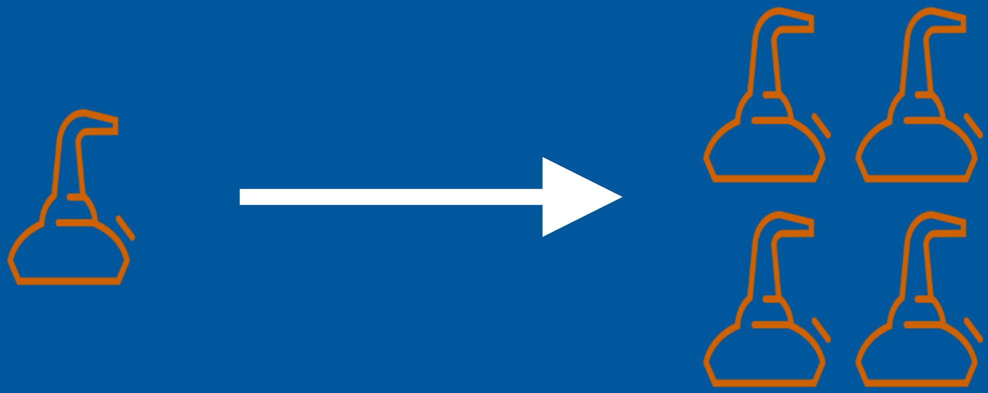
Expansion:



The Benefits of Using Process Engineers to Scale and Automate Your Production Facility

Presenters

Rob Masters

- Epic Distilling
- Distilling Specialist

Scott Davies

Business Development

- Distilled Spirits
- Biofuel

Heriot-Watt University

James Ludford-Brooks

Process Manager - Engineering

- Chemical Engineer
- Malt distillery expansion projects
- Mashing Expertise
- Still operation and sustainability

rmasters@epicdistilling.com
303-947-8225

Scott.Davies@briggsplc.co.uk
+44 01283 566661

James.Ludford-Brooks@briggsplc.co.uk
+44 01283 566661

Briggs - Background

<u>Design, build and expand:</u>

Breweries

Distilleries

<u>Offer:</u>

Chemical, Mechanical, and Electrical Engineering

Project Management

Mashing equipment

Energy recovery systems

<u>Based in:</u>

Rochester, NY, USA

Burton on Trent, UK

Briggs - Background

- In-house engineering, manufacturing and automation capability
- Been around the block (270 years recorded history – founded 1740)
- Leverage our experience and lessons learnt
- Helps to avoid pitfalls
- Bought Pfaudler (Brewing) Rochester, (NY) USA, 1994

Briggs - Background

MORTON

ROBERT MORTON & CO. LTD.

MORTON

RMDG

RMDG

Robert Morton DG Limited

Giusti

WELLINGBOROUGH ENGLAND

GIUSTI

RICHARD SIZER LIMITED

ENGINEERS – KINGSTON ON HULL

Briggs - Distilled Spirits Experience

<u>Locations:</u>

United States, Scotland and Ireland

<u>Design Studies and Equipment Supply:</u>

263,000 – 789,000 PG (0.5 - 1.5 MLPA)

<u>Expansion Projects:</u>

Malt: 3 – 6.3 Million PG (6 to 12 MLPA)

Grain: 55 – 68 Million PG (105 to 130 MLPA)

Talk Agenda

Expansion

Basis of Design

Capacity Planning / Scheduling

Plant Layout / 3D Modelling

Automation and Control

Conclusions

Expansion

Strategies to increase the distillery production volume

1. Maximise capacity of existing equipment

- % plant capacity utilisation

2. Add/Replace existing equipment

- Improve turnaround time, yield, and efficiency
- Overcome process bottleneck

3. Build a new distillery

- Start again afresh

Maximise capacity of existing equipment – without compromising quality

Maximise capacity of existing equipment

Extended shifts, more labour

- Run faster or longer?
- Good Yields? Could they be better?

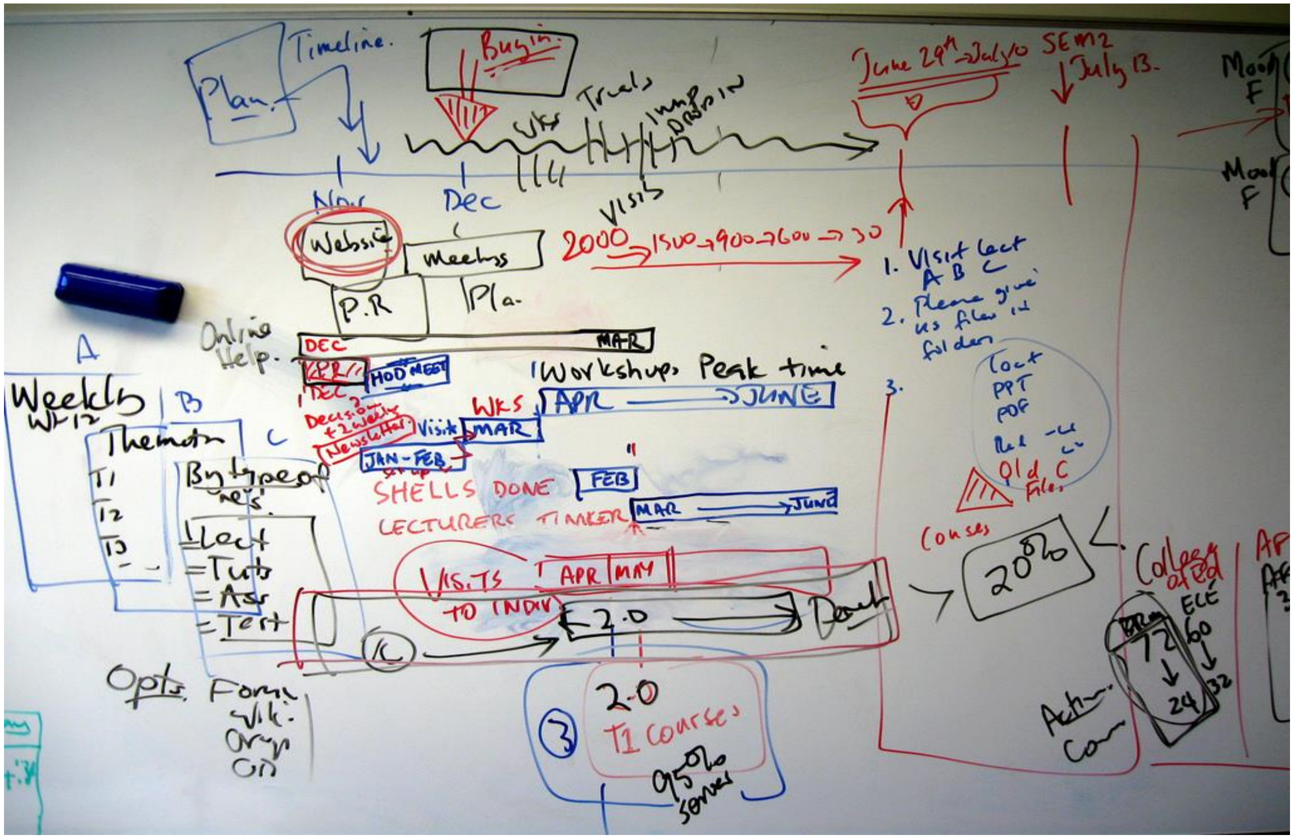
Operating equipment outside its original design

- Is it safe to do so?
- Overfilling / overloading= Possible risks
- Increased equipment wear rate and maintenance
- Is it sustainable?

