The PROFIBUS Group

20th Anniversary Celebration Conference

PROFIBUS System Design

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Control System Design

⇨ What do we mean by Control System Design?

- ✓ Choosing and putting together a collection of available parts to achieve the desired automation functions and performance reliably and at the minimum cost.

It should be simple!

1. Understand the desired functions.
2. Select suitable parts.
3. Assemble according to the specifications.
4. Understand what makes systems reliable/unreliable.
5. Understand where costs are incurred.

Control System Design

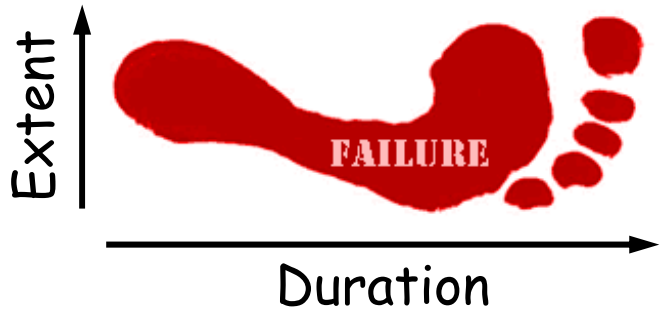
- ⇨ Understand the desired functions
  - ✓ The Control System Designer must understand the process, its objectives, constraints, costs and dangers.
- ⇨ Select suitable parts.
  - ✓ The Designer must be familiar with the range of available components and devices, their characteristics and relative advantages/disadvantages.
- ⇨ Assemble according to the specifications.
  - ✓ The Designer must understand the rules, requirements and recommendations for the system and use of components.

Control System Design

⇨ Understand what makes systems reliable/unreliable

- ✓ Dealing with device failure and replacement.
- ✓ Understanding system reliability and the importance of health checking and rapid fault location.
- ✓ Designing the system to be fault tolerant.
- ✓ Minimising the impact of faults that will inevitably occur.
  - Minimise the extent or effect of the failure
  - Minimise the duration of the failure.

Minimise the "footprint" of a failure when it happens.



Control System Design

- ⇨ Understand where costs are incurred.
  - ✓ Understand that cost is not just encountered during procurement and installation.
  - ✓ Costs extend over the lifetime of the system.
  - ✓ Total costs include:
    - Procurement/purchasing
    - Installation and commissioning,
    - Maintenance and fault finding,
    - Servicing/updating
    - Replacement,
    - Decommissioning,
    - Disposal.

Control System Design

- Control system design normally proceeds by building on previous designs.
  - ✓ But, designs based on badly designed systems will be bad!
  - ✓ Only by using experience from operations and maintenance can we develop good system designs.
  - ✓ In my experience it is rare for such feedback mechanisms to be present. Particularly when design is carried out by sub contractors.
  - ✓ This problem is particularly noticeable in fieldbus systems where the problems are not obvious.
- Designers must know about mistakes that have been made in the past.
  - ✓ Feedback from operations and maintenance is essential.

PROFIBUS System Design

⇨ "A common mistake that people make when trying to design something completely fool proof is to underestimate the ingenuity of complete fools."

Douglas Adams

- ✓ Fool proof design is impossible.
- ✓ Good design minimises the chances of people making mistakes.
- ✓ Simplicity and clarity are the key factors.
  - Simple, understandable designs are always the best.
  - Good documentation is essential.
  - Open systems that are not manufacturer specific have big advantages.

Minimising the failure footprint

⇨ There are three basic ways to minimise the impact of faults in system design.

1. Make failures less likely – Minimise failure frequency.
2. Restrict the effects of any failures that will inevitably occur – Minimise failure extent.
3. Provide for rapid fault detection or performance degradation, rapid location and rapid repair – Minimise failure duration.

Minimising the failure footprint

1. Make failures less likely – Minimise failure frequency.

- ⇨ Know and implement the design and installation rules.
- ⇨ Improve reliability - use of well tested and reliable devices, connectors and network components.
- ⇨ Use the lowest bit rate that gives the required performance.

Minimising the failure footprint

2. Restrict the effects of any failures that will inevitably occur – Minimise failure extent.

⇨ Well thought out network layout and design.

⇨ Think about using:

- ✓ Separate networks or different masters (distributed control),
- ✓ Different segments (segmentation),
- ✓ Dealing with common cause failures.

