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Safety in biomedical labs: ground up

Chesapeake Area Biological Safety Association
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SingHealth DukeNUS ACADEMIC MEDICAL CENTRE

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Where I live

Where I work

Established in 2005, first US-style graduate-entry medical school

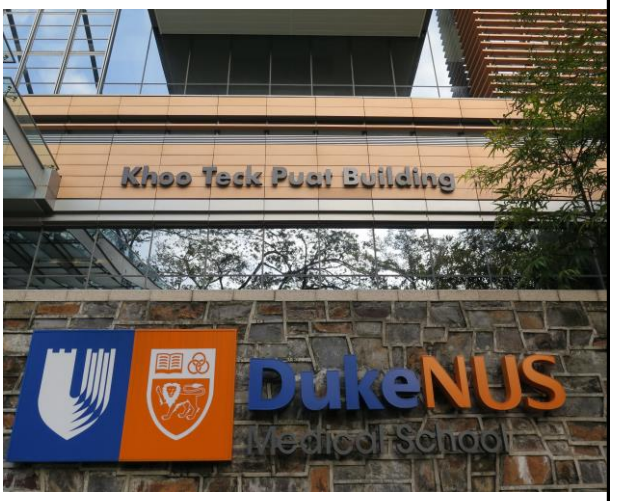
Medical education with a strong research component

> $674 million in grants

>120 patents granted, >20 licenses executed, 17 spin offs

7,800 peer-reviewed journal articles

Co-located – Singapore's largest healthcare group – augments translational research



Where I work

- **Wet bench labs**
- **Insectary**
- **Fly lab**
- **Animal Biosafety level 3 facilities**
- **Mouse and rat facilities**
- **Imaging**
- **Cell Sorting**
- **Mass Spectrometry**
- **Imaging**

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About myself

- Head, Safety, Health and Emergency Management Department
- Serve in various Biosafety Organizations
- Consult in the field of Biorisk Management in Southeast Asia and elsewhere
- Master's degree in Human Factors and Systems Safety from Lund University in Sweden
- I root for the underdog- the lab bench workers who are stuck with so many rules which they really don't know how to translate into their everyday work life
- My motto is that "safety is simply the way you work"

Outline

- Safety Science and the Sociotechnical system of work
- Two concepts in Safety Science
  - Goal Conflicts
  - Work-as-planned vs work–as-done
- Lessons we can learn

Safety Science

- Safety Science is an international medium for research in the science and technology of human safety
- It can be related to work, home, leisure
- Safety Science is multidisciplinary

Sociotechnical System

- **Sociotechnical systems** in organizational development is an approach to complex organizational work design that recognizes the **interaction between people and technology in workplaces.**
- The **social** aspects of **people and society** and **technical** aspects of **organizational structure** and **processes.**
- Not just material technology, but procedures and related knowledge

Sociotechnical System

- Sociotechnical refers to the **interrelatedness of *social* and *technical* aspects** of an organization or the society as a whole**.** Sociotechnical theory therefore is about ***joint optimization*****,** with a shared emphasis on achievement of both **excellence in technical performance and quality** in people's work lives.

(source: Wikipedia)

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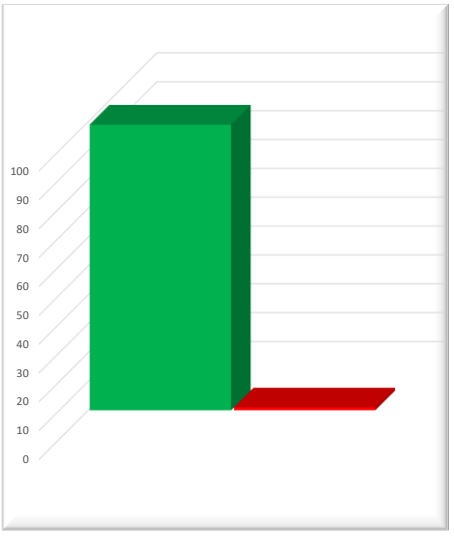
Complex Systems

Complex Systems

Two views of safety

The practice of safety is to prevent accidents, and yet we spend a lot of time analyzing accidents and trying to learn from them. Why do we do this? That is the exact question that Erik Hollnagel asked and came up with the concept of safety I and safety II. He wrote, “An unintended but unavoidable consequence of associating safety with things that go wrong is a creeping lack of attention to things that go right”.

