

A person wearing a grey checkered suit jacket, a white shirt, and a black belt, carrying a brown leather bag. The background is a dark green wall with faint mathematical formulas and diagrams, including a coordinate system with axes labeled 'a' and 'b', and a vector diagram with angle 'theta'.

AUTOMATED CAPITAL EQUIPMENT DEVELOPMENT

**INTRODUCING NEW TECHNOLOGY INTO EXISTING
PROCESSES IN A MANUFACTURING FACILITY**

Paul Gardner



Paul Gardner Bio

Background & Expertise

Process Engineering/Manufacturing professional with over 36 years operational experience, 31 years in the automotive industry developing technically challenging automated capital process equipment, establishing and managing Lean world class operations. Joined Sensata Technologies in 2014 through the Schrader Electronics acquisition - responsible for all global manufacturing strategies, process development of all core sensor product roadmaps and NPD/CM project execution

I established TPM sensor manufacturing operations for Schrader Electronics (SEL) in UK, USA and China growing annual volumes from 100K per year in 1999 to over 85 million units per year in 2015. Over this period was responsible for operations, manufacturing development roadmaps, investing \$150M and delivering successful automation projects for global OEM Automotive customers resulting in manufacturing capability of \$500Million/year of TPMS products.

Prior to Joining SEL in 1999, had 14 years experience working for Japanese privately owned auto component manufacturers starting in process engineering key contributor role a progressing to manufacturing and engineering management roles.

Professional & Academic

Chartered Engineer Fellow of the IMechE



Fellow of the IET



- Bsc (Hons) Mechanical Engineering – University of Strathclyde, Scotland
- MSc Advanced Manuf, Technology and Management – Queens Belfast

Automated Capital Equipment Development

- This presentation discusses the Schrader / Sensata journey, developing complex machines required to manufacture complex products in high volume
- Highlights Lessons Learned
- Focuses on the standardisation of the equipment development process

- The evolution from one prototype line to multiple high-volume lines in numerous global locations

New product concepts require Special Purpose Manufacturing Equipment

- New to the world products require new to the world manufacturing equipment
- Aggressive Business Growth requires significant and timely capital investment
- Conflicting pressures of ROI and Customer Expectations result in trade offs, but should never mean intentional H&S or quality compromises
- Taking time to consider the H&S risks are fully understood early in the design process may cause frustrations but will result in robust cost-effective solutions

Why bother?

- Bhopal
- Flixborough
- Texas
- Bradford city fire
- Piper Alpha



Why Change?



Investment in Automation

- 1** Ensures Safety & Quality Risk Mitigation
- 2** Improve Product Quality and Manufacturing Efficiency
- 3** Stay ahead of the competition through Product and Process Evolution
- 4** Achieve Commercial & financial excellence

- 1 Rational – Justification of capital spend
- 2 Design concepts – key stakeholder inputs
- 3 Legislation in global locations
- 4 Ensuring Compliance
- 5 Suitability/Flexibility
- 6 Internal and external customer acceptance & sign off

Challenges



Designing at Global Business level

- Designing in the machine operator, the maintenance team's and environmental protection is not just a job for the HSE professional
- Development Engineers should ensure all H&S risks are considered from the outset with a cradle-to-grave approach (design to decommission). This can be supported with the use of a machine FMEA template
- Future machine repurposing should also be considered (helps with next gen ROI)
- These principles apply to Construction, Building & Facility Management etc

Lessons Learned

**Invest time
Designing at the HQ
facility to simplify
and standardise
specs**

- R&D projects must consider Design for Manufacture
- Mitigate risks at product design stage. Reduce or eliminate risk in process i.e. chemicals
- Primary focus on machine
- Then integration into existing lines
- Defines facility requirements
- Leading to Factory Spec Requirements