Typical Alcohol Yields

Grain	L / Te	gal / bushel
Malted Barley	400	4.6
Unmalted Barley	380	4.4
Rye	325	4.2
Wheat	385	5.6
Oat	300	2.4
Corn	395	5.2

Example of Grain type and ethanol yield



Scheduling production strategy and plant utilisation

Plant utilisation

Under/Over utilisation?

Process bottlenecks

- Product transfer
- Cleaning

Multi-purpose vessels

Production schedule (Campaign basis)

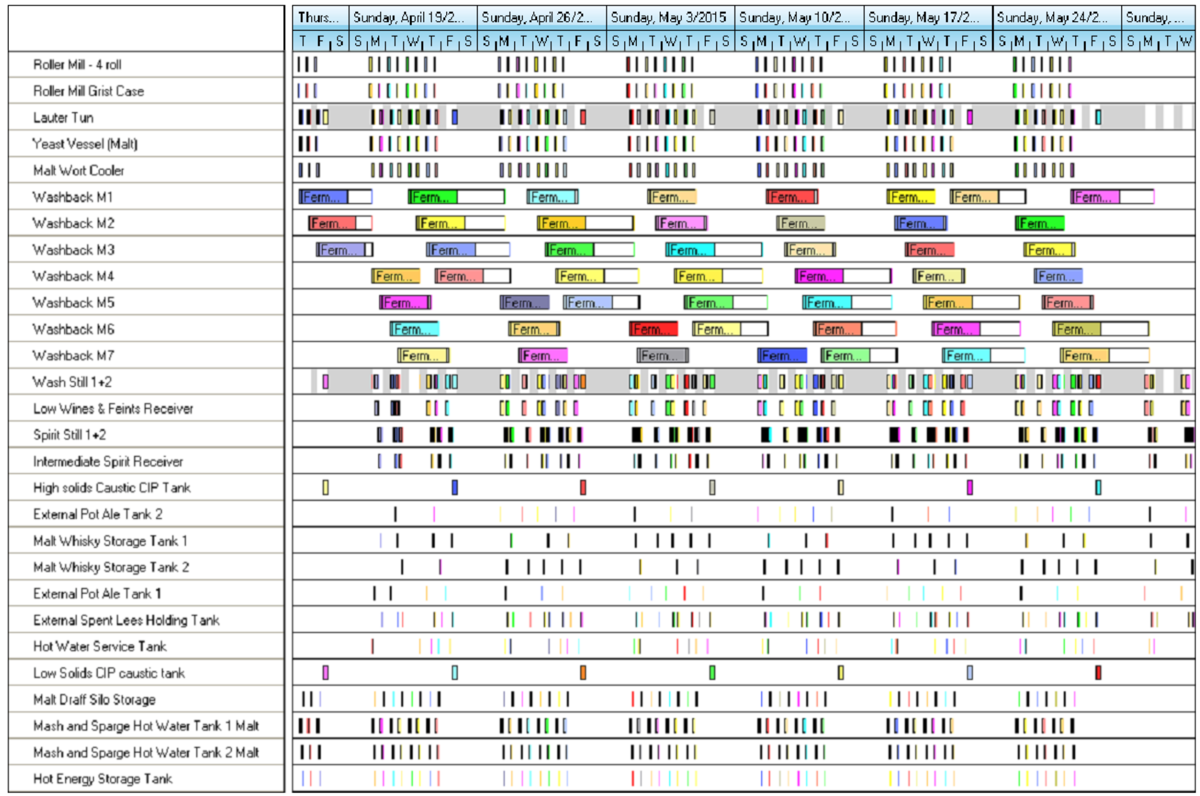
Develop a model?

- Draw – pencil or CAD
- Excel
- SchedulePro

Map unit operations

Flex plant operation and campaigns

Identify plant utilisation and potential bottlenecks



Adding/replacing equipment

Replacing /Adding New Equipment

Exceed performance of existing equipment

- benchmark current system
- Determine turnaround time / speed
- Set your design Yield
- How it will be integrated into the existing plant?
- What services or utilities does the equipment require?
- maintenance / common spares
- Process Guarantees?
- This is a good time to look for some engineers - FEED

Getting the team together – useful disciplines

- Project Manager – Overlord, driving things forward to meet the programme - and budget!
- Chemical Engineer – Understands the fundamentals and overall process
- Automation Engineer – Defines control and instrumentation
- Electrical Engineer – Cables and power
- Mechanical Engineer – Equipment sizing and loads
- Civils Engineer – Steel in the ground
- Draughtsman – Engineering drawings

Benchmarking

- Document what you do now before you change anything – understanding of your spirit character and where it comes from, gives you insight as to which technologies are suitable for your distillery and their likely impact

- Needs to cover current process and recipes, raw materials and water quality

- Detail your processing regime

- Worth investing in analysis of worts/wash composition, which should include as a minimum: gravity (OG/FG),pH and yeast type & viability – also consider more detailed analysis such as dextrins/triose/maltose/glucose/lactic acid/glycerol/acetic acid. For Lauter worts haze is also important

Basis Of Design

<u>Define what you want to achieve</u>

- Plant capability
- Raw material type and amount
- Utilities type and amount
- Product type and amount
- Site location
- **See BOD Example**

Mash Vessel	
Number	1
Diameter	2.3 m
Grain Charge	765-957 kg, weighted average of 810kg. Additional detail in mass balance.
Mash Ratio	(2.1 – 2.9 L/kg) To allow volume for cold quench.
Grist Mash in Temp	65ºC
Cooking Temp	74ºC
Cooking time	1 hour
Cool to Mashing	1 hour & addition of malt
Cooling method	Cold water quench
Mash out Temp	60°C (Optimum temperature for malt).
Conversion Time	1 hour
Transfer to Lauter Tun	24 m3/h (10 minute transfer) – Malt & Irish Whiskey route.
OR	
Transfer & cooling	1 hour to cool from 60°C to 18°C whilst transferring to washback (by passing lauter tun) at 50 hL/h. – Grain Whisky & GNS route.
Max TAT (Cycle Time)	5 hour TAT

Mass Balance

Identify all the inputs and outputs, for example:

Raw materials

- Malt / Grain
- GNS
- Botanicals

Co-products

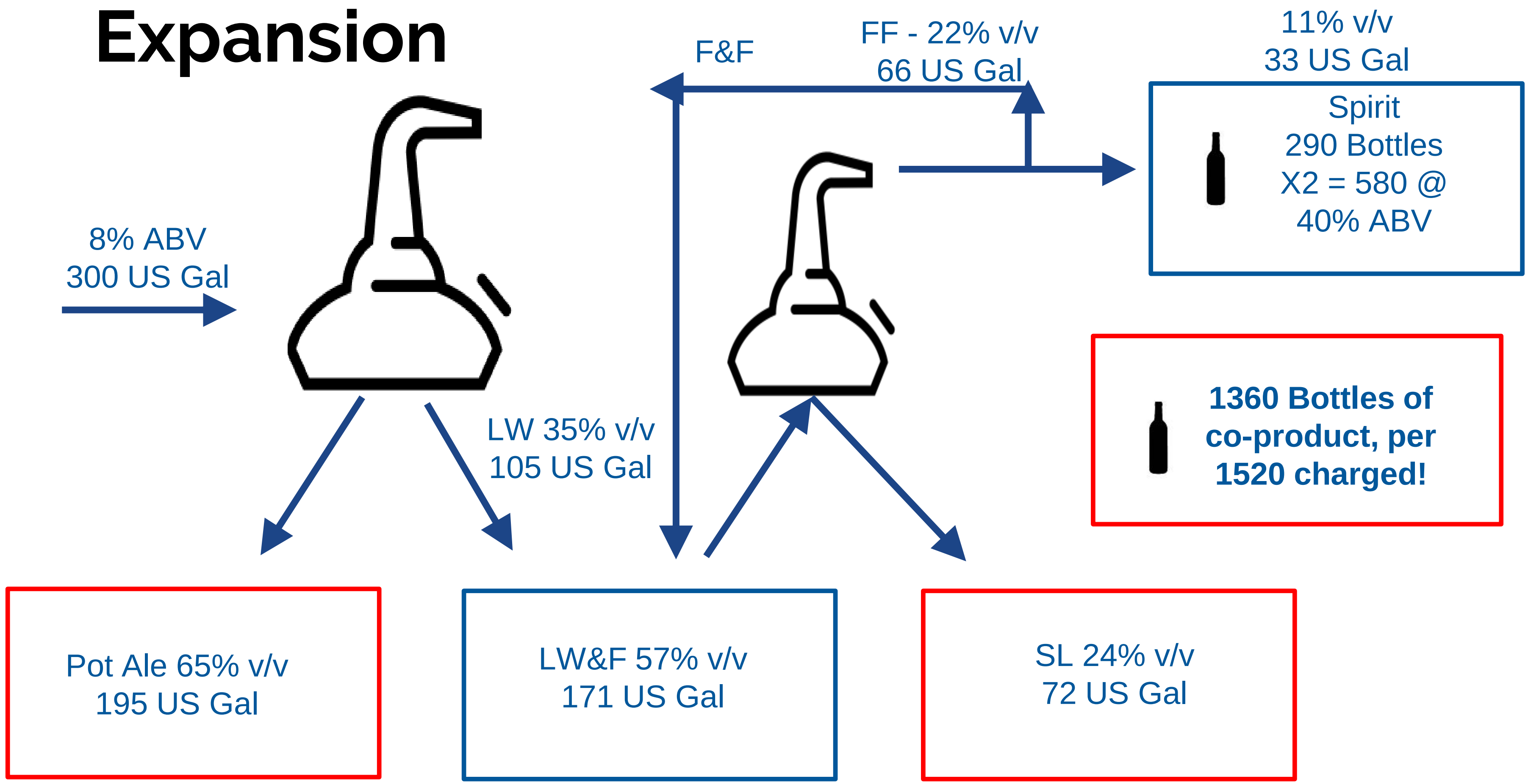
Utilities

Finished product

See Mass Balance Example

The largest output from a distillery is not spirit!

Mass Balance - Pot Still Expansion



Effluent handling – 267 Us gal to be handled for every 300 US gal charged
Bottle Size – 75 cl

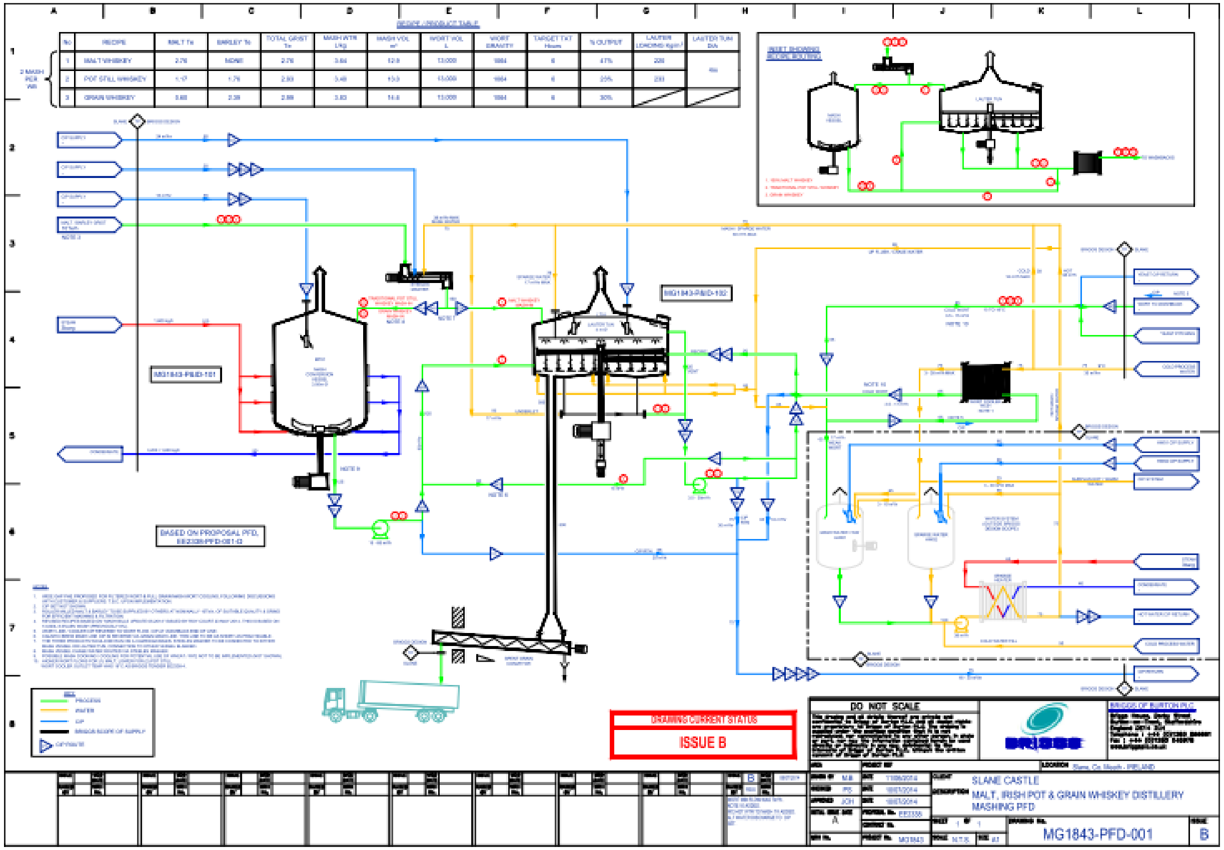
Utilities

Often the site constraint on Max Expansion

- Steam / Boiler (Fuel) – usually > 80% of Total Energy use.
- Pot stills typically evaporate 33-35% of Charge to recover the alcohol. for 2 stage pot distillation ~ 46.5 MBtu/PG (7.2 kWh/lpa) Thermal heat is required. Can also use 8.3 MBtu /Us gal evaporated as an estimate – it will be a big number!
- Electricity ~ 20% of energy use
- Water – for production only10-20 US gal/PG depending on process. Cooling is often largest user if unrecovered, cooling water can be closed circuit, need not be evaporative cooling tower.
- Compressed air – instrument air/draff/spent grains

