Modelling and control summaries

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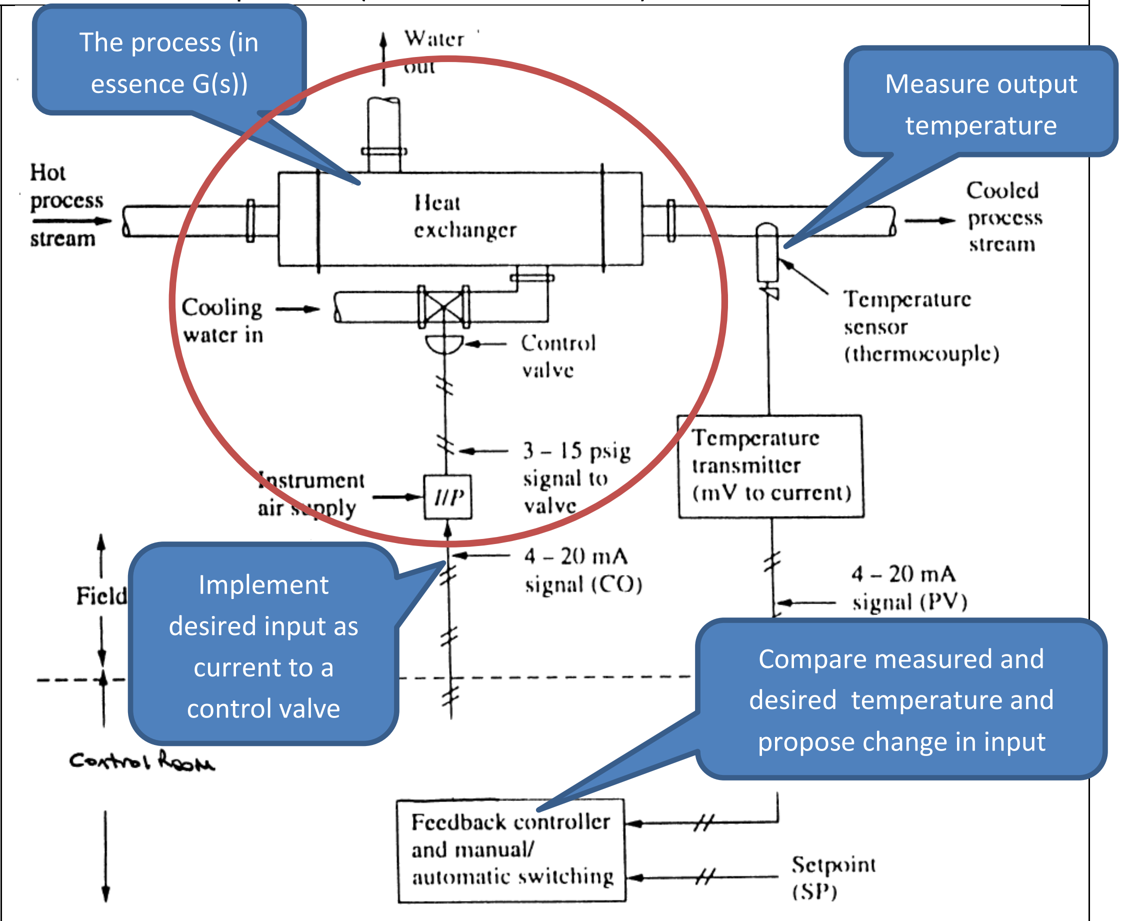
Intro. to feedback 3 – implementation

FEEDBACK INVOLVES MEASUREMENT, DECISION MAKING BASED ON THE MEASUREMENT AND INPUT ADJUSTMENT.
In order to design this effectively, we need a systematic framework for analysing the process.

