Connecting Legacy Machines & Equipment as part of a Digitalisation Strategy

How to overcome the real challenges facing manufacturers on their journey to a Smarter Factory

Planning and designing an open architecture Smart Factory strategy that will be both scalable and vendor agnostic.

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1. Who this white paper is written for:

Managing Directors, Technical Directors, Automation Engineers and Managers, Systems Architects, Operations Directors and Managers, Control Systems Managers.

2. What are the 'take-aways':

This paper is written to allay the concerns surrounding the uncertainty of investment into adopting elements of Industry 4.0 or starting your journey for this (a.k.a. Smart Factory or Made Smarter).

It explains how by selecting a particular type of hardware 'Machine Data Interface' (MDI) or 'Human Machine Interface' (HMI), which can be use as a 'digital gateway' to legacy machines, thus facilitating the connection of sensors and collection of data into a common architecture.

It also explains software standards of interconnect, that will allow you to be vendor neutral and be able to pick the most appropriate platforms for your digitalization requirements.

3. Introduction:

"My biggest challenge is connectivity" – said a manufacturing solutions architect who works for a household name in the food and beverage sector. This is a sentiment echoing around manufacturers, who are desperate to yield the benefits of the latest software tools for improvements in productivity, maintenance and process improvements. In short, these managers want the benefits these tools offer, but connected to the real time sensor data in their machines and processes.

As an example, there are plenty of companies selling maintenance planning software, running on smart tablets, but are still reliant on manual data intervention, rather than learning real plant data directly from the sensors on the machines.

4. Made Smarter Review

The 2017 UK Made Smarter Review listed 31 barriers to adoption of industrial digitalization. At no. 3 & 6 respectively were 'lack of certainty to the solution working' and 'legacy infrastructure…'. At no. 2 was 'lack of skills to design new systems and implement'. My findings in manufacturing sites supports these views. Whilst no. 2 is solved by finding the right partners to work with (barrier no. 4), the challenge of connecting to legacy controls and machinery needs to be overcome in order to provide confidence that the solution will work.

Barriers to adoption of Industrial Digitalisation included:

- Concerns around Cyber Security
- Lack of technical skills to design new systems and implement *
- Finding the right partners *
- Lack of certainty of the solution working
- Legacy infrastructure *
- Cultural change
- Internet Connection Speed
- Lack of awareness of new technical solutions *
- Equipment costs
- Access to funding

*Topics addressed in this white paper

These topics can be summarized in the following categories; skills shortages, limited access to innovation, perceived cost (and ROI), weak data security, limited knowledge of Industry 4.0, poor infrastructure, limited empirical evidence.
For a copy of the Government 'Made Smarter' Review click here.

5. Made Smarter – Smart Factory – Industry 4.0 – Digitalisation

The term – Made Smarter or Smart Factory, is a more relevant term to use than the term of Industry 4.0, which often frightens away business leaders for adopting digital solutions which converge operational technology with information technology. We prefer to start with the business need, rather than the technology available. If the business need is to get to the lead measures that produce waste, so you can improve the process before waste is created. Or to understand when and why a bearing is about to fail, so that it can be replaced and a root cause can be understood. Then we can use technology to collect that data, in real-time and present it to the people who need it.

All too often business managers take siloed approaches to their own needs; planned maintenance management is one project, OEE (overall equipment effectiveness) is another project, Statistical Process Control yet another and shop floor visual management is another... Yet to make these highly capable and AI enriched solutions perform at their best, they all need access to the same equipment, so why treat them separately?

How many factories have you seen with challenges like this? Managers and business leaders, need more data at their fingertips in order to know where best to allocate resource to drive down waste & energy, to increase uptime and to increase productivity & profit. But their factory is full of legacy equipment, machines and control panels ageing up to a quarter of a century (and older). And even today, some of their present suppliers of machinery are struggling to grant them connectivity into a truly open architecture standardized solution that would allow all machines and all equipment to be connected on a single network where all data from all machines can be made available to all software applications. Without this, the roll-out of Made Smarter to SMEs will be piecemeal, fragmented and not be able to demonstrate a promising ROI.

6. Beginning the journey to develop your Smart Factory Journey

It is possible, with planning and forethought, standardizing on vendor agnostic methodologies, and working with vendors and integrators who are prepared to connect to each other for the benefit of the end-user.

