Development of supervisory/advisory control of pan and fugal station operations
[Smart Supervisory Control System]

Ross Broadfoot[1] and Roland Dodd[2]

[1]Queensland University of Technology, Brisbane, Australia
[2]Central Queensland University, Rockhampton, Australia

Objective: To develop and implement a supervisory/advisory control system to improve the efficiency of the operations of the pan stage and fugal stations

Processing objectives:

1. **Throughput rate** (not hinder crushing rate)
2. **Sugar recovery** (minimum final molasses purity)
3. **Sugar quality** (consistent mean size, uniformity, pol, moisture, temperature, colour)
4. **Steam consumption** (reduce consumption and reduce variation in consumption)

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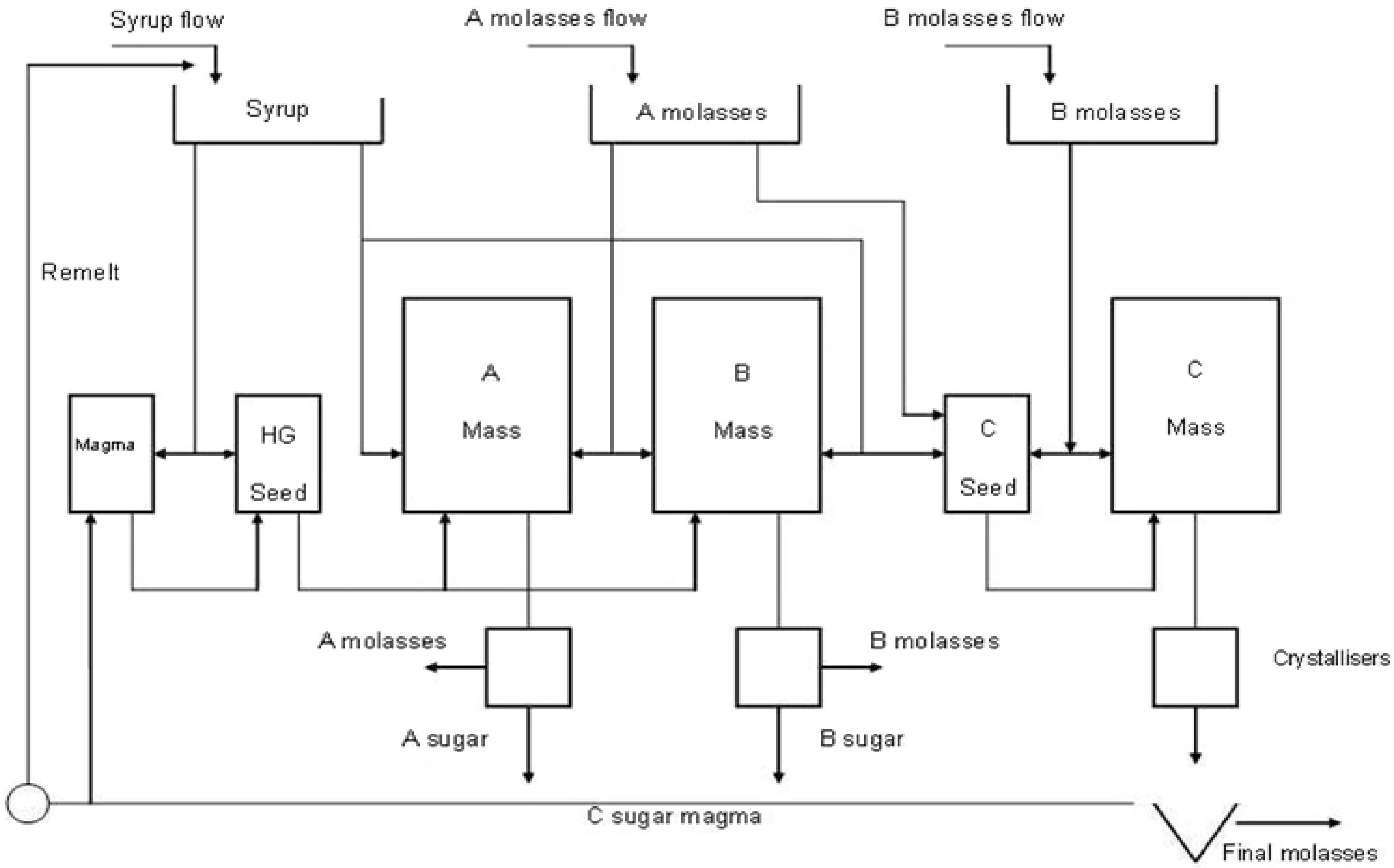
Typical Australian pan stage and fugal station