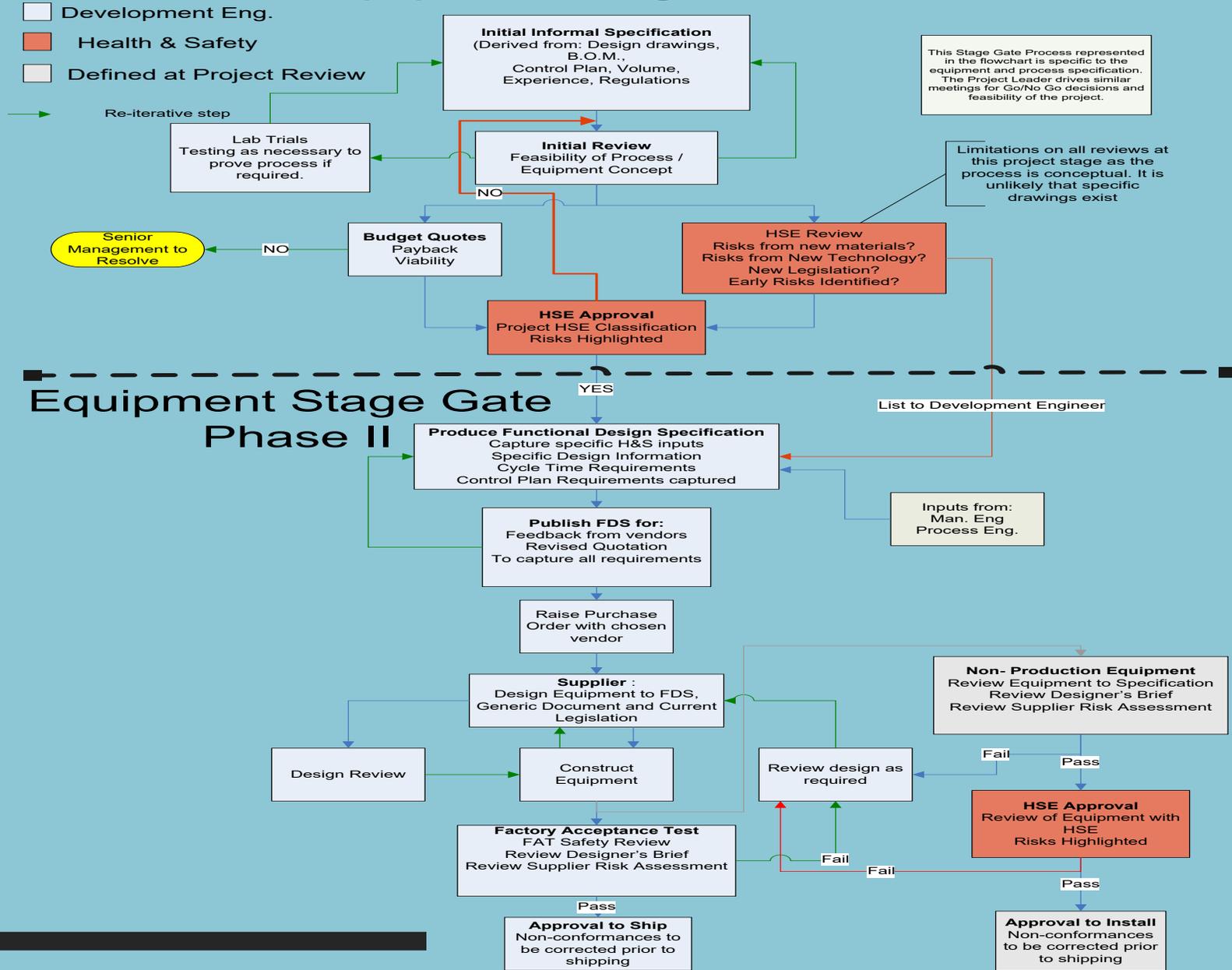
**Expansion needs
a clearly defined
and documented
process ...**