Insights and recommendations:

- It is possible to connect to and collect data from even the oldest of machines. But this takes a little engineering and planning in order to concentrate that data in the right way.
- Encourage your machine vendors and automation contractors to provide secure data access to their new installations so that you can collect data from this equipment.

- Consider working with a partner or consultant to develop a 'digital' strategy for your business, that will define your journey and the end results that you desire. Productivity, cost savings, energy reduction, improvements in uptime, are the most common outcomes.
- Having an automation and controls standards and specifications document for your business will ensure that you don't 'sleep walk' into challenges of disparate systems or become hooked into a single supplier.
- Your own engineers are a valuable resource into the operation, designs and challenges of your current machines and equipment, but they will likely need outside help to develop your Smart Factory Strategy.
- Try to avoid different functions in your business developing their own systems in isolation. See section 7 below.

7. Defining your requirements and designing your architecture

Before you start, you need to understand the 'data' requirements of different stakeholders in your business. Why? Because different roles, have different demands, but often the machine and plant data is common throughout, so your digital strategy needs to consider an architecture which will make any and all data available to all functions. For example:

Production:	Productivity data, OEE (overall equipment effectiveness), machine throughput and cycle times.
Planning:	Scheduling of works orders on to machines, visibility of progress, capacity planning.
Quality:	Waste, scrappage, reject rates, machine and process deviations that contribute to poor quality.
Maintenance:	Monitoring of critical machine parameters for predictive maintenance planning.
Finance:	Productivity monitoring, work in progress, cost of waste, cost of quality, true manufactured cost accounting.

Creating a digital architecture, based around HMIs & MDIs as digital gateways to new and old machines and processes, will create a common data source that can be accessed by specialist software platforms that your individual functions and requirements can draw from:

The following diagram (fig 1) is an example architecture of a typical factory floor:
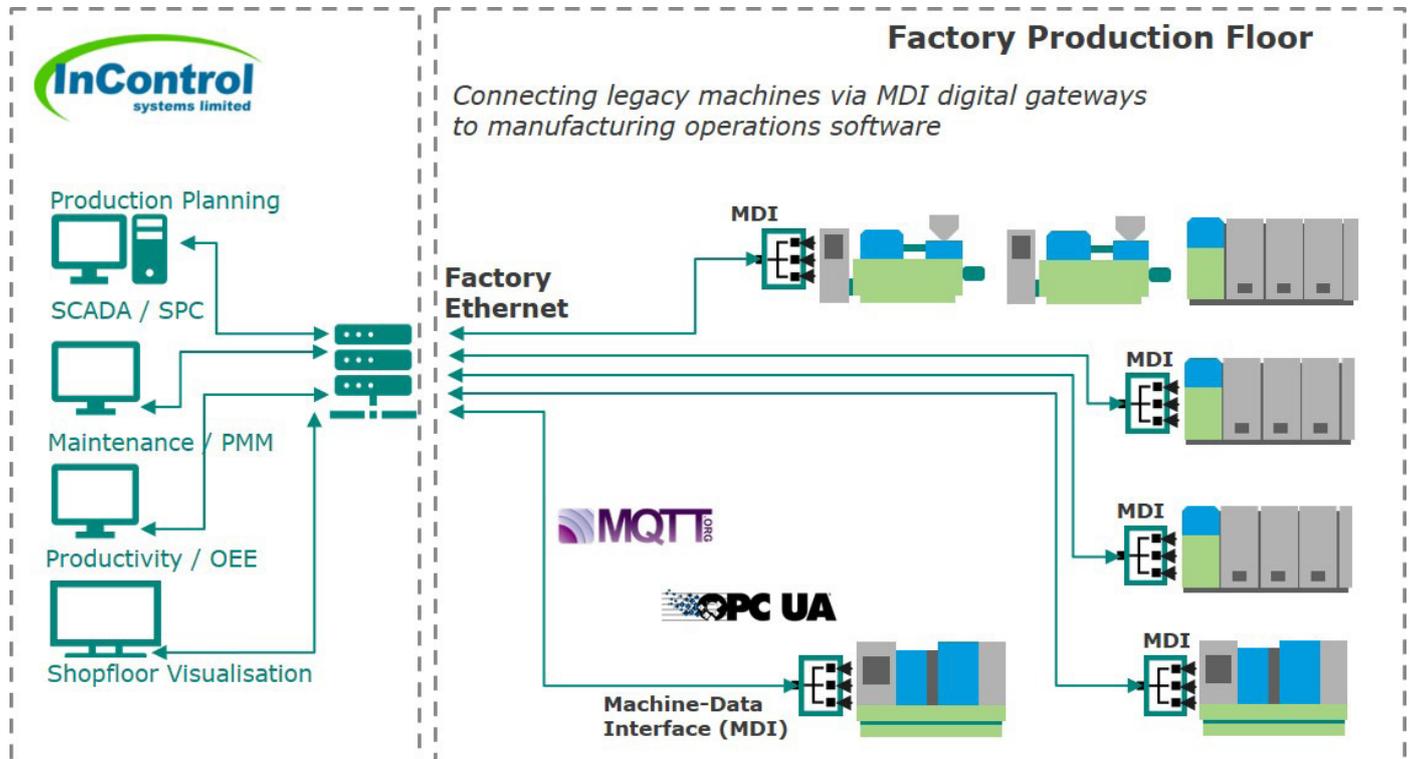

