Conscious Competence:
We Need To Think About That!

Carl Sandom, iSys Integrity Ltd.

International System Safety Training Symposium
6 August 2014, St. Louis, USA
Something about me

• Specialize in:
  – Software Safety
  – Human Factors & Safety

• Employment record:
  – iSys Integrity
  – Praxis Critical Systems
  – Thales Defence UK
  – UK Royal Air Force (22 years)

• Over 20 years safety experience
Why I Joined the Air Force

Air Force

Navy

Army
iSys Integrity

- Safety Management
  - SMS development
- Systems Safety Engineering
  - Safety assurance (producer)
  - Safety auditor (reviewer)
- Safety Training:
  - Systems Safety
  - Software Systems Safety
  - Human Factors for Safety
  - Safety Management
Conscious Competence: We Need To Think About That!

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Presentation Aim

• To raise awareness of some important issues related to safety competence for organizations and individuals involved in acquiring, developing or maintaining safety-related systems.
Conscious Competence Model
Conscious Competence

Start

**UNCONSCIOUS INCOMPETENCE**
You are unaware of the skill and your lack of proficiency

**UNCONSCIOUS COMPETENCE**
Performing the skill becomes automatic

**CONSCIOUS INCOMPETENCE**
You are aware of the skill but not yet proficient

**CONSCIOUS COMPETENCE**
You are able to use the skill, but only with effort
As Donald Rumsfeld might put it....

Unconscious Incompetence
You don’t know that you don’t know how to do something.

Conscious Incompetence
You know that you don’t know how to do something and it bothers you.

Conscious Competence
You know that you know how to do something and it takes effort.

Unconscious Competence
You know how to do something and it is second nature; you rock at it.
To put it another way......
The 5th Stage

1. Individual presented with new job or task, or assessed as not competent
2. Unconscious incompetence (unaware of limitations)
3. Conscious incompetence (during training and development)
4. Conscious competence (trained and assessed as competent)
5. Unconscious incompetence (develops bad habits or lapses)
6. Unconscious competence (develops good habits)
The Challenge?

From Conscious Incompetence to Unconscious Competence

- Unconscious incompetence (unaware of limitations)
- Conscious incompetence (during training and development)
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Individual presented with new job or task, or assessed as not competent
An example to ease understanding

From Conscious Incompetence to Unconscious Competence

30 days of hula-hooping for 30 minutes - focusing on mastering a hoop-technique called "Paddling"
The Competence Conundrum
Competence Defined

• The ability to undertake responsibilities and perform activities to a recognised standard on a regular basis (UK HSE)

• Combination of:
  – Skills
  – Knowledge
  – Experience
Competence Defined

- Incompetence often used synonymously with terms
  - Human failure
  - Human error
- Incompetence is one factor that could lead to human errors
- Competent people make
  - Slips
  - Lapses
  - Mistakes
What’s the problem?

• Many organizations that develop safety-related systems don’t adequately address safety competence
• Often the approach is reactive and programme dependent
• Organizational competence may be categorized as:
  – Distributed Competence
  – Limited Competence
  – False Competence
Distributed Competence

• Outsource safety engineering to contractors
  – Contractors provide safety process expertise
  – Staff provide system and domain knowledge

• Competence is ‘distributed’ between internal and external staff

• Does not address competence issue
  – Organizational culture important
  – Inherent risks and limitations
  – Inadequate for safety management
  – Considered cost effective
Distributed Competence

- Unconscious incompetence (unaware of limitations)
  - Individual presented with new job or task, or assessed as not competent
  - Unconscious incompetence (develops bad habits or lapses)
- Conscious incompetence (during training and development)
- Conscious competence (trained and assessed as competent)
  - Unconscious competence (develops good habits)
Limited Competence

• ‘Volunteer’ one or more employees with responsibility for safety engineering on a specific programme
  – QA
  – ILS
• Often have little or no safety competence and have to teach themselves and learn safety 'on the job'
• The ‘one eyed man’ approach
Limited Competence

- Conscious incompetence (during training and development)
  - Unconscious incompetence (unaware of limitations)
    - Individual presented with new job or task, or assessed as not competent
    - Unconscious incompetence (develops bad habits or lapses)
    - Unconscious competence (develops good habits)
  - Conscious competence (trained and assessed as competent)
False Competence

• Organization has some partially competent staff but their knowledge and skills are not up to date
  – Under confident (conscious incompetence)
  – Over confident (unconscious incompetence)

• Lack of Continuing Professional Development
  – New techniques and methods (e.g. STAMP)
  – Updated standards (DO-178)
  – Limited domain knowledge

• Competence gap!
False Competence

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Judgement and Competence?

- Professional judgement is a necessity
  - Many SR systems <5 years old no data
- Safety Assurance ultimately reliant upon professional judgement
- Systems developers should make clear:
  - Where judgement is applied
  - Basis of competence
Professional Judgement

• Or expert opinion is defined as:

“The ability of a person or group to draw conclusions, give opinions and make interpretations based on a combination of evidence from diverse sources”

(McKenna 2006)
Professional Judgement

• Statistical Inference:
  – Predictive
  – Used for safety claims
  – Based upon evidence available

• Inferences can be wrong (e.g. software reuse)

• In the absence of actual evidence:
  – Probabilities are judgments
  – Judgements often based on judgements

• Should exercise extreme caution
Professional Judgement

• Judgement often used to span assurance gap
  eg:
  – Exhaustive testing software difficult
  – SIL 1 software testing > 10 years continuous!