Minimising the failure footprint

3. Provide for rapid fault detection or performance degradation, rapid location and rapid repair – Minimise failure duration.

- ✓ Provide facilities in the design for rapid fault diagnosis and fault location.
- ✓ Provide in the design for hot device swapping without reconfiguration.
- ✓ Use designs that allow for a quick fix.
- ✓ Provide redundancy when appropriate. Needs to be well thought out!
- ✓ Use standardised, vendor independent solutions rather than being locked into manufacturer specific solutions.

Techniques for minimising fault impact

- Pluggable devices that can be removed/replaced without impinging on network operation.
- Connector systems that do not break the bus or loose termination when disconnected.
- Termination solutions that allow devices to be removed or replaced.
- Appropriate network design and segmentation so that physical layer faults allow critical plant operation to continue in the event of failure or device replacement.
- Layout tricks providing a quick fix in the event of failure.
- Layout for rapid troubleshooting.
- Appropriate solutions for redundancy.

The need for training

- Existing PROFIBUS and PROFINET training includes:
  - ✓ Certified PROFIBUS Installer – 1-day.
  - ✓ Commissioning & Maintenance (Troubleshooting) – 1-day.
  - ✓ Certified PROFIBUS Engineer (DP+PA) – 3/4-days.
  - ✓ Certified PROFINET Installer – 1-day
  - ✓ Certified PROFINET Engineer – 3/4-days
  - ✓ AS-i Commissioning & Maintenance course – 1/2-days.
  - ✓ System Design course – 1-day.

