet säkerhet som en del av sin värdegrund. Ledarskapet är drivande när det gäller säkerhetskultur och måste kommunicera att säkerhet är viktigt.

”Utredning av säkerhetskulturen i Försvarsmaktens helikopterverksamhet”, september 2008

… på uppdrag av Statens Haverikommission, Sverige

www.mto.se/publikationer/flyg/

Lena Kecklund, Ingrid Anderzén, Sara Petterson, MTO Säkerhet
Clemens Weikert, Lunds Universitet

Bakgrund – Vad är problemet?

- Sedan år 2000 har det inträffat flera allvarliga olyckor med militära helikoptrar och sammanlagt har fjorton personer omkommit
- Försvarsmaktens helikopterverksamheten har under en period av tio år (1997-2007) genomgått större omstruktureringar
  - förändringar av organisation, uppgifter, förutsättningar och teknisk utrustning

Underlag för helikopterutredningen

- Tillgänglig dokumentation
  - Arbetsordningar, styrande dokument, regler
  - Protokoll
  - Verksamhetsrevisioner
  - Riskanalyser
  - Driftstörningsanmälan (avvikelserapporter)
- Ett 50-tal intervjuer på olika nivåer i organisationen
  - Skvadron/Division/Kompani
  - Flottilj
  - Högkvarter
  - Tillsynsfunktion
  - Ett 50-tal intervjuer på olika nivåer i organisationen
- Det goda exemplet

Utredningens upplägg

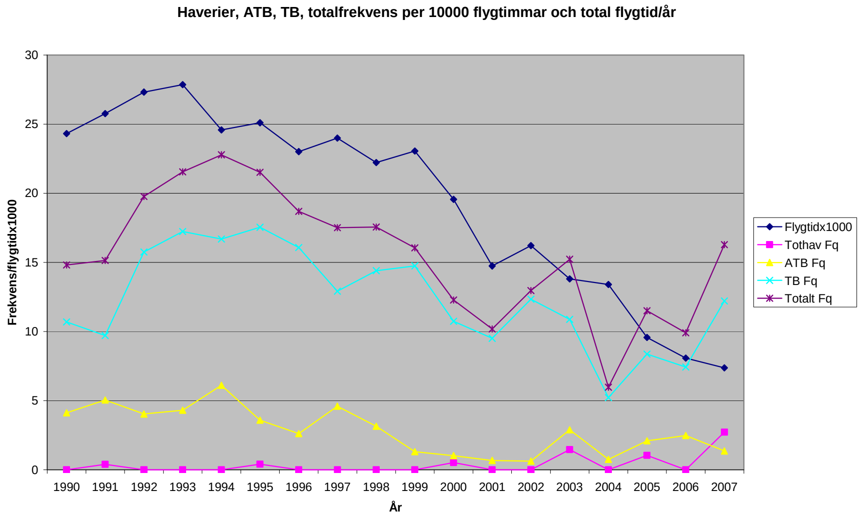
- Kunskapsläget – säkerhetskultur
- Vad krävs för en god säkerhetskultur?

- Hur ser det ut i den aktuella verksamheten?

- Förbättringsområden

Resultat

Flygtid och haverier



Vad fann vi? - Summering

- Uppgifter, kompetens, resurser är inte i balans
- Säkerhet är inte en grundläggande värdering
- Det saknas en oberoende tillsynsfunktion
- Ledningsstrukturer och ledarskap är otydligt
- Kulturskillnader har inte hanterats
- Kända problem åtgärdas inte

Rekommendationer

1. Återuppbyggnadsperiod

- Återuppbyggnadsperiod med **”lugn och ro”** för att återställa balansen mellan uppdrag och resurser (”time out”)
- Ge inga nya uppdrag, och de befintliga uppdragen bör anpassas till arbetet med återuppbyggnaden
- Försvarsmakten behöver göra en långsiktig och bred planering som riskanalyseras för att avgöra hur lång återuppbyggnadsperioden ska vara
- Försvarsmakten bör se över helikopterflottiljens nuvarande organisation

2. Gör säkerhet till ett prioriterat område

- Gör säkerhet till ett prioriterat område i Försvarsmakten som tydligt visas i värdegrund, verksamhetsstyrning, mål, policydokument och ledningens beteende
  - skapar förutsättningar för ett proaktivt säkerhetsarbete
  - inför begreppet säkerhet som en del av Försvarsmaktens värdegrund
  - kommunicera fortlöpande att säkerhet är ett prioriterat område

MTO Säkerhet

2. forts

- ta fram en säkerhetspolicy och tydliga och mätbara säkerhetsmål för organisationen och behövliga dokument för riskstyrning
- ge flygande personal särskilt anpassad utbildning i Human Factors/MTO och CRM
- se över kompetensbehovet i säkerhetsfrågor och Human Factors/MTO i hela verksamheten, särskilt inom:
  - Tillsynsfunktion (FLYGI) och Flygsäkerhetsfunktion
  - Alla ledningsnivåer i verksamheten