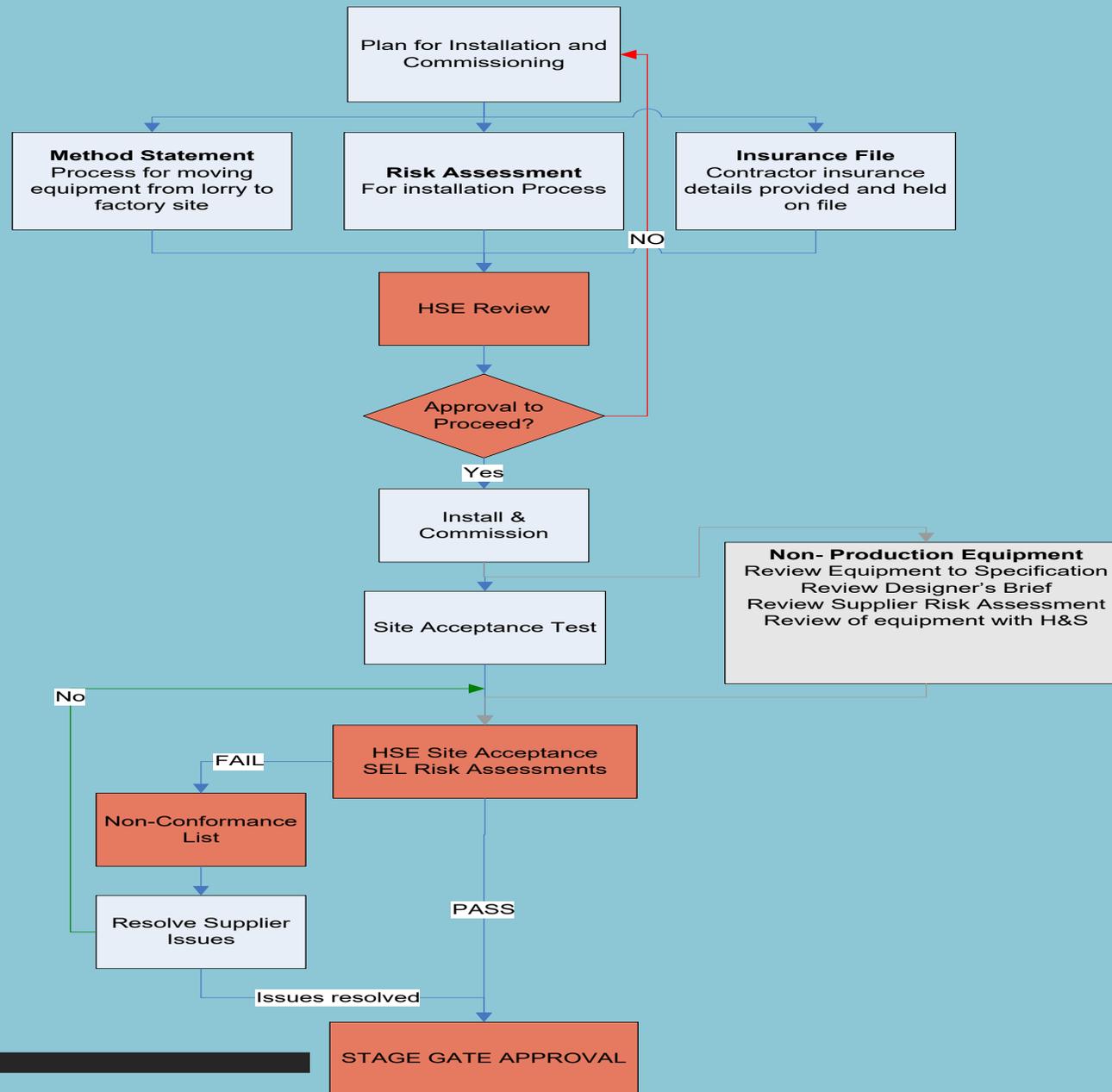
The Stage Gate Process

Key Steps

- Design (URS & FDS)
- H&S Review and approval at each stage in the process
- Specification Sign Off & Order
- FATS
- SATS
- Evaluation and education
- Sign off & Handover