Process Flow Diagram (PFD)

- Overall Process Concept
- Main equipment items
- Main Pipework routes
- Cleaning Routes (CIP)
- **See PFD example**



Process & Instrumentation Diagrams (P&IDs)

Basically, how does it all hang together? – forms basis for 3D model

Diagrammatic representation of the system

Colour coordination by type

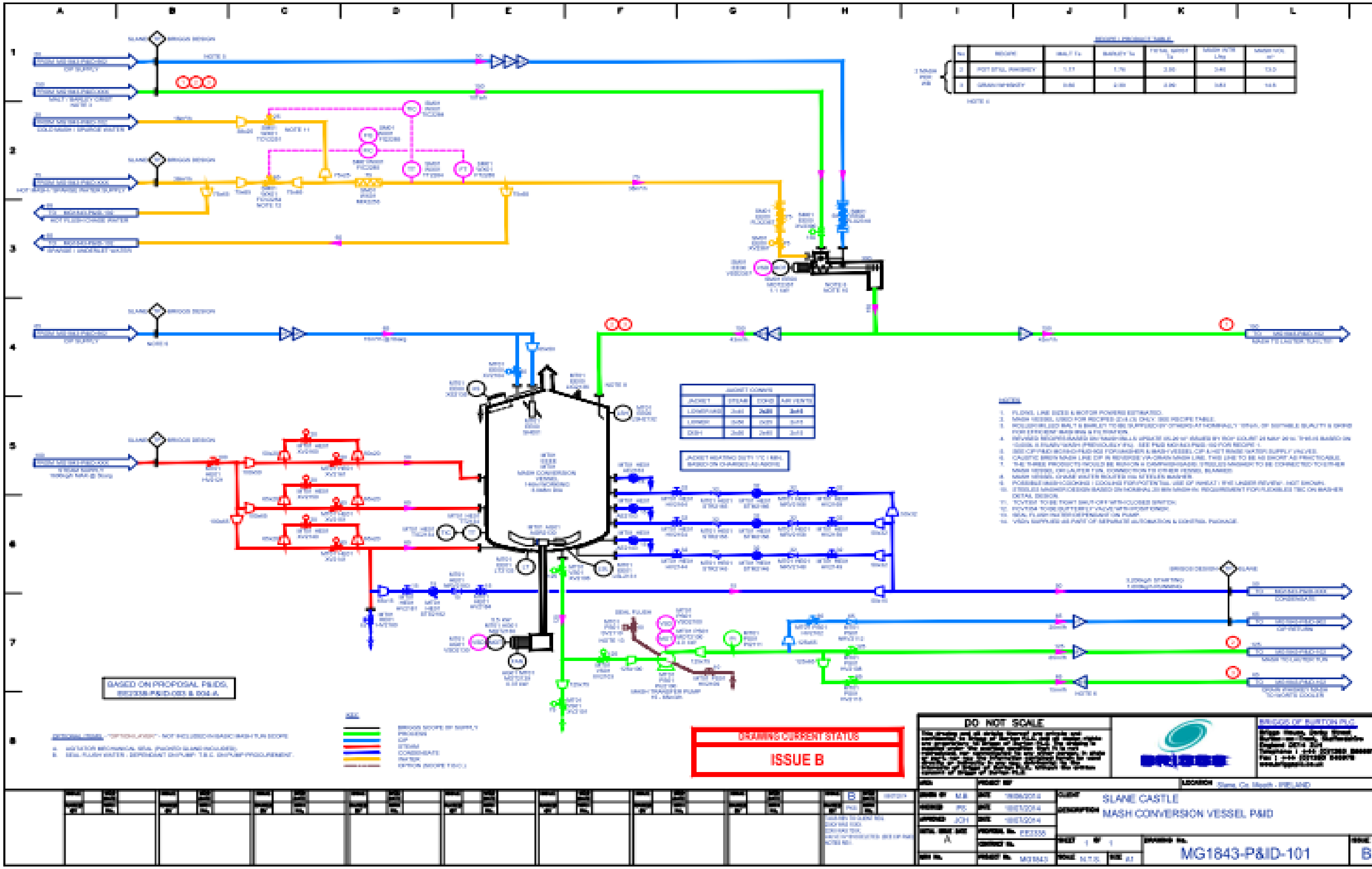
- Process, Steam, CIP, Water

Represent “As built”

Useful for expansion and upgrade

See P&ID Example

— P&ID


DRAWING CURRENT STATUS
ISSUE B
DO NOT SCALE
SLANE CASTLE
MASH CONVERSION VESSEL P&ID
MG1843-P&ID-101
B

Design Review

Iterative, key stages during project

Undertake Risk Assessments & Safety Review

Consider recording a risk assessment – HAZID or HAZOP methodology is also possible

- Design out risk
- Design in safety

People

- Visitors and operators

Plant Operation Safety

Typical hazards arise from:

Pressure containing equipment

Hot fluids

Rotating machinery

CO_2 Atmospheres (Fermentation)

Dust and Flammable atmospheres

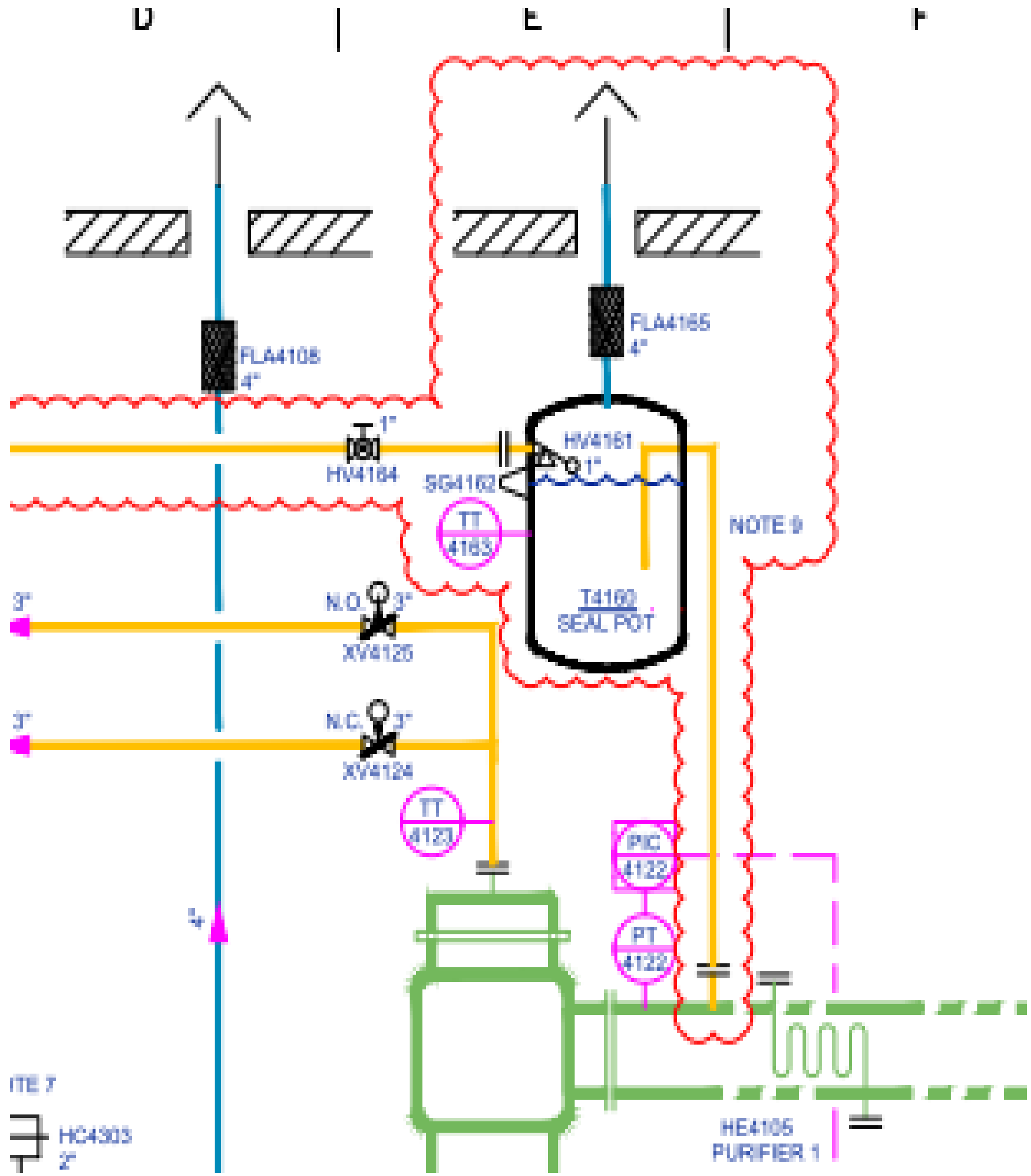
Clean In Place (CIP) Chemicals – Acid & Caustic

