

## Back to the Future

Modern Computing in Railway History

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## How is a railway like a computer? 1

if all trains ran according to schedule and never broke down, there would be little need for a signalling system  
[BR Railway Signalling HB]

cf functional programming, formal specification  
where the behaviour can be successfully circumscribed,  
don't need to consider interaction between agents

cf C A R Hoare in Communicating Sequential Processes  
" ... **no need to distinguish between events initiated by the object and those initiated by some agent outside the object ... avoidance of causality leads to simplification**"

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## How is a railway like a computer? 2

Today, full automation is quite feasible  
... how has this come about?

Railway history as a process of circumscription  
... circumscription leading to a closed-world  
foolproof? – against foreseeable perturbation of the system  
[Consider some examples of events protected against]

What are the dangers that remain?  
To what extent is there still discretion for agents?

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## Aspects of circumscription 1

Trend towards fail-safe:  
safety guaranteed if not fairness and liveness

Key to automation  
possibility of stimulus-response mechanisms  
to detect & correct (or at any rate neutralise)

signalling of its nature is communication =  
stimulus/response

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## Aspects of circumscription 2

Understanding of a fully automated railway derives from  
state-based views

... not black box, but make explicit stimulus-response  
patterns that are encapsulated in electronic  
components

cf. model railway: synchronisation of signal and train is  
contrived

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## Aspects of circumscription 3

Understand wrt to now obsolete mechanical signalling  
processes

Basic concepts  
Signalling protocols: distant, home and starting signal  
Blocks: absolute blocking, permissive working  
Track circuits

Division of responsibility  
+ transfer of control between signal boxes  
Communication between station-supervisor and signal box

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## Aspects of circumscription 4

What purposes do these serve? Consider consequences of  
ignoring signalling protocols  
relaxing blocking restrictions  
dispensing with track circuits  
liberalising the communication regime

Role of agents complementary:

responsible driver slows down at distant  
proceeds cautiously in permissive working  
responsible signalman clears signals in particular  
sequence  
follows the communication protocols faithfully

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## Aspects of circumscription 5

Other factors concerned with synchronisation of activity

- interlocking cf. every point and signal is a free agent
- continuous braking cf. every carriage can move independently
- forms of prohibition: denial of privileges  
signalman can't set the points against the signal  
driver can't cross a stop signal: Automatic Train Control
- synchronisation points in protocol
- means of interrogation for confirmation
- check the route is set-up

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## Moral of railway history

Behind the modern railway there is an exceedingly complex network of crafted:

- engineered objects / environments
- social conventions / training / education

Full automation on this scale could not have come about without experiment and practice

It is never totally foolproof, always subject to unforeseen hazards ... *hazards shape history*

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