- Both A and B sugar are product sugar (0.85 mm mean size)
- 8 Pans (mainly batch but several continuous). Batch pans up to 240 t (not stirred). Operate in a tight schedule (cutting between pans).
- One operator on the pan stage; one operator on the fugal station
- High level of automation

Typical pan/fugal process scheme in Australia



Why the pan, crystalliser and fugal stages?

- Complex management (8 pans undertaking different duties and strong influence on other stations)
- Main feedstream (syrup) varies in composition and has strong impact on operations
- Several recycle streams
- Pan characteristics change (e.g. vacuum problems)
- Syrup and molasses characteristics change
- Steam consumption varies and affects HP-LP balance (steam venting and make up)
- Strong impact on factory revenues ➢ sugar premiums and pol recovery from syrup

Factors affecting throughput rate

- Cane composition (vary with farmers supply and seasonal)

Massecuite type	Massecuite % cane	
	Early season	Mid-season
A	12.8	22.6
B	11.5	8.1
C	6.6	4.6

- Pan stage decisions and performance

(e.g. boilback of A molasses onto A massecuite, quantity of liquor onto B massecuite, exhaustion, swing pan on A or B massecuite)

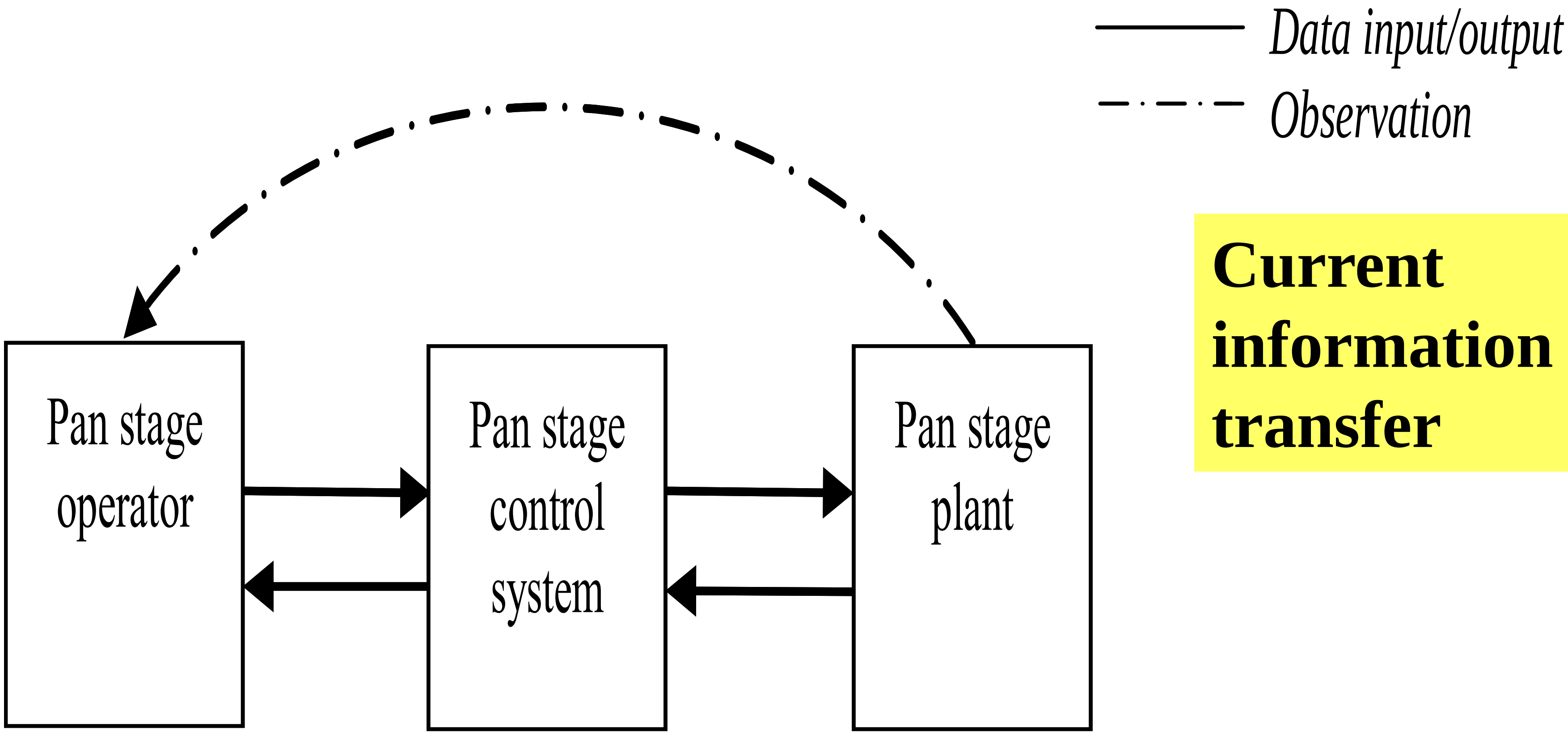
What is the smart supervisory control system (SSCS)?