MTO Säkerhet

3. Skapa en oberoende tillsynsfunktion

- En oberoende tillsynsfunktion och en extern kravställare bör finnas för flygsäkerhet inom Försvarsmakten
  - Tillsyn måste ske av en part som har en oberoende ställning och eget mandat att utfärda sanktioner
- Överväg om en samordning kan ske med Transportstyrelsen för att skapa förutsättningar för bl.a. kompetensöverföring

MTO Säkerhet

4. Utveckla styrning och ledarskap inom helikopterverksamheten

- Skapa tydliga ansvarsförhållanden och utveckla verksamhetsstyrning
  - Verksamhetssäkerhetsansvaret och de ekonomiska resurserna bör finnas i samma funktion

MTO Säkerhet

5. **Utveckla ledarskapet inom Helikopterflottiljen**

- Skapa tid för ledarskap
  - Synligt ledarskap
  - Ledarskapet bör kunna fokusera på att leda verksamheten i nuläget och inte på att hantera nästa förändring.
- Kontakten mellan flygchef och flygande personal bör ökas.
  - En lokal flygchef på varje verksamhetsort
- Flygchef måste ges ett tydligare ansvar och en möjlighet att koncentrera arbetet på kärnverksamheten (flygning)
- Uppmärksamma och utveckla kompetens och arbetssätt för psykosociala arbetsmiljöfrågor

MTO Säkerhet

6. **Skapa arbetssätt för att hantera förändringar och kulturskillnader**

- Koppla förändringen till en utveckling av verksamheten och medarbetarna.
  - Lyft fram vad man vill utveckla och kommunicera ett tydligt syfte med förändringen.
- En förändring bör alltid föregås av en riskanalys
- Lyft fram och synliggör de kulturskillnader som fortfarande finns och hantera dem till verksamhetens fördel

MTO Säkerhet

7. Åtgärder för att förbättra lärande och erfarenhetsåterföring

- Utnyttja de verktyg och riskanalyser som finns och utveckla nya där det inte finns. Använd dessa inte bara för övningar utan för all verksamhet, uppföljning och återkoppling

- Avvikelserapporteringssystemet bör anpassas till dagens verksamhet med en bättre blankett där kodning och klassificering även finns för Human Factors/MTO

MTO Säkerhet

”Vår förhoppning är att denna utredning skall kunna fungera som ett underlag för ett fortsatt långsiktigt arbete med att utveckla och förstärka säkerhetskulturen i Försvarsmaktens helikopterverksamhet.

Det är viktigt att utredningen inte används för att i efterhand peka ut ”syndabockar”.

Alla, från högsta ledningen till stabs- och operativ personal, måste förstå att aktörer på olika nivåer som regel gör så gott de kan med den information de har och med de förutsättningar de arbetar under.”

MTO Säkerhet

Safety culture work in other high risk organizations

Clemens Weikert[a*], Marcus Arvidsson[b], & Lena Kecklund[b]

[a] Lund University, Lund, Sweden

[b] MTO Safety, Stockholm, Sweden

Abstract. The paper discusses the emergence of the concept Safety Culture, its definition and gives a short overview of the benefits of a good safety culture. The foundations of safety culture in all parts of organizational activities/functions are addressed. A model of safety culture is presented and discussed shortly. The roles of Management and Leadership in safety issues are noted, i.e. safety as a core value for management, the responsibilities of management.

Based on research performed by the authors extensive examples of safety culture work and the importance of management involvement in three different high risk organizations are presented and discussed (Swedish Armed Forces Helicopter Wing; LFV Group Air Navigation Services [air traffic control] and Bristow Group [offshore helicopter services]).

1. Introduction

The term safety culture was first introduced by IAEA International Nuclear Safety Advisory Group INSAG-1 in 1986 [1] following the Chernobyl accident. The intention was to denote that management and organizational factors are important to safety and that problems in those areas could were the contributing causes to the accident.

However, the importance of management and organizational issues to nuclear facility safety, first clearly surfaced in relation to the aftermath of the accident in 1979 at Three Mile Island (TMI) Unit 2 in USA. The US Nuclear Regulatory Commissions (NRC) investigation revealed that “The one theme that runs through the conclusions we have reached is that the principal deficiencies in commercial reactor safety today are not hardware problems, they are management problems.” [2]. The report also stated that “The NRC, for its part, has virtually ignored the critical areas of operator training, human factors engineering, utility management and technical qualifications.” Thus the investigation showed that these important areas so far had been neglected in nuclear safety work.

1.1 Definition of safety culture

The British Health and Safety Executive [3] defines safety culture as: “An organization’s safety culture is the product of the values, attitudes, perceptions, competencies and patterns of behaviour of individuals and groups that determine the commitment to and the efficiency of the safety management of the organisation. Organisations with a positive safety culture are characterised by communication based on mutual trust and a shared perception of the importance of safety and by confidence in the efficiency of preventive measures”. This definition seems to be the most widely used when looking through literature on the subject.

1.2. A simple model of safety culture

There is a simple model of safety culture consisting of three interacting elements: Risk management, Understanding and Behaviour [4]. To make sure that the organisation has a positive safety culture all three elements have to be considered. This model can be used as a basis for change and for working towards a better safety culture (see fig. 1).