Equipment Stage Gate Phase I



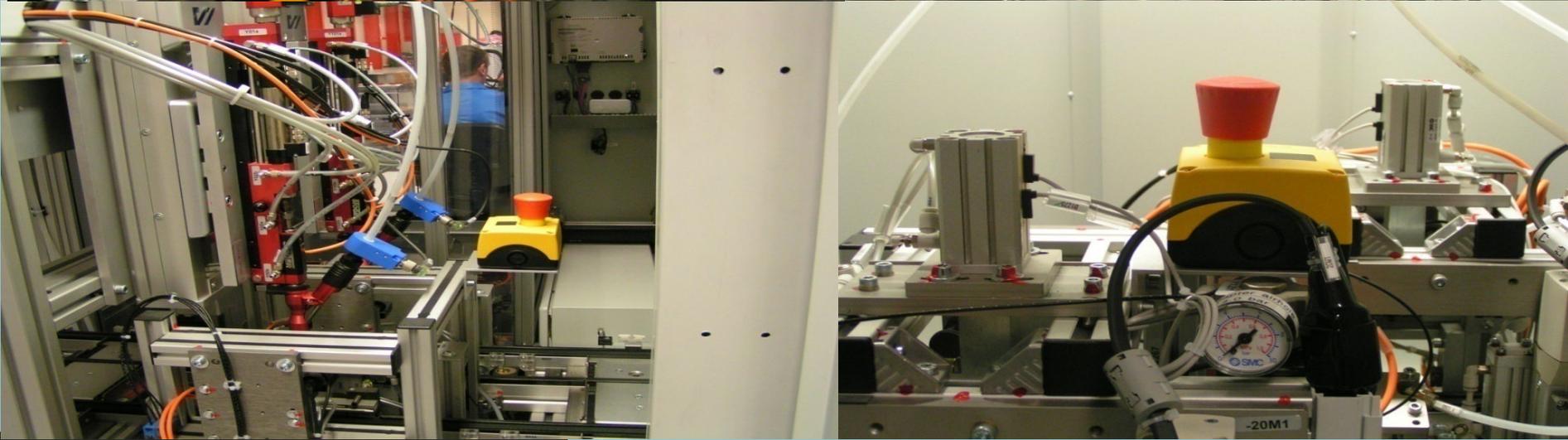
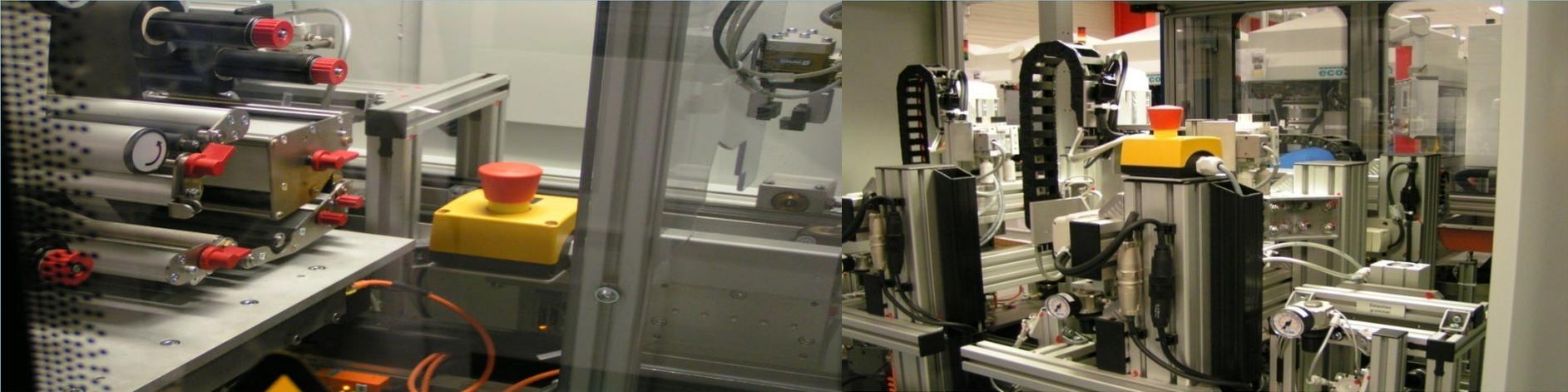


Following this process means simple design changes for safety become the new standard
Schrader/Sensata's URS issued to machine designers/developers

Examples:

- Engineering and technical teams do a different role from machine operators, different risks and do require a tailored risk assessment, safe system of work and sometimes technology (teach pendants etc.)
- Emergency stops should be easily reached from any maintenance or operational position.
- This will mean that an e-stop is required inside some of the cells where a maintenance person could not reach an e-stop that is positioned outside of the cell.