- Management tool to assist the pan and fugal station operators to make better decisions for managing the stations

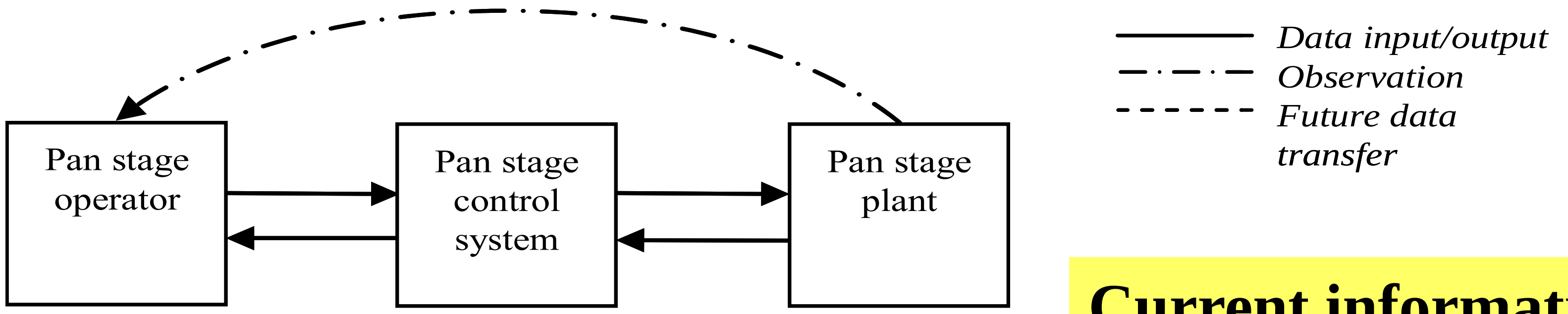
- "Expert" system incorporating rule based decisions making, process models, interface with operators

- Incorporates six process models
  - Syrup prediction models (sucrose and impurity rates)
  - Fugal station A and B molasses production model
  - Pan stage phase determination models
  - A, B and C massecuite flow model
  - Empirical pan models (boil-on rates of syrup and molasses)
  - Stock prediction model for storage tanks