Two views of safety



600 workers
44 hours/week
2018-2020
Things that go right =99%
Things that go wrong =1%

New View of Safety – is to support the workers who 99% of the time do the right things and prevent an accident

Old view (safety I) vs new view (safety II)

Old view /Safety I	New view /Safety II
Analyzing things go wrong	Analyzing things that go right
Workers are not always the liability that causes an accident	Workers are the ones that prevent an accident
Too quick to blame human error	Looks at the entire socio-technical system
Not a holistic approach –looks only at negative outcomes like an accident	Holistic approach - Safety-II is about all possible outcomes: involving everyday work performance; learning from best performance: and near-misses accidents and disasters

People at the workplace

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Rasmussen model of boundaries

- Workplace is dynamic
- SOPs and instructions are restrictive cannot deal with every changing demand
- Human behavior at work is strongly controlled by goals and constraints
- Workers make adjustments to how they work to meet production and safety demands
- This variability is called “degrees of freedom” or “local variability”
- Rasmussen used a model of boundaries to plot this variability in work performance

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Goal Conflicts

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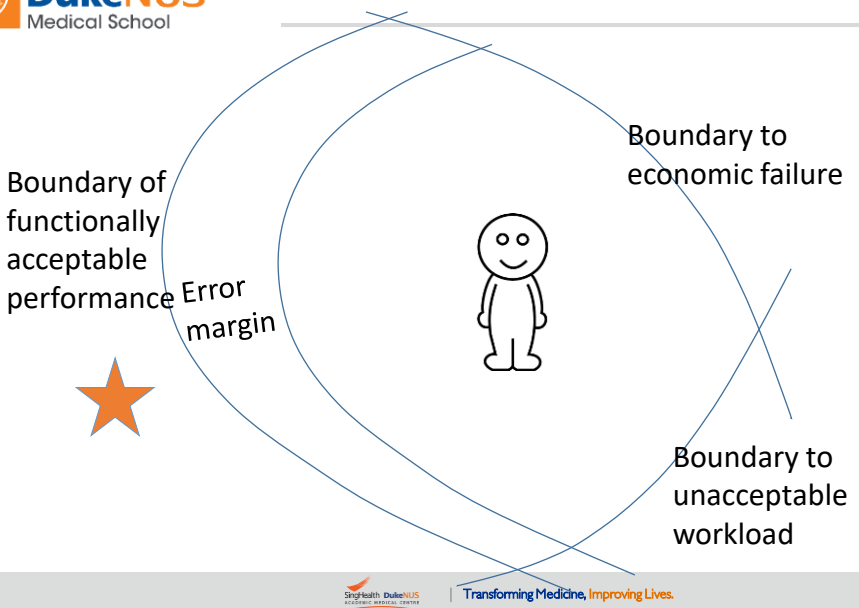
Rasmussen model of boundaries



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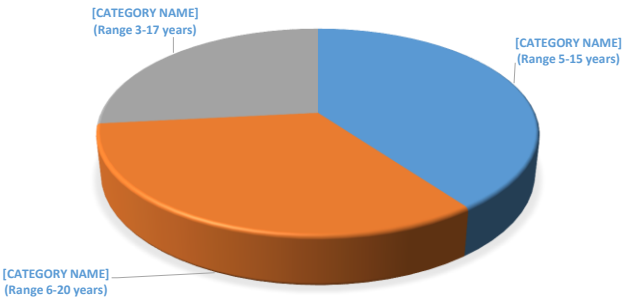
Demographics of participants n=24