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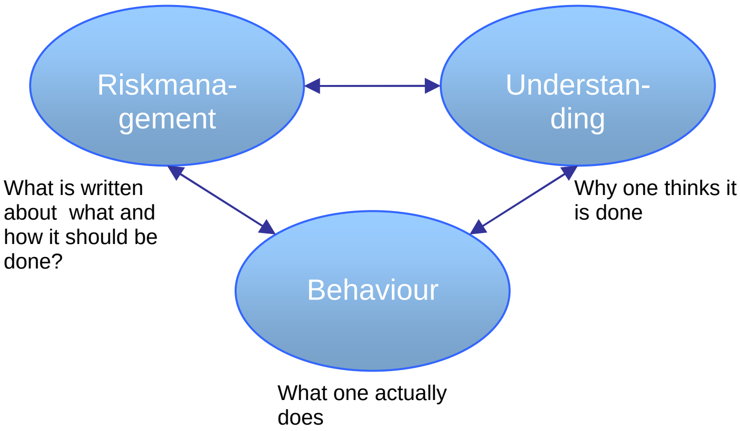

FIG. 1. Skriver's safety culture model.

Risk management is the "hardware" consisting of rules, routines, managements systems, checklists and documentation. External legal demands and internal demands made within the organisation create demands on the risk management of the organisation. Risk management includes governing documents and guidelines for how the organisation and its employees should act related to safety.

Understanding is about the attitudes towards and knowledge about risk management in the organisation of co-workers on all levels, i.e. towards all rules and routines of the organisation. This implies that there is knowledge as well as motivation to follow established rules and routines and to understand that safety is a core value with high priority in the organisation. The existence of this understanding and priority within top management is a prerequisite for its existence among the co-workers.

Behaviour means the actual actions and how one behaves in relation to safety. This is about how management and employees take care of safety issues in daily work, in decisions that are made and how one prioritizes. Top management, for example, must through its own behaviour show that safety issues are important and that the reporting of deviations is essential by giving feedback, encouraging reporting and take action when deficiencies are brought to attention. The key to safety is correct behaviour and to achieve results in safety work, the behaviour of all employees has to be influenced in a desirable direction.

Each element above is important per se [4] but in order to change and improve the safety culture of an organisation one has to work with all three elements together. The character of the risk management in an organisation affects the attitudes of the co-workers towards following existing rules and instructions. The understanding of the risk management system and attitudes to safety issues by the co-workers influences their behaviour. Participation of all employees in planning for safety work is also important in order to foster understanding and acceptance. If the co-workers find the safety work to be legitimate they will be motivated to behave in a safe manner. The risk management system has to be designed in a way that corresponds to the activity of the organisation. If the rules are difficult to follow in practice they will not control behaviour. Thus the different elements of the model act together and to achieve a change all three have to be considered as a whole.

According to Reason, accidents and incidents are a result of rare specific conditions in which deficiencies or holes in various organisational defence layers are combined in a way that allowing hazards to slip through [5]. Analogous with Reason one could say that if there are deficiencies ("holes") in one or more of the elements - Risk management, Understanding and Behaviour there is an increased risk for errors [6]. The situation and latent circumstances can lead to the lining up of "holes" causing loss of resilience of the system creating a clear accident risk (see figures 2 and 3).

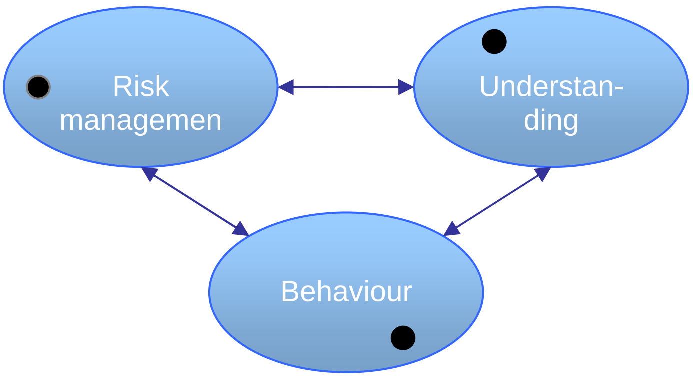

FIG. 2. Deficiencies ("holes") in risk management, understanding and behaviour.

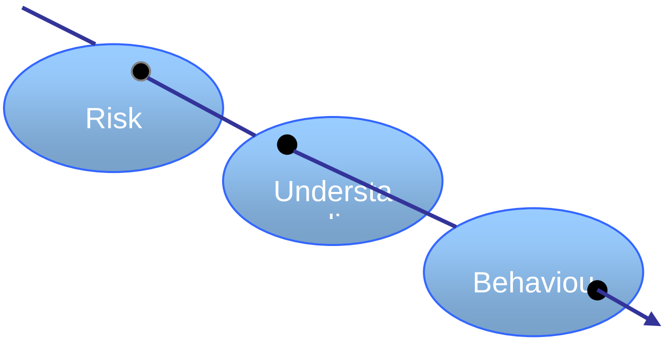

FIG. 3. System failure

2. Other high risk organizations than nuclear power plants

In this section examples of safety culture work and the importance of management involvement in three different high risk organizations based on research performed by the authors are presented and discussed (Swedish Armed Forces Helicopter Wing; LFV Group Air Navigation Services [air traffic control] and Bristow Group [offshore helicopter services]).