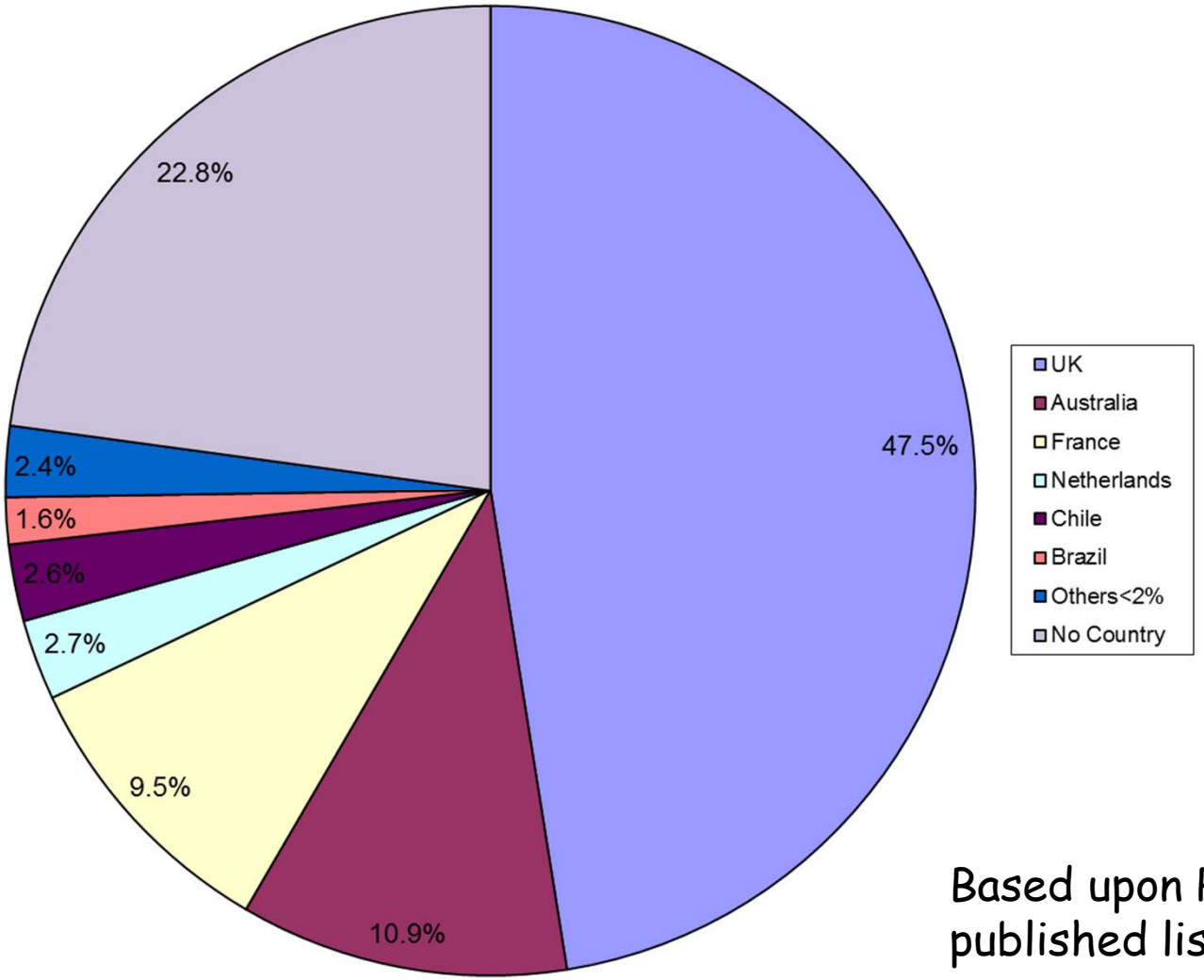
Existing Training

- The Installer training provides a basic introduction to the technology and covers the rules for good system layout and installation.
- The Installer training was designed for those involved in installation, but it also provides a good grounding for anyone involved in PROFIBUS at any technical level.
- In the UK and Australia we use the Installer course as a prerequisite for all other network training.
- Approaching 5000 PROFIBUS Installers have been trained worldwide (compared to ~4000 PROFIBUS Engineers).

The importance of Certification

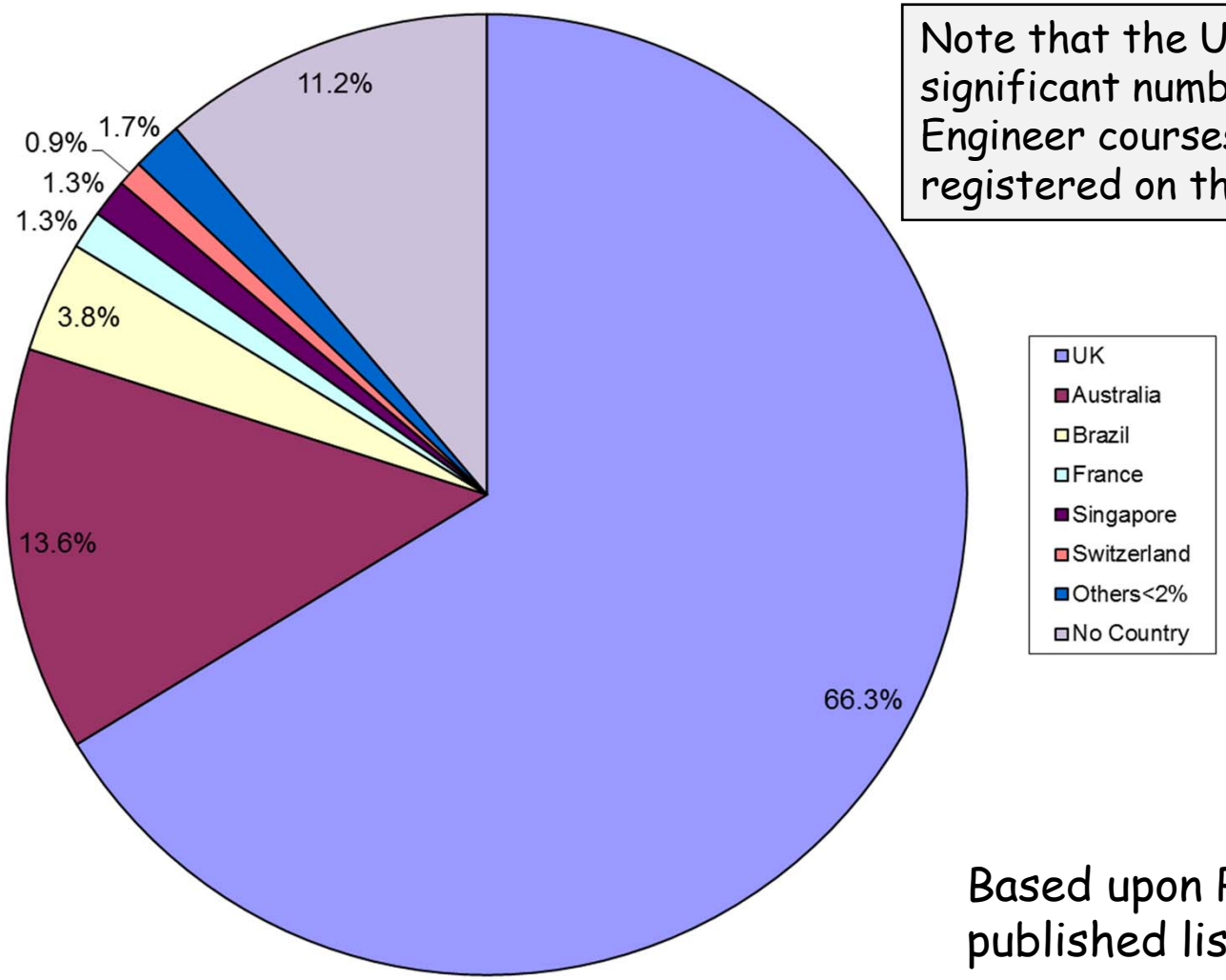
- How important is Certification in the UK?
  - ✓ It seems to be very important since the UK has far more registered certified PROFIBUS Installers and Engineers than any other country.
- The Certified Installer is now seen as a minimum requirement within the UK for any Certified Installer is widely accepted in the UK as the minimum standard for anyone involved at a technical level with PROFIBUS.
- Most people doing the Installer training in the UK also take the non-certified Commissioning & Maintenance course.