Fig 1.

8. Using digital gateways:

HMI: Human Machine Interface – often called an operator terminal, but could be an industrial touchscreen. These are often the data connection into machines that you already have on site. You might be able to use these to connect to and collect data from your machines into your digital architecture. Or you might find that adding a number of new HMIs into your factory, can give you the access to data that you need.

MDI: Machine Data Interface – these are effectively 'black box' hidden devices, industrial PCs or 'edge controllers' that can be sourced from a number of vendors. Selecting and specify the right device with the right connections, can allow you to standardize on a small number of MDIs as your digital gateway to legacy machines and plant processes.

See fig 2 for a diagram of how digital gateways can connect to legacy machines.

What data can be collected?

Almost anything is possible with the right planning and solutions. There are two ways to collect data from existing machines:

a/ Via a network or serial comms interface direct to the machine. This is often the simplest way, because all of the data you need could be inside the PLC or controller of the machine. However, often the machine vendor may expect payment to grant access to and support your efforts to make this connection. Sometimes, the machine is so old, that you cannot even find someone to have this discussion.

b/ Via additional sensor or analogue/digital connections. This is simpler than you would imagine because using a machine data interface will facilitate a number of analogue and digital inputs that can be simply wired to existing or new sensors, without the need to undergo the challenges in a/ above.