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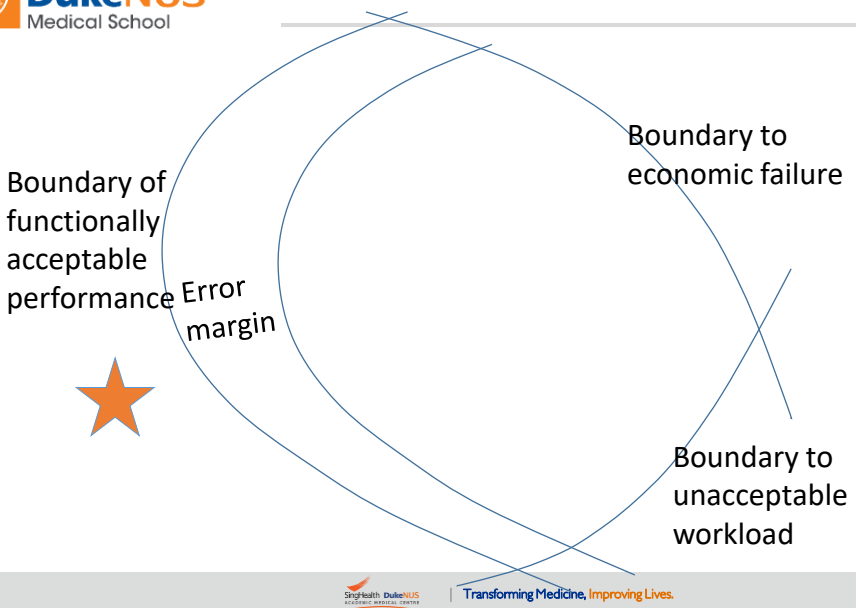
Rasmussen model of boundaries



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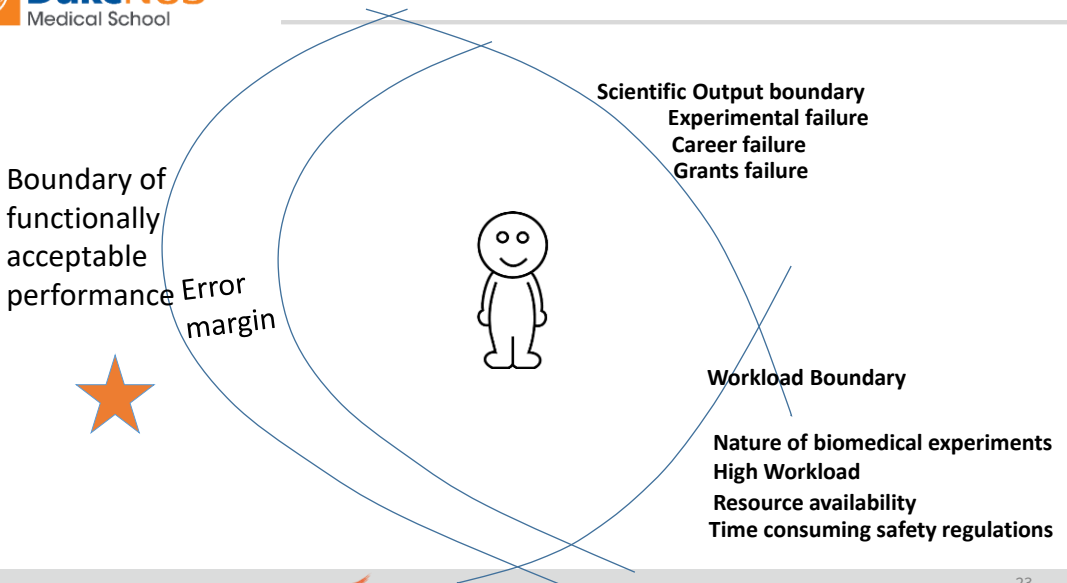
Results