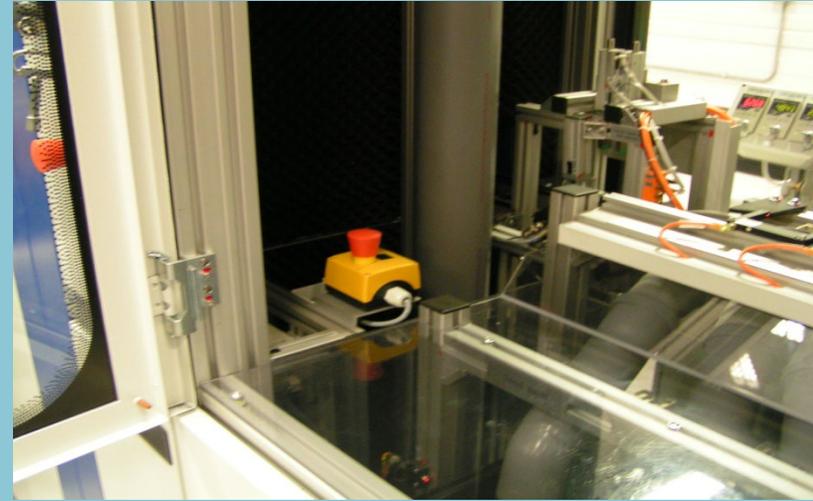
Retrofit improvements now standard design feature



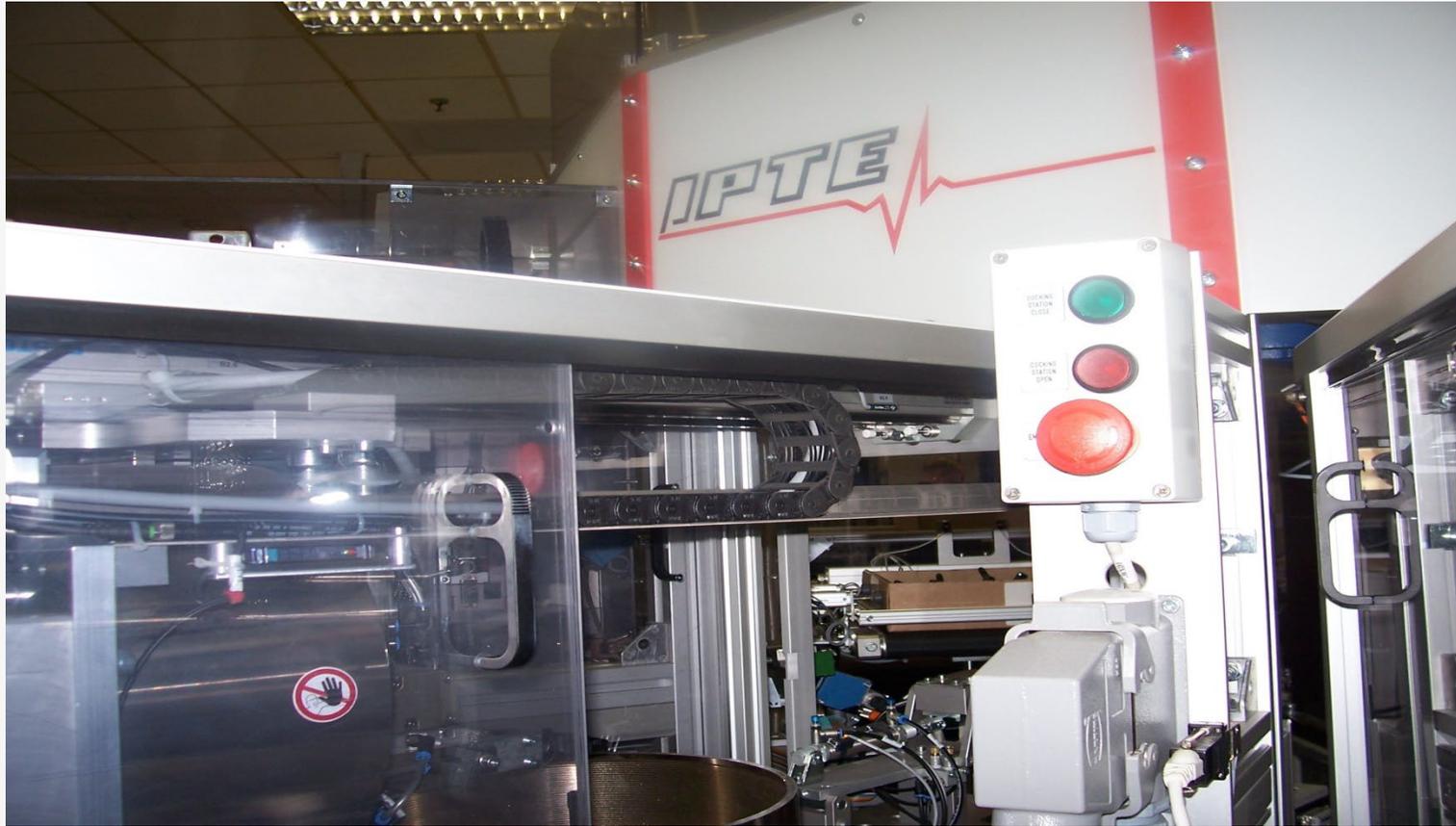
Does guarding provide the safest operating solution?