Plant Operation Safety

- In case of Still over pressure there must be a relief device with a flame arrester to vent outside of the building. – bubble pot is simplest, accurate sizing is important

- It doesn't replace the requirement for an anti-Vacuum valve

- Overfilling can also cause significant hazards – see later



Example - Bubble Pot and Anti Vac Valves On a Pot Still

Plant layout & 3D modelling

Plant Layout

Go with the flow

Consideration to material in and out

Leverage gravity

Visitor and plant operator experience

Use Computer Aided Design (CAD)

Plant Layout

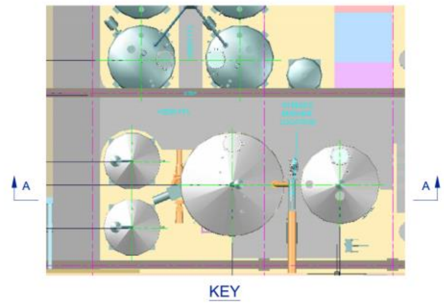
3D plant modelling at the Conceptual stage

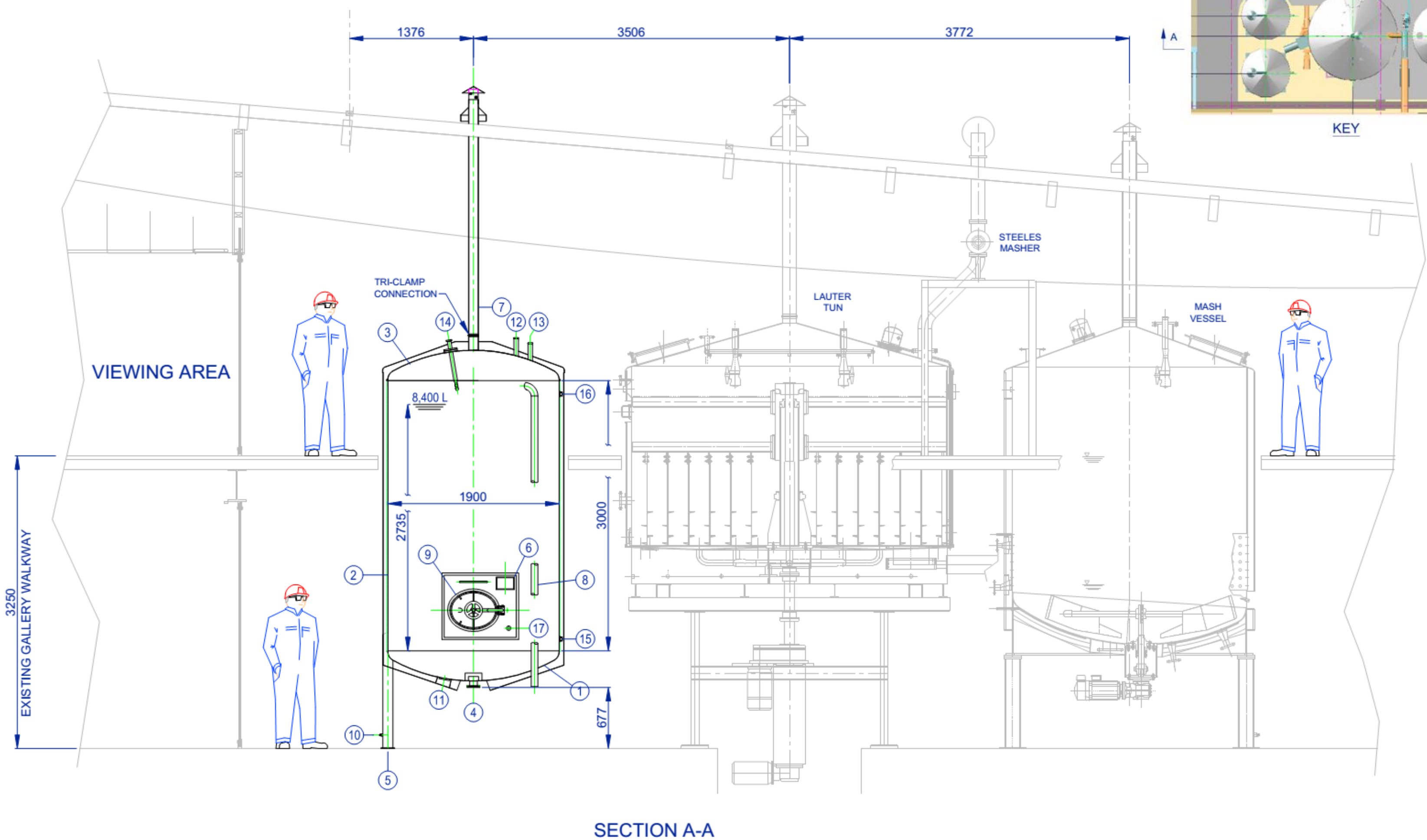
- major plant items
- buildings & structures
- pipe bridges only (i.e no detailed piping design at this stage)