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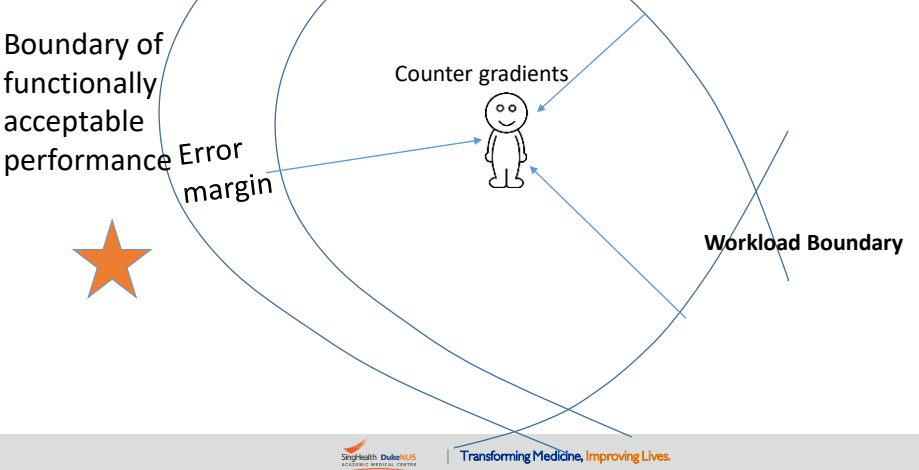
Results

Mental Risk assessment
Team Work
Experience and familiarity



Counter gradients employed

Methods	Proportion of participants who mentioned the method (%) n=15	Boundary being avoided
Mental safety risk assessment	100	Safety boundary
Team work	100	All three boundaries
Experience and familiarity, which is achieved by the following:		Safety and scientific output boundary
• Mentoring by seniors	100	
• On the job learning	100	
• Learning from accidents experienced by participant or colleagues	100	
• Sharing of experience and expertise through culture of open communication	100	
• Learning from safety information sheets and internet	53	

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Work-as-planned vs work–as- done

Human work can be described in four types:

1. work-as-prescribed: formal laws, regulations, rules, etc

2. work-as-imagined: senior management, middle management, policy makers

SOP and safe work instructions with a mental image of how work should be done

Work-as-planned vs work–as- done

Human work can be described:

3. work-as-done: how work is really done

trade-offs and compromises workers make all the time

dependent on the local situation

if nothing goes wrong, gaps not visible, productivity is rewarded

if something goes wrong, gaps glaringly visible,

investigations say SOPs are not followed and additional rules are made.

this in and of itself can create conditions that are new threats to safe production

4. work-as-disclosed: what workers are willing to tell

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What to participants think of safety SOPs

	Yes %	No %	No opinion %
Read SOPs?	13	75	12
Are safety SOPs useful	21	58	21
Should be practical	50		50
Use consult lab workers	50		50 (didn't seem to matter)
Should local variability be allowed	96		4
Safety SOP about institution and blame tactics	29		71

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Examples of variability with mental risk assessment

SOP- <u>always</u> use secondary container within and outside the lab for infective agents

What do the workers really do?

- No secondary container within the lab - BSC to centrifuge or incubator
- Able to separate within the lab as opposed to elevators, other buildings etc
- Some use screw cap tubes and tighten the cap when they go from BSC to incubator

They use ice bucket and never forget that!!!

- Some differentiate based on the virus - vector borne vs air borne

Examples of variability with mental risk assessment

SOP says use centrifuge safety cup for all infective agents

What do the workers really do?

It takes longer so:

Some differentiate based on the virus - vector borne vs air borne

Safety cup for high-speed centrifugation only

What participants said

- ***Multiple things have to be lined up, like a drama production with each player knowing what to do and others stepping in if one is unable to perform the task"***
- ***"it is designed very precisely, you have a tight schedule. You cannot afford to make a mistake"***
- ***"You definitely have to plan well, the way I see it it's like a choreography it has to be"***

What participants said

- *" catch the balls so that none fell to the ground"*
- *"so you reduce each person's workload to a doable amount"*
- *"our team has a very good synergy if some of us are very tired, we will say let's just process some of the samples. For example, if it is 2 am we will decide to stop blood taking and maybe we do swabs, so rather than take the risk and achieve the results we reduce the work"*

What participants said

- *"In the beginning, we need to do more carefully… Once you are fluent in the work then you can omit some steps"*
- *"We are now rescuing recombinant viruses that is a new thing for our lab, we did a fake rescue several times, there is no virus we practice without the risk"*
- *"What I am now is because of this one person in the lab who I learned from…".*

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So why the fuss?