2.1 Swedish Armed Forces Helicopter Wing

Using questionnaire data from a study comparing safety culture, organizational climate and psychosocial work environment in two Swedish Air Force units [7] an extensive correlation and multiple regression analysis was made. In the original study 90% of the questionnaires were returned, divided equally between the two units. The relations between the dimensions of the safety culture questionnaire were studied and in some cases related to the results from the climate and psychosocial questionnaires. The results show that quality of leadership correlates significantly with all dimensions of the safety culture questionnaire (higher quality leadership = better safety culture). The multiple regression analysises show that 'safety perception', 'safety behaviour' and attitudes towards safety are predicted by factors like reporting, communication, organizational learning, just culture and work situation (all predictions statistically significant). 'Just culture', 'flexibility' and 'work situation' are predictors for the organizational climate variable trust/openness and 'work situation' for operational risk-taking (all statistically significant). The results of the study clearly indicate the importance of organizational factors for safety culture in safety-critical organizations [8].

2.2 LFV Group Air Navigation Services

The aims of this study were to gain a better understanding of the safety culture concept in an air traffic control setting in general and to study the relationships between safety culture and organizational climate during organizational and technical changes in Swedish air traffic control [9].

The questionnaire method used to assess safety culture was based on nine aspects that according to the literature are considered central in a safety culture.

Study locations were two air traffic control centres (ATCC) and the Air Navigation Service division (ANS) head office in Sweden. Even though the safety culture mean scores differed somewhat across the three study locations, the patterns of the mean score profiles were the same. The administrative ANS unit had generally somewhat lower scores compared to the two operative ATCCs. The dimensions Communication, Justness, and Flexibility generally received somewhat lower scores compared with the rest of the safety culture aspects.

Individual factors such as gender, age, time in company, and time in current position had almost no effect on how safety culture aspects were perceived. On the other hand, managers had more positive assessment of the safety culture compared to non-managers, with many statistically significant differences between the two groups.

The investigations concerning existing relationships between safety culture aspects and organizational climate dimensions showed that the two organizational climate dimensions, Support for ideas and Conflicts, were positively and most frequently related to the various safety culture aspects (a high score on Conflicts means a low level of conflict) at the two ATCCs. However, very few relationships were found between the safety culture and organizational climate concepts at the administrative ANS unit.

2.3. Bristow Group

Bristow Group is a world leading provider of helicopter services for the oil and gas industry, operating more than 400 helicopters in more than 20 countries, flying over 300 000 hours in a variety of environments. A basic idea with the Group is the separation of 'management' and 'leadership', where management deals with strategy, goals and tasks while leadership deals with culture, teamwork and co-workers (see fig. 4).

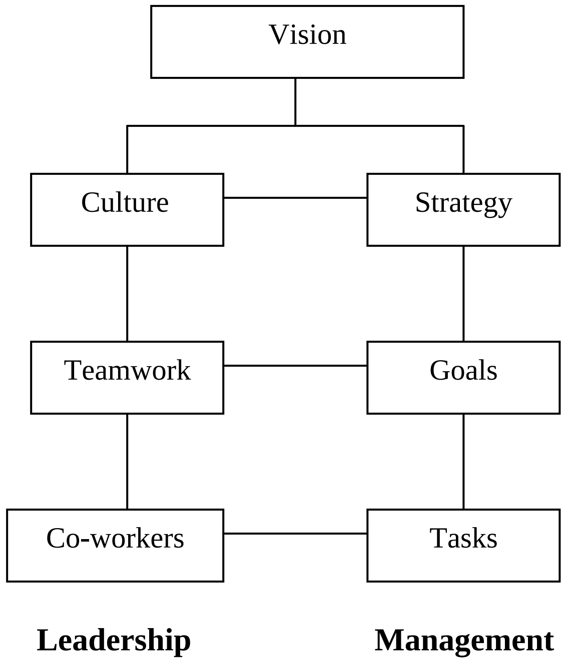

FIG. 4. The relationship between leadership and management.

Management takes care of the Safety Management System and the leadership is the driving force behind the safety culture. In 2005 Bristow published a document to show how they expect leaders in the Group to behave:

- Lead through examples according to the Groups core values
- Build trust and confidence in the staff you work with
- Keep people informed
- Take responsibility for you actions and hold others responsible for theirs
- Involve your co-workers, learn their views, listen actively for what they have to say and represent their views honestly
- Be clear about what is expected and give feedback
- Show tolerance for people's diversity
- Show your co-workers gratitude and encouragement for their contributions and performance
- Consider different alternatives, including both short-term and long-term effects and be resolute in your decision-making.

During 2007 Bristow introduced "Target Zero", i. E. a 'zero-vision' concerning accidents. The Group is of the view that "Target Zero" only can become credible if supervisors on all levels really show adequate safety management behaviours including the communicating of the message. By clearly identifying safety culture as something that has to be treated differently from a Safety Management System Bristow points towards leadership as the ingredient necessary to build a strong safety culture and thereby making the organisation's Safety Management System more efficient [10].