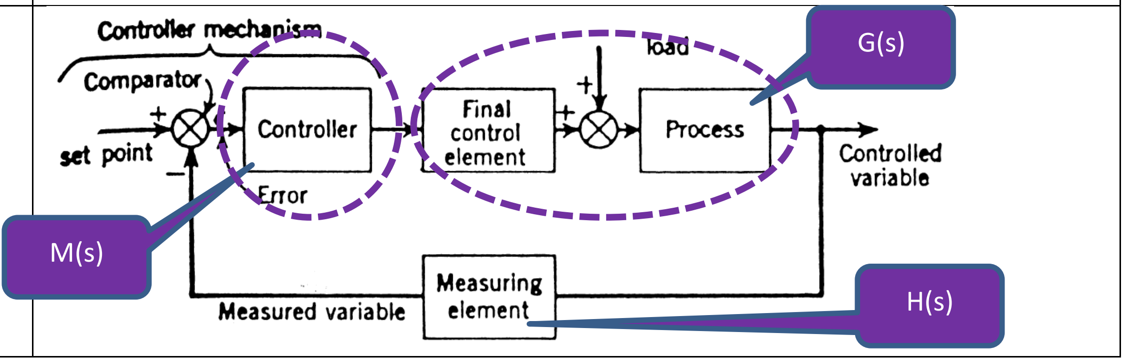
Heat exchanger: this is a very common component within industry . The aim is to ensure the output stream is at the desired temperature (so a bit like a shower).

This diagram is useful as it shows the key processes involved in feedback.
i) measurement
ii) decision making.
iii) implement input u(t).
iv) process dynamics.

Output depends through the process dynamics on the selected input.

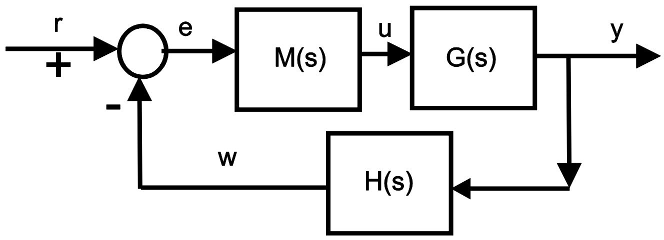


We use an equivalent block diagram to simplify analysis as this is far easier to work with.

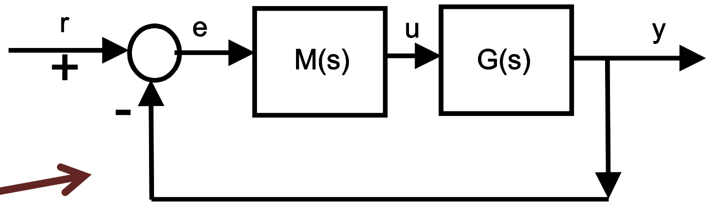


SUMMARY – we can reduce the implementation to a simple block diagram with 3 key blocks and a comparator. Note any valve dynamics are considered part of the process.

1. G(s) represents process dynamics between the input u(t) and output y(t).
2. u(t) is the result of the decision making.
3. Decision making is captured in M(s) and typically uses the error between the measured output w and the target r, that is e=r-w.
4. w(t) is the measured output from sensor H(s) – true output y(t) is of course unknown.



CAVIAT: It is common to assume H(s)≈1, that is sensing is instantaneous and accurate. Hence simplify diagram to:



COMPARING OPEN-LOOP AND CLOSED-LOOP: Detailed analysis of block diagrams is in the chapter on block diagrams. Here the equations are assumed. Let R(s) be desired target.

OPEN- LOOP (N(s) to be chosen)	CLOSED- LOOP (M(s) to be chosen)
$Y(s)=G(s)U(s)=G(s)N(s)R(s)$	$Y(s)=\frac{G(s)M(s)}{1+G(s)M(s)}R(s)=G_c(s)R(s)$

KEY OBSERVATIONS:

1. The transfer function between the target R(s) and the output Y(s) is very different in open-loop and closed-loop.
2. This means that the closed-loop and open-loop will have different poles, different steady-state gains and different behaviour.
3. We know that it is impossible to design N(s) to give good open-loop control in general due to uncertainty in modelling G(s).
4. The challenge is to design an effective control law M(s) so that the behaviour of $G_c(s)$ is good, not withstanding any errors in the model assumed for G(s).

The challenge for students is to undertake the analysis of $G_c(s)$ and determine effective mechanisms for selecting M(s) so that $G_c(s)$ has the desired behaviour.

REMINDER: An automated feedback system requires four main components:

1. A sensor to observe the output.
2. A comparator to compare the output with the target.
3. An intelligent component to decide what the new input should be. [In practice the comparator is embedded within this.]
4. An actuator, or similar, to implement the desired input.