Detailed stage

- Add detailed piping

Engineering plans and elevations are taken from the 3D model as required





General Arrangement Drawing

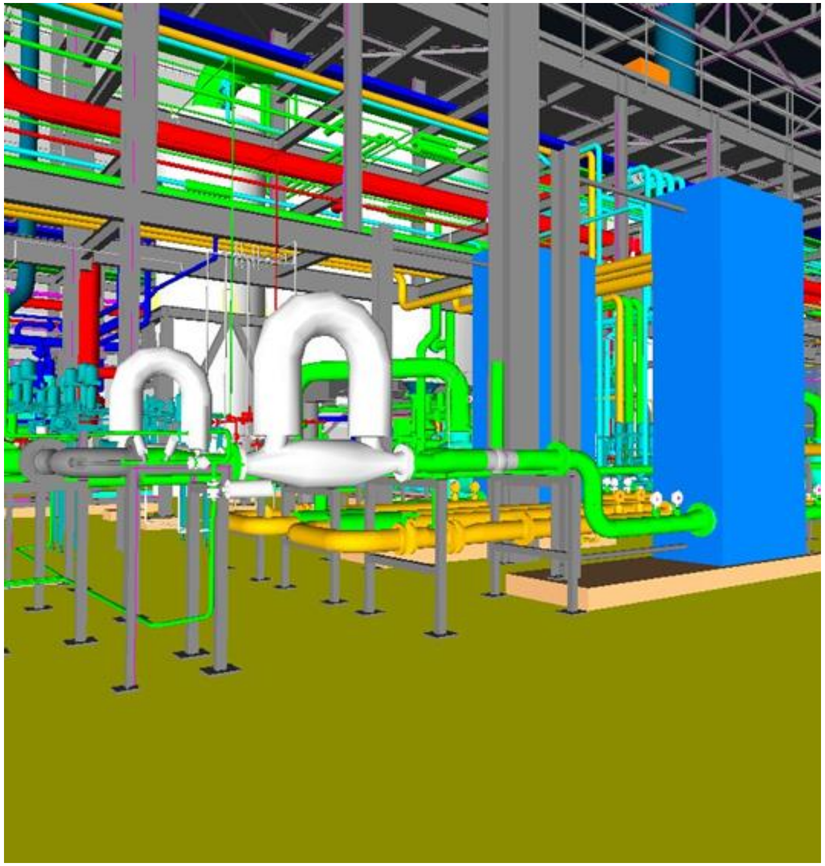
3D Model

Leverage Computer Aided Design (CAD)