- Efficiency and risk – Can the production operator still perform tasks without unnecessary guarding?
- The layout and machine design should take into account access for the operator for normal activities, e.g. for resetting any operator controls, refilling materials, or product changeovers.
- All normal activities should be possible from outside the guard or interlocked door.
- To reduce downtime, and if it is **safe** to do so all possible areas where a stoppage could occur should to be located outside guards.
- An example that we encountered was the manufactures of the machines put key normal activities behind interlock doors resulting in continuous down time and resets
- Our conclusions included that the operator should have access to a vibrating bowl and channel, a fixed or interlocked guard used to shield the operator from any moving parts. It may not be acceptable to put everything behind an interlocked door.

Internal fixed guarding



Final test cells



HSE input: Research and Development Engineering teams

Do they need HSE Design input?

When should HSE get involved?

‘Engineers know what they are doing!’

HSE involved at proof of concept, but encourage entrepreneurial mindset

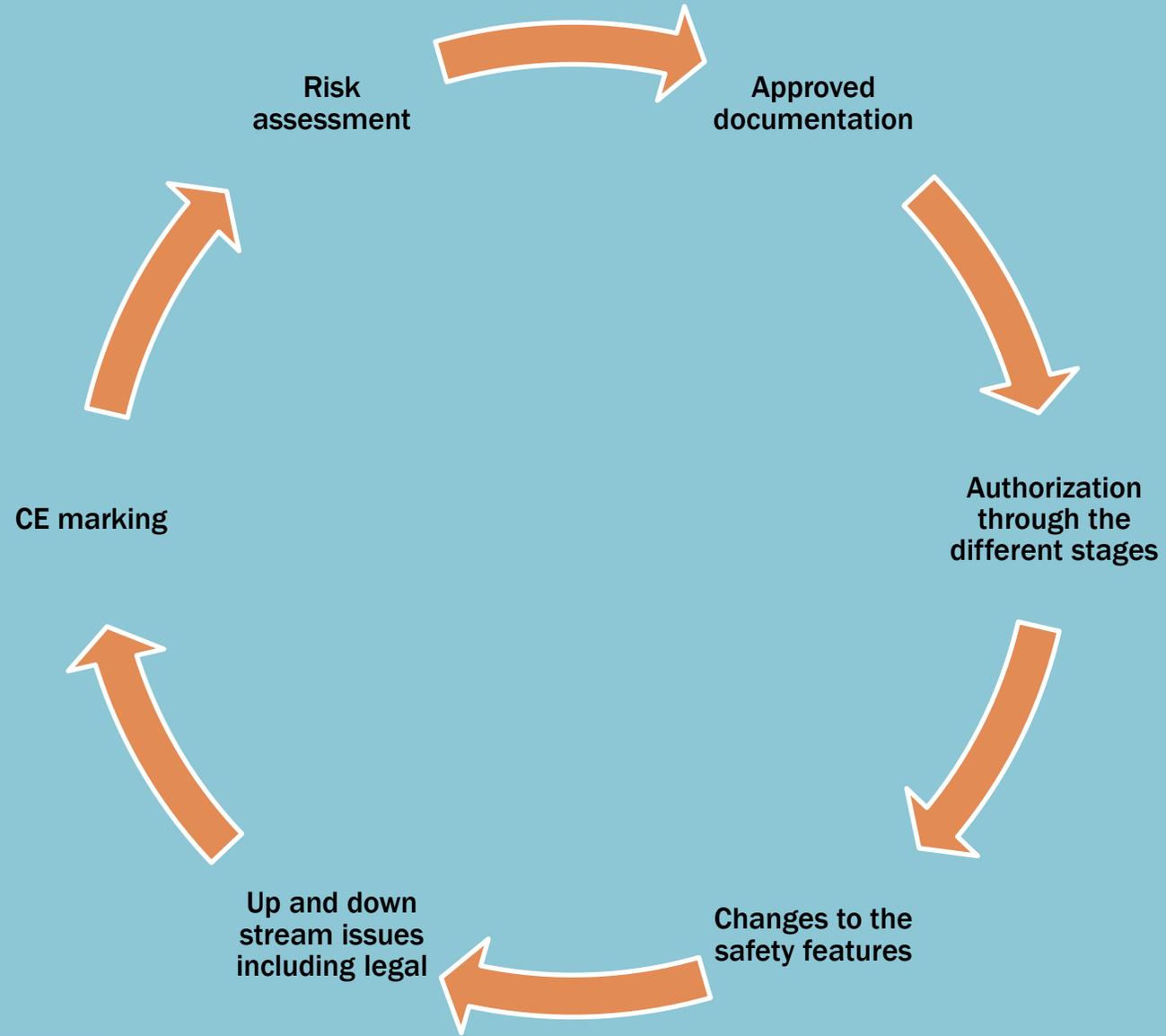
This ensures a safe evolving business and low risk technical advancements of the product road map

Gates and safeguards must be in place to ensure what is designed in an R&D lab is vetted and considered safe for transfer to the manufacturing environment

Chemicals acceptable in the lab might not work in production due to the risk levels – explosion risks, fumes, waste management etc.

New products bringing new development and market opportunities should be compatible with existing processes to enable integration of new technology safely.

Meeting the requirements.....



Our Evolution: from customer to competent supplier

In house machinery builds

In house mechanisation team can be agile to address the grey areas

Own and manage transfer between our sites within UK/EU and global sites

Potential to place their product on the market?

Team Ownership

Specifications

Drawings & document management

Components selection

- Mechanical, Electrical, pneumatic

EHSR (Essential health and safety requirements)

Risk assessments

Validation and verification

User guides

Training material

Declaration of Conformity/Incorporation

CE/CA marking

Competent expert

Self-certification

In Conclusion

It's a complicated process merging new technology into old or add it into existing process.

Having a well-defined procedure is essential

The development process must be planned and managed at each and every stage involving key stakeholders

- Installation protocols should include users, risk assessments, Provision Use Work Equipment assessments, training and snagging lists etc....
- This will result in significant cost savings and will result in efficiency improvements if all H&S risk mitigations are effectively designed in from outset.