Both HMIs and MDIs can be sourced to allow the connection to and collection of data in your machines and processes.
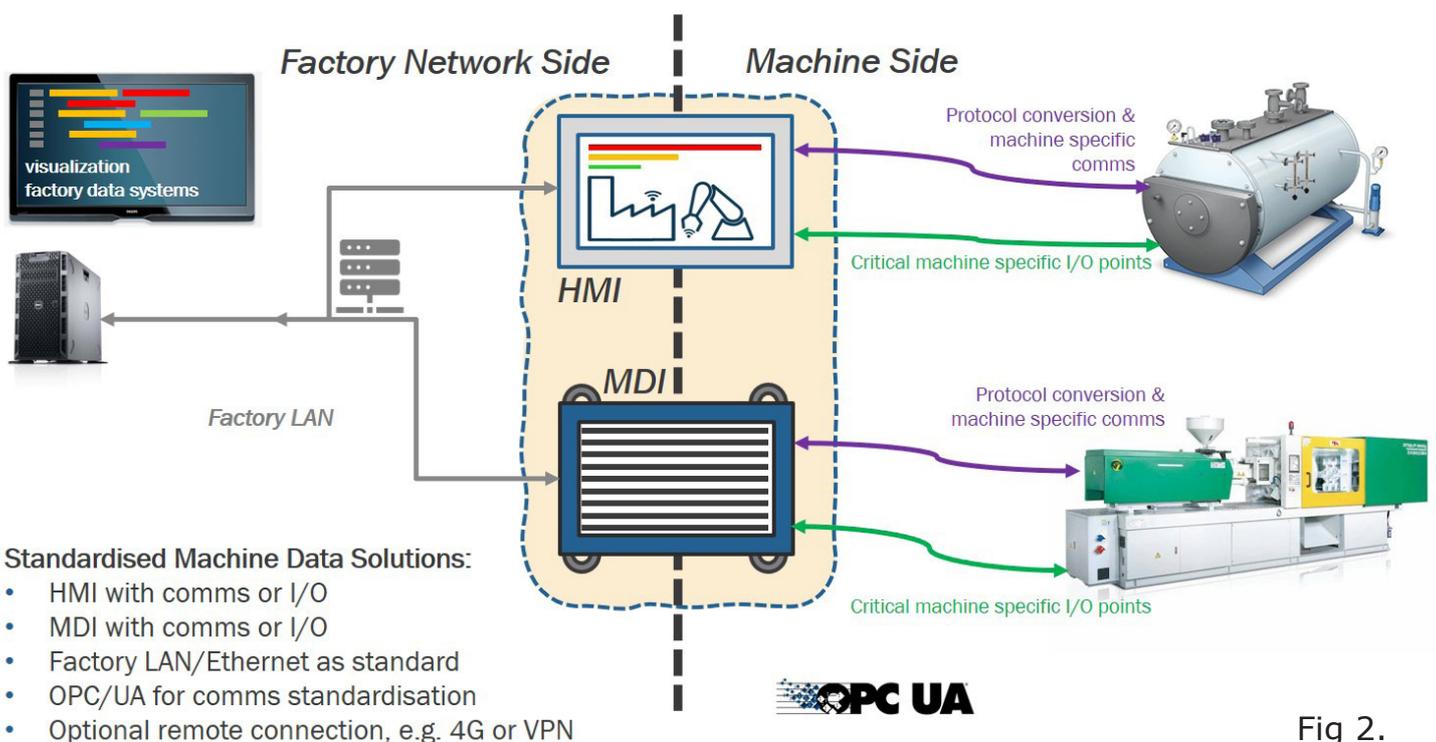

Fig 2.

9. Adopting standards:

Adopting and stating the standards of connectivity for your data is essential. One challenge that most business have is merging the knowledge and requirements of the IT function, with the OT (operational technology) function, such as controls and automation. However, it is essential that both parts of your business come together for the common good.

Below are a couple of open standards that allow communication between systems:

MQTT: Message Queuing Telemetry Transport

is an open OASIS and ISO standard (ISO/IEC 20922)[4] lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP; It is designed for connections with remote locations where a "small code footprint" is required or the network bandwidth is limited. Source: https://en.wikipedia.org/wiki/MQTT

OPC UA: Open Platforms Communications – Unified Architecture

The OPC Unified Architecture (UA), released in 2008, is a platform independent service-oriented architecture that integrates all the functionality of the individual OPC Classic specifications into one extensible framework. Source: https://opcfoundation.org/about/opc-technologies/opc-ua/

10. The ISA-95 framework:

The connectivity of plant data (see figure 3) from Level 1 on the ISA-95 model, through controls equipment to Level 3 and 4 is possible by adopting the correct architecture, using OPC-UA and MQTT, data can be routed (if not directly from the machine), through 'Machine Data Interfaces' (MDIs) acting as digital gateways from the machine to the factory Ethernet network. A common MDI design can therefore be used to facilitate a standardized methodology to solve the real challenges that face manufacturers on their


Fig 3.

https://www.incontrol.co.uk/
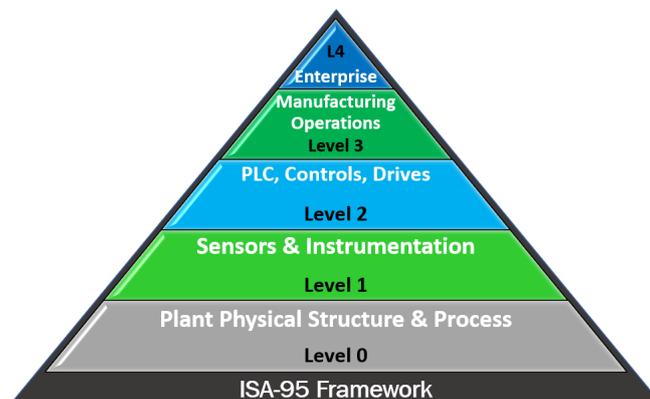
11. Executive summary:

Most manufacturers will need some outside help to achieve successful returns on their investment with their journey to a Smarter Factory.