3. Conclusions

The importance of management commitment for safety is very often stressed in the literature. In order to foster a good safety culture the management needs to behave in a way that clearly demonstrates that safety is important. The three studies outlined in this paper support this view by providing results that demonstrate relationships between leadership and safety culture. In addition, safety culture seems to be related to other organisational aspects since correlations were found between safety culture and organisational climate. Thus, to understand and build a strong safety culture a more holistic view might be needed that take other organisational aspects in consideration. However more research is needed in order to gain a better understanding of contributing factors and their relative importance for an organisations safety culture.

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[6] KECKLUND, L., SKRIVER, J,. BORG, A. & PETTERSON, S. (2008). Safety culture and system failure - a new cheese model. *Poster presented at the Europe Chapter of the Human Factors and Ergonomics Society Scientific Meeting in Soesterberg, the Netherlands, October 15-17.*

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[9] EK, Å., AKSELSSON, R., ARVIDSSON, M. & JOHANSSON, C.R. (2007). Safety culture in Swedish air traffic control. *Safety Science, 45,* 791-811.

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HF in O&G

DESIGN	DRIFT (CRM, OTS, HRA)	GRANSKNING

"The opinion of the forecast's experts underline the crucial role played by ergonomics and especially cognitive ergonomics in ensuring health and safety at the workplace. Interaction with – and indeed dependence on – technology is increasing in almost all occupational fields."

SAP Submit and Pray

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Presentation of master thesis:

HF/HMI Challenges in modern control system design in the Norwegian oil and gas industry

UNIVERSITY OF OSLO
Department of Physics

UNIK – University Graduate Center at Kjeller

Field: Electronics and Computer Technology - Cybernetics

Student and automation engineer: Maryam G. Hessaroeyeh

Evaluation of the thesis is as yet not completed by the University of Oslo/UNIK.

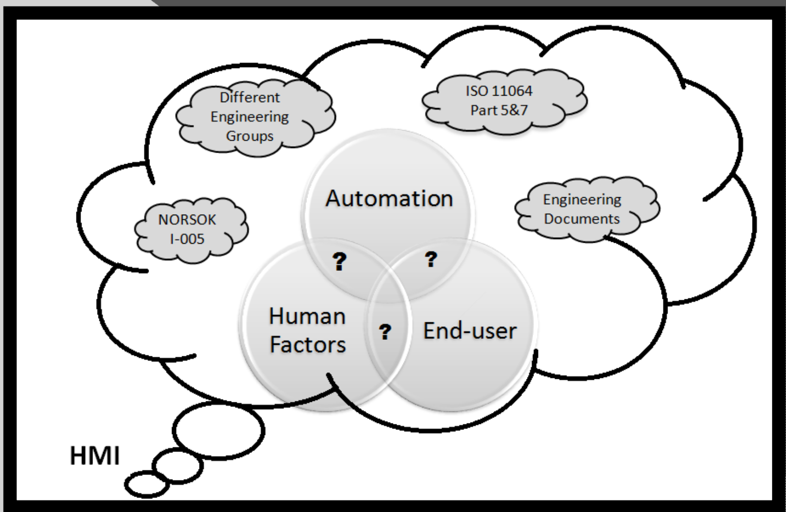
Supervisors:
Jörgen Frohm, HFS AS
Oddvar Hallingstad, UIO/UNIK
Torfinn Lindem, UIO/UNIK
Geir Tandstad, Aibel AS

20. October 2010

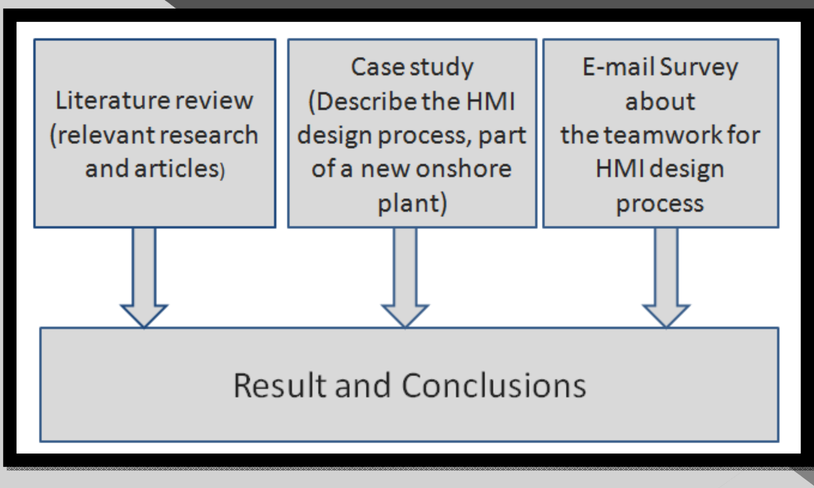
Presentation of the thesis:

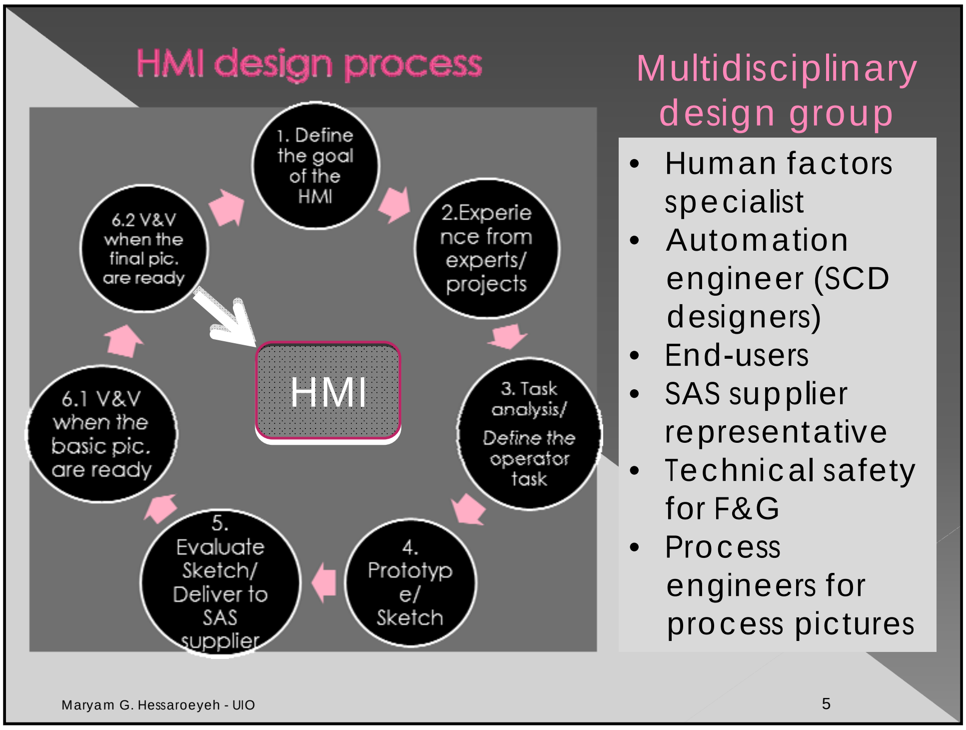
- Research problems and questions
- Methods used
- Literature review
- Case study
- E-mail survey
- Discussion
- Result and Conclusion

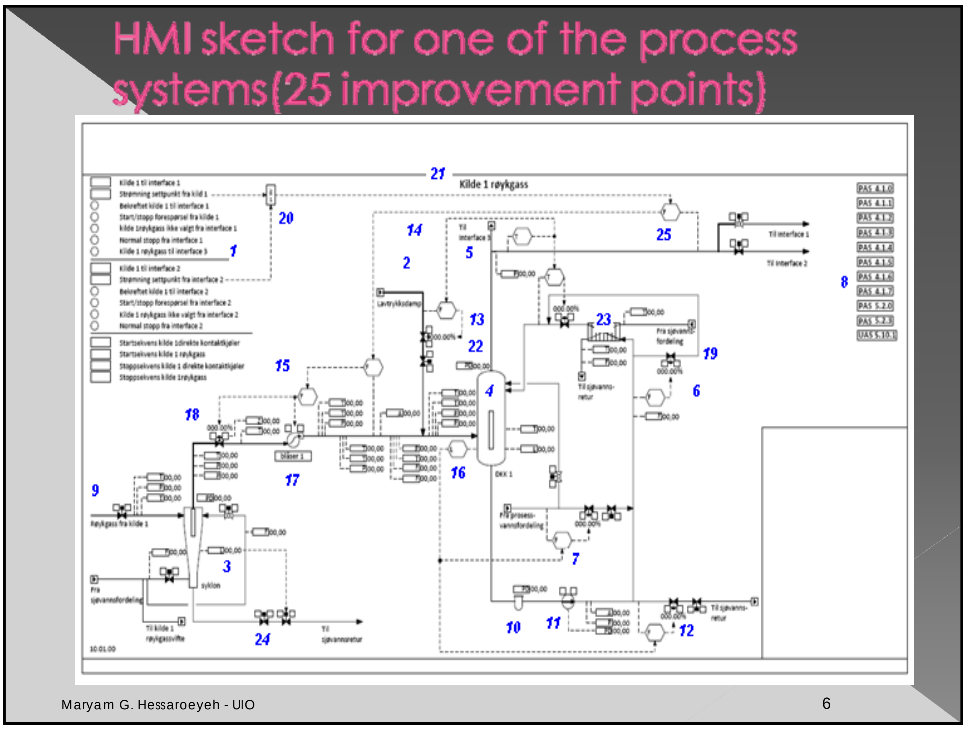
Summary of the problem



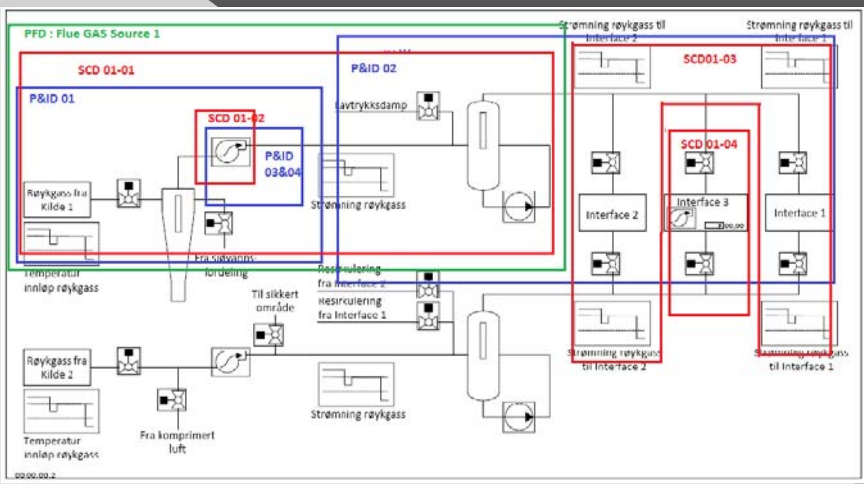
Main methods used:




HMI design process
1. Define the goal of the HMI
2.Experience from experts/ projects
3. Task analysis/ Define the operator task
4. Prototype/ Sketch
5. Evaluate Sketch/ Deliver to SAS supplier
6.1 V&V when the basic pic. are ready
6.2 V&V when the final pic. are ready
HMI
Multidisciplinary design group
• Human factors specialist
• Automation engineer (SCD designers)
• End-users
• SAS supplier representative
• Technical safety for F&G
• Process engineers for process pictures
Maryam G. Hessaroeyeh - UIO
5


HMI sketch for one of the process systems(25 improvement points)
Maryam G. Hessaroeyeh - UIO
6

Basic deviation of engineering documents used for part of the HMI Sketch-LSD



Result of E-mail survey about the following topics:

- Start of the HMI design process
- Definition of "HMI engineer"
- Engineering documents needed for design
- Multidisciplinary design group
- Automation knowledge about HF
- HF knowledge about automation

Discussion and Results about the following topics

1. Ensure operator has a permanent overview of their system.
2. Ensure the required exchange of information during shift change is minimized.
3. Ensure requirements of all potential users have been considered.
4. Ensure that all information presented are relevant to the operator task.
5. Ensure including all the information required for particular task is presented on a minimum number of displays.
6. Role of LSD in control room.
7. Describe HMI design process.
8. Teamwork between HF, automation, end-users and other engineering groups during the HMI development process.

Main questions remaining:

- Shall the basic rules for HMI design process be based on standards and regulations or based on each project/company culture?
- Is HMI design process in various projects based on ISO 11064-5 and ISO 11064-7 ?

Thanks for your time

INVITASJON

Human Factors in Control

20-21 oktober
2 0 1 0

Menneskelige og organisatoriske faktorer i ulykkesgranskning

6.juni

Kjære deltaker!
Vi vil med dette invitere til møte i HFC-forum (Human Factors in Control).

Møtet holdes onsdag 20. og torsdag 21. oktober 2010 i Statoils lokaler i Vassbotnen 23, Stavanger. Vi starter registreringen kl 10:30, fra kl 11:00 kommer siste nytt om ulykken i Mexicogulfen, "Deepwater Horizon" fra en av dem som deltar i granskningen – J.E.Vinnem, fulgt av lunch fra 11:30 til 12:30. Vi har et fyldig program. Vi avslutter 15:30 på torsdag.

Vi har reservert rom på Thon Hotell Maritime i Stavanger, tlf: 51 85 05 00, referanse 4814660 eller SINTEF. SINTEF kan bestille rom for dere – kryss av på siste side. Vi håper du har anledning til å delta, og ønsker at du fyller ut og returnerer det vedlagte registreringsskjemaet, senest 12.oktober. Vi ser frem til din deltakelse.

Program (NB: Endringer kan forekomme)
Tema for møtet vil være "menneskelige og organisatoriske faktorer i ulykkesgranskning" og vi har et program med mange spennende innlegg, diskusjoner og workshop. Foredrag holdes bl.a. av Mike Broadribb, nå BakerRisk, som var sentralt i granskingen av ulykken ved BP's Texas City Refinery 23/3-2005, og fra Dr Kathryn Mearns - The University of Aberdeen, om sammenhengen mellom Human Factors og CRM. De vil bidra med mange interessante perspektiver på menneskelige og organisatoriske faktorer i granskninger samt underliggende årsaker til ulykker. Det blir besøk hos Acona hvor vi får anledning til å se nærmere på en beredskapsentral som benyttes av en rekke selskap i olje- og gassindustrien.

Visjon og hovedoppgave for HFC forumet
HFC visjon: "Kompetanseforum for bruk av HF innen samhandling, styring og overvåkning i olje og gass virksomheten." HFC hovedoppgave: "Å være et forum for erfaringsoverføring som bidrar til å videreutvikle HF metoder til bruk ved design og vurdering av driftskonsepter." (Om HFC, se: www.hfc.sintef.no)

Vil minne om konferansen i regi av Human Factors and Ergonomics Society Europe, 13-15/10 - 2010 i Berlin – tema "Human Centred Automation". Se http://www.hfes-europe.org/. Proceedings fra 2009 møtet var "Human Factors – A system view of human, technology and organisation" og kan bestilles fra HFES. Dessuten Ergonomi konferansen i Stavanger 6-8. September se www.nordicergonomics.org. Vi vil også benytte anledningen til å minne om kurset "MTO-Human factors" ved UiS som går høsten 2010, og NTNU kurset "Introduksjon til HF og integrerte operasjoner" - våren 2011, se videre.ntnu.no/link/nv12296

Vennlig hilsen
Arne Jarl Ringstad /Statoil, Atoosa P-J Thunem/IFE, M. Green/HCD, Håkon Fartum/DNV, Stig Ole Johnsen/SINTEF.