Normalization of deviance

First coined by sociologist Diane Vaughan when reviewing the Challenger disaster.

The root cause of the Challenger disaster was related to the repeated choice of NASA officials to fly the space shuttle despite a dangerous design flaw with the O-rings.

Vaughan describes this phenomenon as occurring when people within an organization become so insensitive to deviant practice that it no longer feels wrong.

And if nothing happens each time, they keep doing it

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How should we manage this?

Participant's ideas:

- Safety SOPs should be aligned to the work SOPs
- Generic at institution level – specific at lab level
- Risk mitigation should be in the actual work procedures
- Simple point form
- Biosafety column in experimental procedure
- Remove repetition
- Relevant to the lab worker
- Identify high risk steps and have consequences for non-compliance

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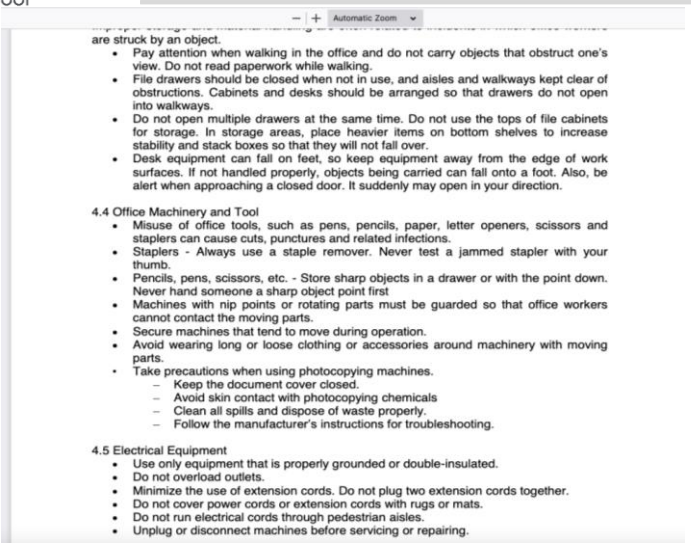
Examples



are struck by an object.

- Pay attention when walking in the office and do not carry objects that obstruct one's view. Do not read paperwork while walking.
- File drawers should be closed when not in use, and aisles and walkways kept clear of obstructions. Cabinets and desks should be arranged so that drawers do not open into walkways.
- Do not open multiple drawers at the same time. Do not use the tops of file cabinets for storage. In storage areas, place heavier items on bottom shelves to increase stability and stack boxes so that they will not fall over.
- Desk equipment can fall on feet, so keep equipment away from the edge of work surfaces. If not handled properly, objects being carried can fall onto a foot. Also, be alert when approaching a closed door. It suddenly may open in your direction.

4.4 Office Machinery and Tool

- Misuse of office tools, such as pens, pencils, paper, letter openers, scissors and staplers can cause cuts, punctures and related infections.
- Staplers - Always use a staple remover. Never test a jammed stapler with your thumb.
- Pencils, pens, scissors, etc. - Store sharp objects in a drawer or with the point down. Never hand someone a sharp object point first
- Machines with nip points or rotating parts must be guarded so that office workers cannot contact the moving parts.
- Secure machines that tend to move during operation.
- Avoid wearing long or loose clothing or accessories around machinery with moving parts.
- Take precautions when using photocopying machines.
  - Keep the document cover closed.
  - Avoid skin contact with photocopying chemicals
  - Clean all spills and dispose of waste properly.
  - Follow the manufacturer's instructions for troubleshooting.