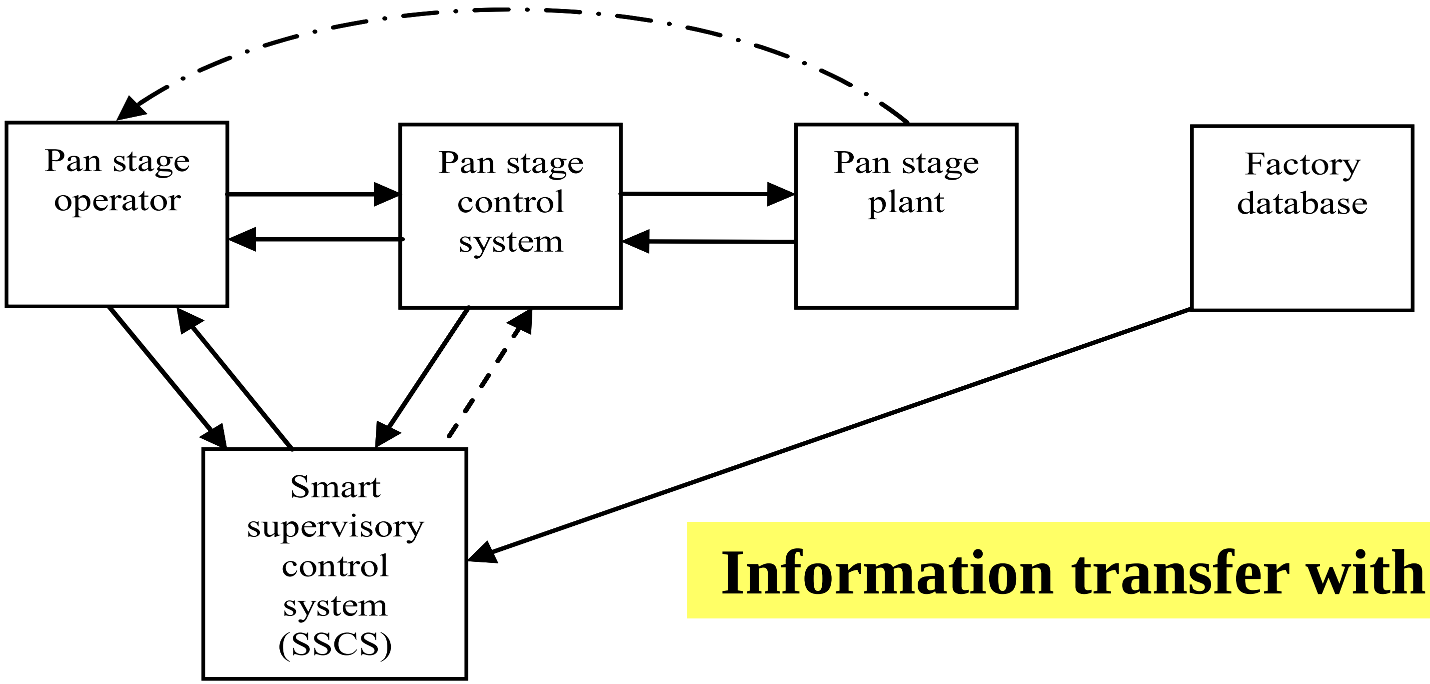
Comparison of supervisory methods



Current information transfer



Current information transfer



Information transfer with SSCS

Main procedures (1)

- Cane receival data → **estimates** of syrup rate and purity (sucrose and impurities)
- Fugal logging (receivers, individual fugals, fugal doors) → **estimates** of A molasses rate, purity and brix; similarly for B molasses
- Pan phase determination and use empirical boil-on rates (function of phase and steam rate) → **estimates** of instantaneous consumption of syrup, A molasses and B molasses

Main procedures (2)

- Model for massecuite production rates→ use estimates of syrup rate and purity, target massecuite purities and exhaustions
- Stock tank estimations – quantities of sucrose and impurities (purities)
- Laboratory data (estimates of massecuite and molasses analyses; usually at least 12 h after sampling)

Main procedures (3)

- Rolling average corrections (use lab analyses, actual massecuite quantities dropped from pans, actual stock tank quantities)→improved estimates for syrup conditions, purities for A and B molasses

Examples of outputs from SSCS

Recommendations for:-

- Swinging pan on A or B massecuite
- Quantity of A molasses onto A and B strikes
- Cycle time for the next round → Steam rates to each pan
- When to start and complete strikes
- Forecasts of syrup and molasses tank levels