Vær vennlig og returner registreringen innen 12.oktober 2010 til:
rigmor.skjetne@sintef.no

HFC Møte

AGENDA

20 til 21 oktober 2 0 1 0

Menneskelige og organisatoriske faktorer i ulykkesgranskning

Stavanger, Statoil, Vassbotnen 23

Dag 1	Foredrag med spørsmål etter foredragene	Ansvar/Beskrivelse
10:30-12:30	Registrering	HFC/Statoil
11:00-11:30	Status/Siste nytt fra gransking av "Deepwater Horizon"	J.E.Vinnem/Preventor
11:30-12:30	Lunch	HFC/Statoil
12:30-12:45	Velkommen og presentasjonsrunde blandt deltakerne	HFC
12:45-13:45	Organizational and Human Factors in Accident Analysis	M. Broadribb/BakerRisk
13:45-14:00	Kaffe og noe å bite i	HFC/Statoil
14:00-14:30	Toolbox Talk: "MTO faktorer i ulykkesgranskinger."	J.Bunn/Statoil
14:30-15:00	Samarbeid for Sikkerhets nye veiledning for beste praksis ved granskning av HMS hendelser	H. Halvorsen/Samarbeid for Sikkerhet
15:00-15:30	Kaffe og noe å bite i	HFC/Statoil
15:30-16:00	Air Safety Through Investigations – Bridging Theory and Practice.	F.Strand, J.C.Rolfsen/DNV
16:00-16:30	Medias rolle i dekning av ulykker	T. Foss/TV2
16:30-16:45	Litt om min mastergrad	M. Hessaroeyeh
16:45-17:00	Buss til Acona – Fabrikkveien 3	
17:00-18:00	Besøk beredskapssentral Acona	V.Gade/Acona
18:00	Buss fra Acona til Thon Hotell Maritime	
19:00	Middag Tango Bar & Kjøkken - Nedre Strandgate 25	HFC/Statoil

Dag 2	Foredrag med spørsmål etter foredragene	
07:50	Buss drar fra Thon Hotell Maritime	HFC/Statoil
08:15-08:30	Kaffe og noe å bite i	HFC/Statoil
08:30-09:00	"Duk i Buk" – erfaring fra sykehus med metoder som fokuserer på organisatoriske og menneskelige faktorer.	H.Alm/HFN
09:00-09:30	Organisasjonsmessige faktore - kvalitetstap over grensesnitt	L.Hansson/SINTEF
09:30-09:45	Kaffe og noe å bite i	
09:45-10:45	Closing the loop between human factors in accident investigation and implementing CRM	Dr. K. Mearns/Univ. of Aberdeen
10:45-11:00	Kaffe og noe å bite i	
11:00-11:30	Læring av ulykker	R.Tinmannsvik/SINTEF
11:30-12:30	Lunch	
12:30-13:00	Menneskelige og organisatoriske faktorer i ulykkesgranskingen	H.Heber/ Ptil
13:00-14:00	Säkerhetskultur, organisation och ledarskap - mänskliga och organisatoriska faktorer i haveriutredningar	C. Weikert/Univ. i Lund og L. Kecklund/MTO sikkerhet
14:00-15:15	Workshop om organisatoriske og menneskelige faktorer – en gruppe fokuserer på hva som går galt og en gruppe fokuserer på robusthet – "resilience". Vi har to møterom.	J.Rolfsen/DNV ordstyrer og S:O.Johnsen/SINTEF
15:15-15:30	Avsluttning/ evaluering	HFC

REGISTRERING

Human Factors in Control

20. til 21. oktober
2 0 1 0

Stavanger, Statoil

Menneskelige og organisatoriske faktorer i ulykkesgranskning

Ja, jeg vil gjerne delta:

Navn: __ ___________________________________

Tittel / stilling: ____ _______________________________

Organisasjon: ___ ________________________________

Adresse: __ ___________________________________

Kryss av for:
__Lunsj 20/10, __Middag 20/10, __ Bestiller hotell 20/10 __ Lunsj 21/10

Tlf. : __________ Fax: ___________

E-post: _______________

Hvem faktureres (PO-Nr/Bestillingsnr/Referansenr:)___________________

For å være med må man betale inn medlemsavgift eller møteavgift. Medlemsavgiften er pr år:

- 25.000 for bedrifter med mer enn 15 ansatte (dekker 3 deltakere)
- 12.500 for bedrifter med mindre enn 15 ansatte (dekker 2 deltakere)
- 6.500 kr pr møte for ikke medlemmer (og overskytende deltakere)

Medlemsavtale, informasjon og publikasjoner om HFC kan finnes på WEB-siden: http://www.hfc.sintef.no

Vær vennlig og returner registreringen innen 12.oktober 2010 til:
rigmor.skjetne@sintef.no