Installers by Country



Based upon PI web site published list to June 2013

Engineers by Country



Note that the USA do run a significant number of PROFIBUS Engineer courses, but none are registered on the PI web site!

Based upon PI web site published list to June 2013

The need for an Accredited System Design course

- Many of the basic layout and installation errors that are found in networked systems are made at the design stage.
- Therefore the learning outcomes of the Certified Installer course are equally valid for system designers.
- However, there is a clear need for additional training and certification for system designers and engineers involved with the specification, planning and design of these systems.
- The additional material is not appropriate to Installers or Maintenance staff.

The need for an Accredited System Design course

- Many of the larger companies and sectors in the UK and Australia are now asking for an accredited System Design course.
  - ✓ Most Water and Utilities providers, Food and beverage producers, Pharmaceuticals, Bioprocessing, Airports.
- Such an accredited course will allow these companies to ensure that design staff (particularly contractors) are suitably qualified before the design is started.
- We will not be able to impart years of experience in this course, but can at least teach the basic principles of good design and impart an awareness of the wider issues.
- Extensively experienced trainers are essential.

Certified PROFIBUS System Design course

- A new course has been developed by the PI working group for training.
- The development involved extensive input from a number of industries and countries.
  - ✓ In particular, the UK water industry, car manufacturers and machine/parts suppliers, food and beverage industry, airports and material handling and storage users
- The course specification and learning outcomes have been developed and these were submitted for approval at the PI meeting in Sweden a few weeks ago.
- Unfortunately the course was not accredited at this time. However, we are hoping to address the issues soon and obtain accreditation.

PROFIBUS System Design course content

- The control system life cycle, planning for future needs, expansion and changing requirements.
- Environmental considerations, IP ratings, cable material selection and enclosure/connector design.
- Relative characteristics, benefits, choice and integration of appropriate communication technologies for various applications (i.e. where to use PROFIBUS DP, PA, PROFINET, Ethernet TCP/IP, IO-Link, HART and AS-i. Copper, fibre optic and wireless technologies).
- Available solutions for the integration of operation, supervision and engineering information into the control system (SCADA, OPC, FDT, EDDL etc).

PROFIBUS System Design course content

- Solutions for high availability and high reliability systems.
- Network design and layout to minimise fault impact.
- Essential requirements and design options for hazardous areas. Outline only
- Essential requirements and design options for safety related systems. Outline only
- Design rules for bus powered segments (voltage drop calculations).
- Control system and network timing and synchronization issues. Choice of scan time and bit rate.
- Modern solutions for network monitoring.
- Network test and acceptance procedures.
- Network documentation and drawing recommendations.

Feedback

- We would be most grateful for your opinion on this course proposal.
- A printed version of the course specification and learning outcomes is available from me.
- A short questionnaire is provided for your feedback on this important issue.
- We would also welcome your input on the learning outcome document content.

- Thank you for your attention.