• Rate of change of technology etc making problem worse (tools & methods)
Competence and Safety
Competence-Related Accidents

• Incompetence can lead to fatalities, personal injuries and ill health

• (HSE) The inadequate management of competence has contributed to disasters such as
  – ESSO Longford
  – BP Texas City
  – Praxair, St Louis
ESSO Longford (1998)

• Gas plant explosion
• 2 dead, 8 seriously injured
• Royal commission concluded many significant contributory factors including *lack of competence*
  – On morning of accident it was school holidays
  – Senior operations people were away
  – Most senior site person was maintenance supt.
BP Texas City (2005)

- Oil refinery explosion
- 15 dead, 170 seriously injured
- Investigation concluded many significant contributory factors including *lack of competence*
  - Inadequate training
  - Insufficient supervision
  - Lack of operator skill to contain explosion
Praxair, St Louis (2005)

- Exploding propylene cylinders flew up to 800 feet, damaged residential property and started fires.
- Miraculously no one was injured.
- Investigation concluded contributing factor lack of competence:
  - “Communicate with your members who operate gas repackaging facilities the details of this incident and the best practices for handling and storing cylinders”
UK Legal Requirement

• Early UK reference to requirement for competence was made in the common law case of Wilsons and Clyde Coal Co Ltd. v English, 1938

• The case specified that the employer’s duty of care involved a three-fold duty to provide:
  – Safe plant and appliances
  – Safe systems of work, and
  – Competent employees

• Now enshrined in UK Health & Safety Law
Continuing Professional Development

• US National Society of Professional Engineering
  – Mandated continuing professional development (CPD) for license renewal to ensure competency of professional engineers
  – Supports policy of mandatory CPD
  – State legislatures should be encouraged to pass legislation that would mandate continuing professional competency (CPC)
  – 40 US states already mandatory CPC laws
Safety Standards and Competence

- **IEC 61508 Ed. 2 2010**
  - Requirement for staff competence is upgraded from a recommendation to mandatory
- Requirement is to ensure that procedures in place for ensuring that staff involved with functional safety are competent to carry out their work activities
- Effective competence system should be in place to facilitate this
Safety Competence Assurance
Competence Management

• Develop formal approach to CM
  – Competence register and procedure
  – Look at role definitions, ‘task’ and ‘function’ competences
  – Identify and address safety competence transfer requirements
• Ensure continuous improvement of CMS
• Training courses to fill ‘knowledge gaps'
Competence Management

CMS

- Scope
- Policies
- Procedures
- Responsibilities
- Competence Programs
- Forms
- Tracking System
Managing competence for safety-related systems

Part 1: Key guidance

Introduction

1 The guidance on competence applies to everyone, in all industry sectors, whose decisions and work with safety-related systems can affect health and safety. The aim is for all people within scope to be suitably qualified and experienced for their own work activities, roles and responsibilities.

2 A safety-related system according to this guidance is a system whose correct operation is necessary for ensuring or maintaining safety. It uses electrical, electronic, and/or programmable electronic technologies and may include software and people. In general, safety-related systems can be classified as protection systems or control systems.

3 Example safety-related systems include a fire switch that disconnects power from a press on close approach to moving parts; traffic lights; vehicle engine management; boiler management, medical devices, fire management in an intelligent building; gas detection on an industrial chemical plant; emergency shutdown on an offshore gas platform; remote operation of a network-enabled process plant; access protection for nuclear reprocessing; fly-by-wire operation of aircraft flight control surfaces and any information system where erroneous results can significantly affect safety.

4 New technologies, particularly programmable electronics, have enabled such systems to function more effectively and allowed more sophisticated ways to make them safe. At the same time, the new technology has brought its own challenges – particularly increased design complexity. This has thrown the spotlight on the role of staff engaged in the design, development, maintenance and use of these safety-related systems. The achievement of sufficiently low levels of risk is critically dependent on individual and team competence.

1 The effort expended in meeting the principles of this guidance should be in proportion to the risk associated with inadequate competence (see Risk and proportionality).
Competence Guidelines

- IET guidelines developed 1999
- Revised 2007
- Under review with intent to publish 2015
Competence Management Example

**Standard of best practice**

**Technical skills**
- Knowledge
- Behavioural skills
- Understanding

**Individual competencies**
- Task-related
- Function-related

**Assessment Guidance**
- Supervised
- Practitioner
- Expert

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**Competence Assessment**

For each individual competence:
- Make a claim for a level of competence
- Provide evidence to support the claim

For the function as a whole:
- Provide the context of the assessment
- Select an overall level and provide a summary
- Identify actions to improve competence
Safety Competence Transfer

• Safety often not ‘core’ competence
• Solutions often:
  – Distributed Competence
  – Limited Competence
  – False Competence
• More cost effective to develop ‘in-house competence’
• Business retains safety competence
Safety Competence Transfer

• Competence = Skills + Knowledge + Experience
• Use real engineering programme to:
  – Develop in-house safety competence
  – Minimize consultancy costs
• Progressive mix of:
  – Training (Knowledge Transfer)
  – On-The-Job Mentoring (Experience Transfer)
• ‘Train a little – Do a little’
Conclusions
What’s the problem?

- Many organizations that develop safety-related systems don’t adequately address safety competence
- Often the approach is reactive and programme dependent
- Stovepipes result in inconsistent organizational approaches between programmes:
  - Distributed Competence
  - Limited Competence
  - False Competence
Formal Competence Management

- Scope
- Policies
- Procedures
- Responsibilities
- Competence Programs
- Forms
- Tracking System

CMS
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ISSS input welcome!
ISSS/IET collaboration?
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Conscious Incompetence Example

Watch the man on the scooter at the top........
The technical programme this year is impressive. We’ve lined up some outstanding Keynote Speakers and a wide variety of tutorials, papers, posters and panel discussions which should provide plenty of interest and added value.
Any Questions?

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