It is not necessary to embark on the panacea of Industry 4.0, but it is essential to plan for the vision that your company has, so that as you achieve results, from your digitalization programme, you have the ability to scale without unnecessary costs or to change and replace equipment that may no longer meet your bigger needs.

There is a lot of hype around the 'digitalisation' of manufacturing, or Industry 4.0 (call it what you will), but in essence it is a natural progression of what many experienced automation integrators have been installing for the last number of decades.

Our recommendations are to work with technical standards that are open, that allow you to work with multiple vendors in order to find the optimum architecture and strategy for your business. Work with independent systems integration partners that are hardware and software vendor neutral and create a team in your business that cooperate towards your long-term vision.
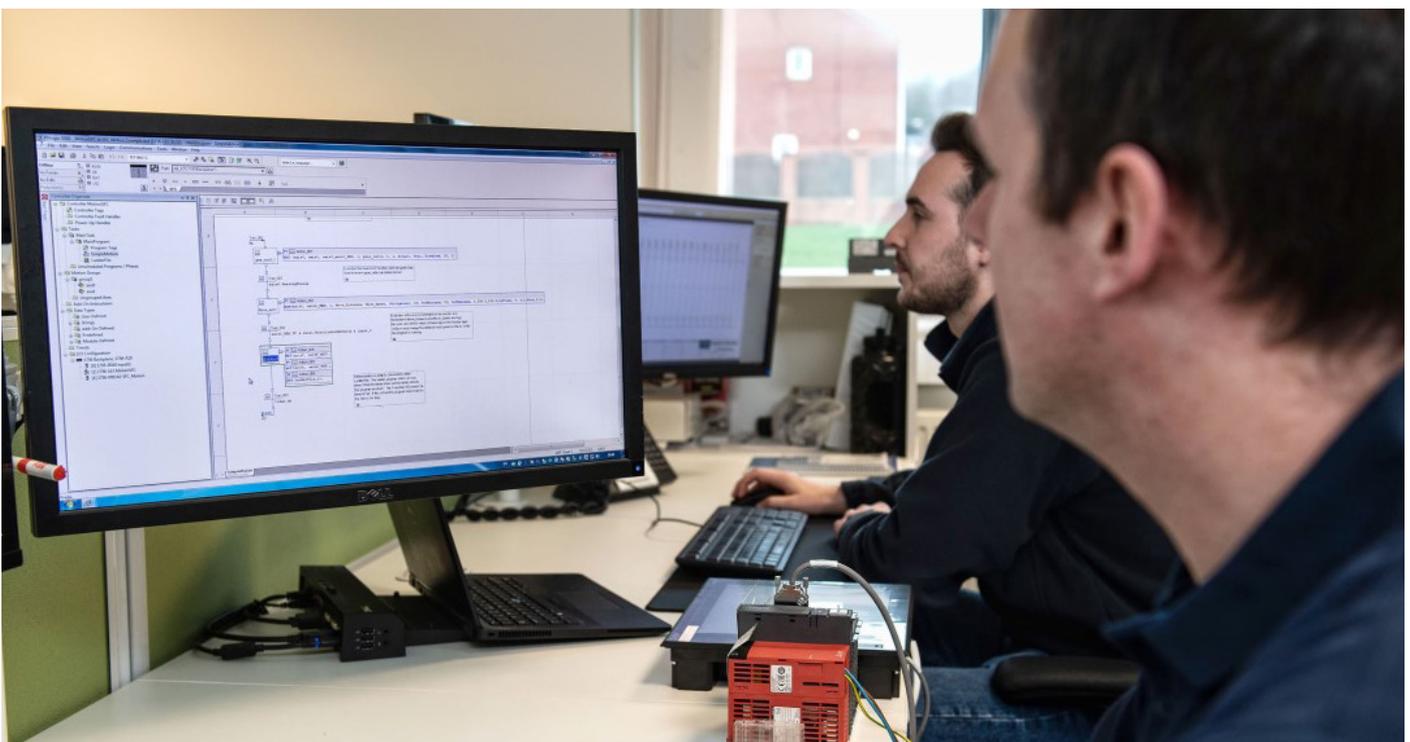
12. Sources:

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