Supervisory or advisory? First step is advisory

Interface for the operator

- Use of Touchscreen

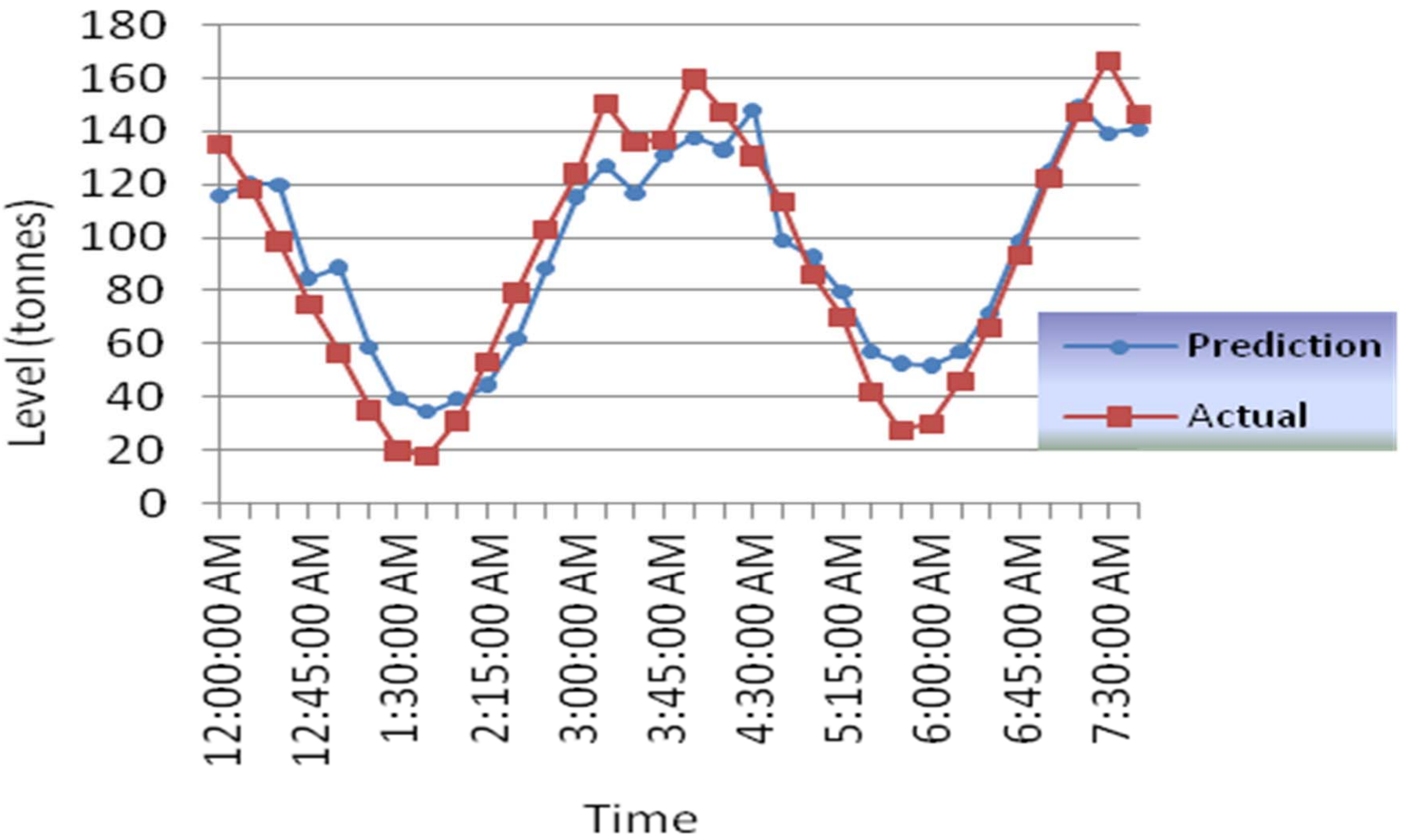
Examples: If the factory crushes at 400 t/h for the next 4 h (with similar cane composition) how will the levels in the syrup and molasses tanks vary if operate with a 3.25 h cycle for the high grade pans and boil a B massecuite in the swing pan?

How will the stock tanks vary if boil an A massecuite in the swing pan?

What will happen to the stock tanks if operate to a cycle of 3.5 h.

→ decision to select best option (more time for crystal growth and exhaustion, reduced steam rate)

Syrup tank level prediction



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Progress

- Data transfer from factory systems completed
- All models developed
- Interface systems being developed
- Large steam savings not likely in tight schedule

Next step: Implement the prototype and refine

Is this a step towards factory wide supervisory control?

Other applications for supervisory/advisory systems in sugar factories

- Extend to juice heating, clarification, filtration and evaporation
  - Ideal for smoothing exhaust steam demand
- Steam and condensate management for the factory

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