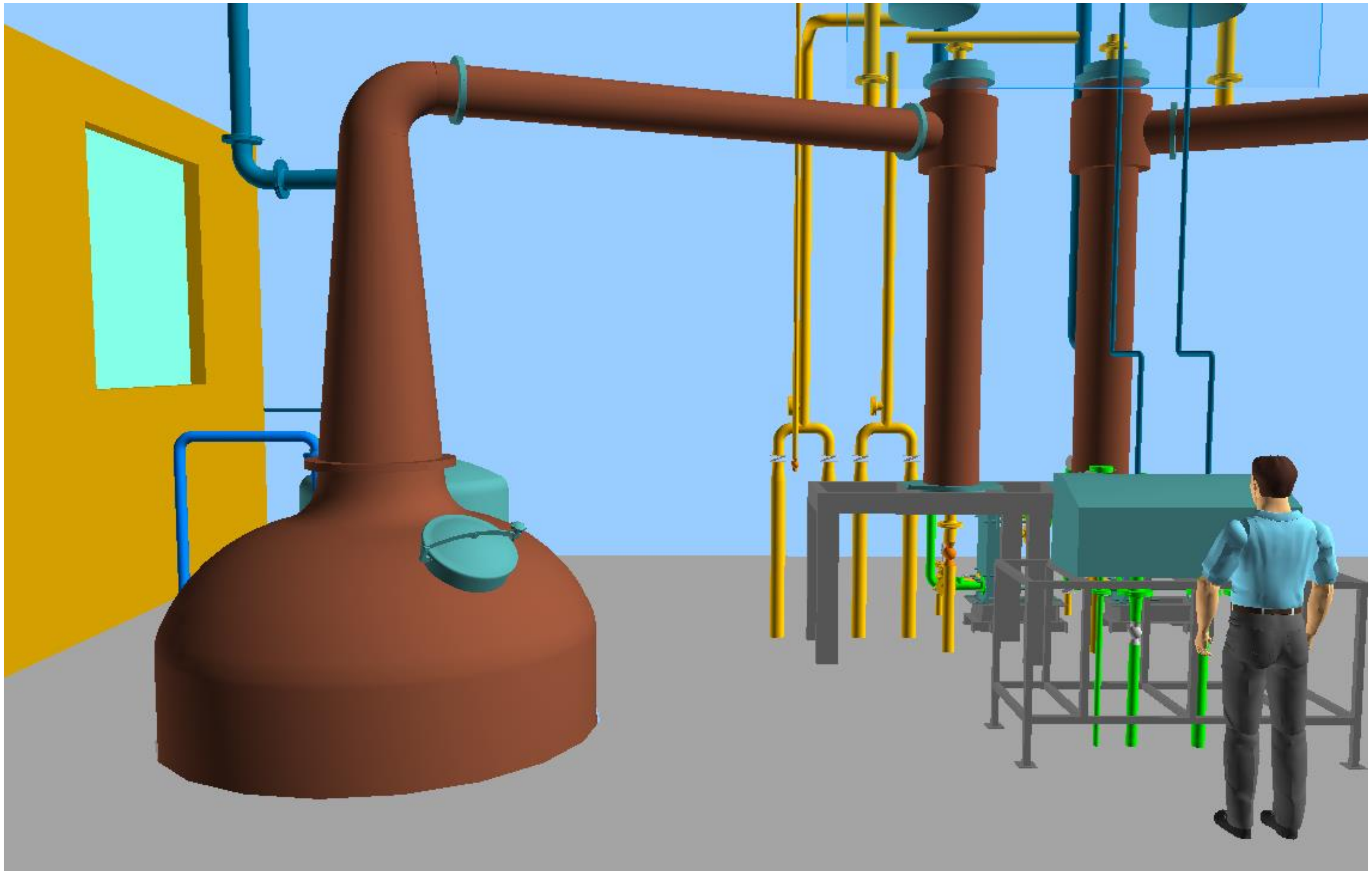
Review plant on a screen

Far easier to make changes during the design stage

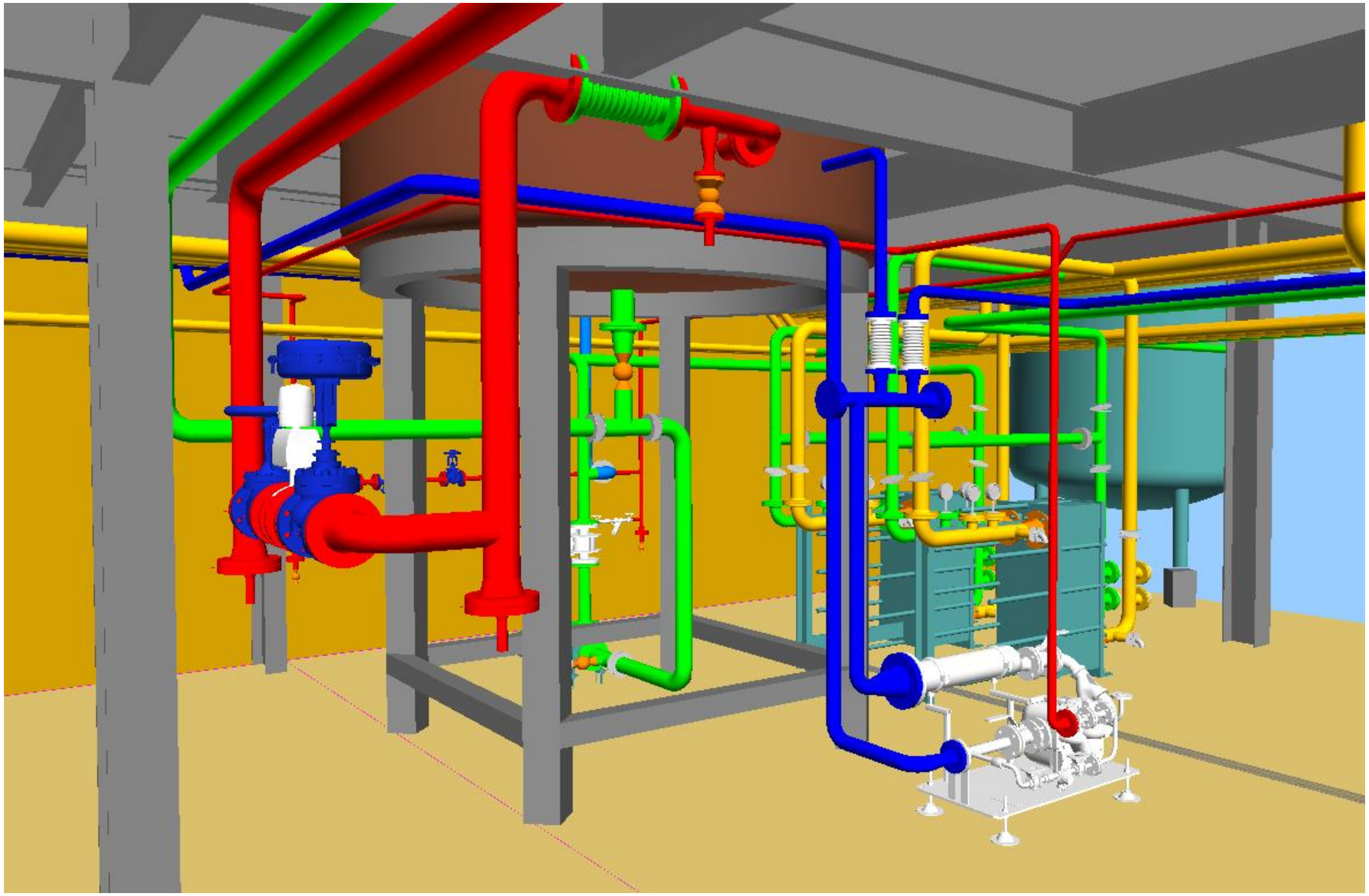
Visualisation of plant useful for stakeholder and operator buy-in



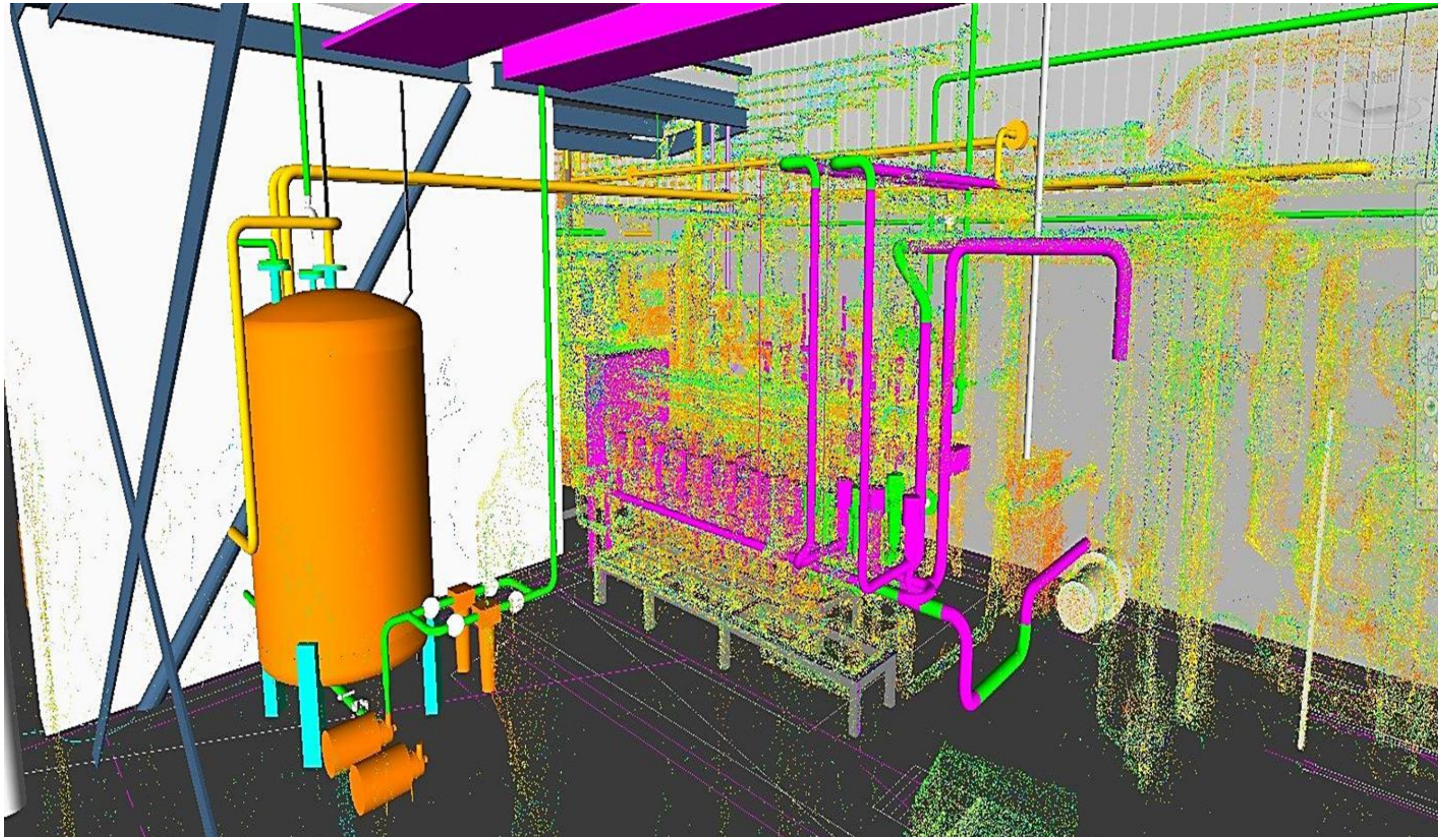
3D Model during design stage (left) and actual from completed project (right)



Process floor with equipment often visitor experience



Plant process floor with pipework and equipment allowing ease of maintenance



Point Cloud + 3D Model

Planning and coordination pipework “break-ins”

Lauter Tun Replacement – adding new equipment creates disruption!

Automation

Automation = antithesis?

Automate mundane and repetitive tasks = More time to innovate and refine your craft

“Automation has crushed distilling, but I can see why it’s done: it’s easier, safer and you don’t have to pay a robot.”

“At our place, there are levers and valves to open and close and cuts to be made. Distilling gin is fairly simple in terms of process, and while we could automate it, where’s the craft in that?