4.5 Electrical Equipment

- Use only equipment that is properly grounded or double-insulated.
- Do not overload outlets.
- Minimize the use of extension cords. Do not plug two extension cords together.
- Do not cover power cords or extension cords with rugs or mats.
- Do not run electrical cords through pedestrian aisles.
- Unplug or disconnect machines before servicing or repairing.

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Examples

https://ehs.stanford.edu/sop-guidance

Stanford

https://safetyservices.ucdavis.edu/units/ehs/research/chemical/sop-templates

https://www.singaporeair.com/en_UK/sg/travel-info/covid19-measures/

What we can learn from other industries

Aviation:

- Safety integrated into flying the aircraft
- Checklist cannot be long
- Normal checklist and Non normal checklist
- Normal procedures entry to exit about 50 steps it develops a flow
- Non normal checklist simply to deal with emergencies: reset system or land don't try to find out what the problem is, they are not engineers
- Written procedure on who is supposed to do what so that there is no conflict

What we can learn from other industries

Aviation:

- Non normal checklist cannot deviate
- In emergency evacuation they follow, Read and Do, gives time to calm down and follow exactly tried and tested procedures

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What we can learn from other industries

Aviation has a very strong safety culture

There is a "just culture" in aviation

There are governing national and international bodies

No-fault reporting for errors and accidents

Recurrent Training

Checklist

https://www.forbes.com/sites/stephenrice1/2020/02/07/what-can-healthcare-and-other-fields-learn-from-aviation-safety/?sh=19e8ff551ce4

How does lessons from aviation transfer to healthcare?

- In recent years healthcare has seen a huge push to adopt aviation safety ideas
- Anaesthesiology has pioneered in incorporating ideas from aviation
- Medical errors are the third leading cause of death in the United States
- Often requires multidisciplinary team, complicated decisions
- Complex situations in healthcare guarantees that singular, straightforward solutions will not work
- Linear processes already have adopted many practices from aviation: Identifying the patients, manufacturing medical products etc

How does lessons from aviation transfer to healthcare?

In more recent years patient safety proponents have realised that:

- Checklists are not the end all and be all of solutions
- Healthcare relies more on experience, cultural differences, patient's preference etc
- Aviation safety practice have to be nuanced to healthcare settings
- Take what works and modify or make new concepts

How does lessons from aviation transfer to healthcare?

"Introduction of a new tool without full consideration of its purpose, benefits and limitations may actually increase risk to patients, providers and the system as a whole. Overimplementation of checklists may erode respect for long-standing healthcare cognitive aids that are effective, have been iteratively improved, and are well suited to specific purposes. Overreliance on checklists as a safety net can lead to omission of other safety practices that may better support safety through reliability and resilience. Checklists are excellent 'aides memoire' and directives to correct procedures, but they are not a panacea".

- Back to basics: checklists in aviation and healthcare, Robyn Clay-Williams,1 Lacey Colligan2,3 Clay-Williams R, et al. BMJ Qual Saf 2015;24:428–431. doi:10.1136/bmjqs-2015-003957

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How does lessons from aviation transfer to healthcare?

"Rather than continuing to try to measure whether interventions such as the Surgical Safety Checklist "work", we suggest that future research might better contribute to patient safety by 1) Recognizing the complexity of surgical care in the activation of any policy document; and 2) Studying whether or not the *actual practice* (i.e. not the policy) actually does lead to improvements in patient safety".

The American Journal of Surgery

Available online 17 November 2021 "Some version, most of the time": The surgical safety checklist, patient safety, and the everyday experience of practice variation

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How should we manage this?

Hybrid Concept

Regulated safety

rule based non-negotiable instructions, commensurate with risk

Managed safety

based on their risk assessment to suit dynamic workplace demands

Messages I want to leave you with….

- Hybrid concept
- Understand how work is done
- Keep it really simple, integrate safety into lab procedures
- Change the way we do safety training
- Use Scenario training
- Use the seniors more effectively

Safety is simply the way we work