Chris Garden - Sipsmith

“Gin providing the tonic for Sipsmith”, The Manufacturer, July 2013

Automation - Overview

Functionality

Measurement

Recipes

Consistency

Reproducibility

Repetitive tasks

Safety

Alarms

Interlocks

Overpressure relief system

Automation - Equipment

Panel

Push buttons / toggle switches

Control valves

Human Machine Interface

Instrumentation

- Temperature
- Pressure
- Flow rate
- Density – auto cut possible

Valves

Pneumatic actuators

Used for difficult to reach locations

Triggered by set points

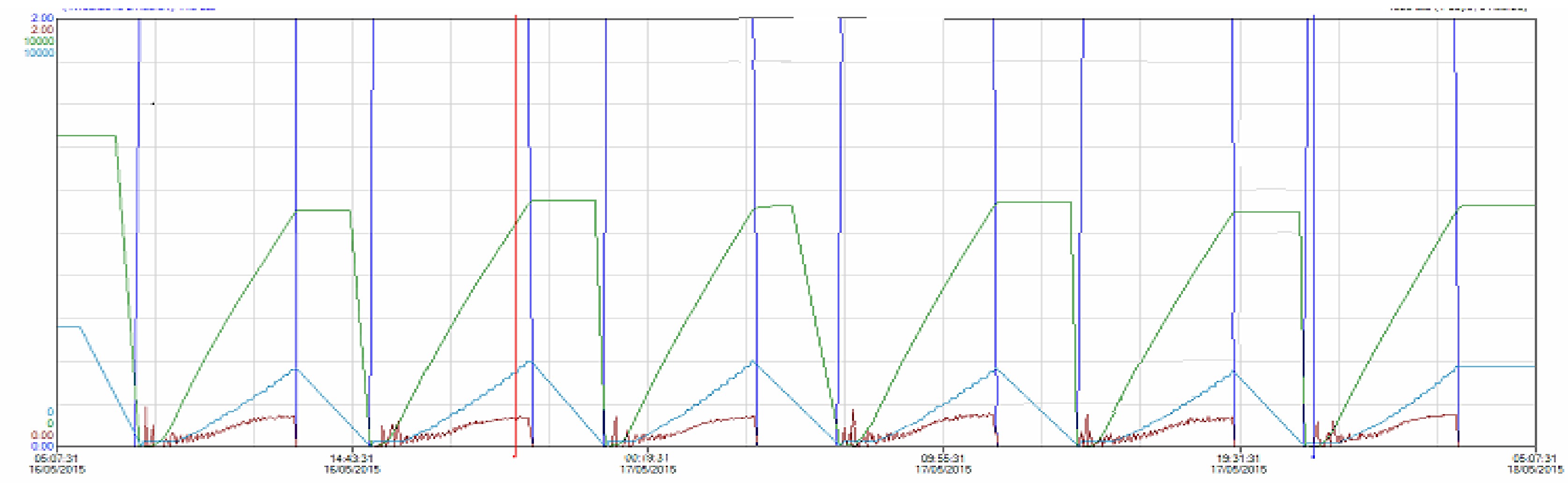
Flow plate (manual operation) and fully automated valve matrix

You cannot control or manage, what you cannot measure

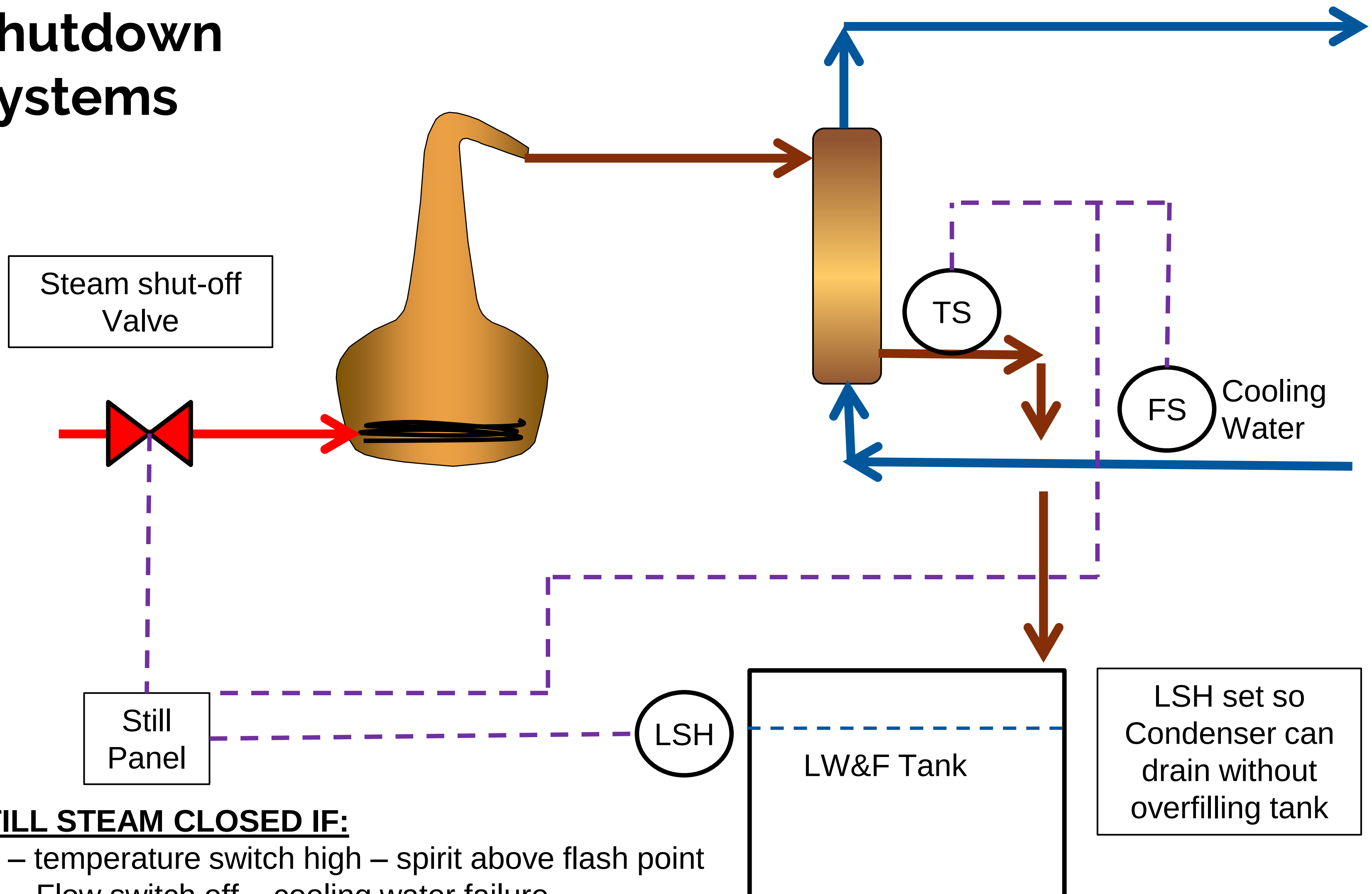
Process consistency

Recipe management

Process control – repeatability, consistent product quality, <u>whoever operates</u>



Still Safety – Shutdown Systems



<u>STILL STEAM CLOSED IF:</u>

TT – temperature switch high – spirit above flash point

FS – Flow switch off – cooling water failure

LSH – High level switch ON – vessel overfill

Thank You

BRIGGS