THE UNIVERSITY OF WARWICK

DEPARTMENT OF COMPUTER SCIENCE

Fiona Linton.

ACE   January 26 and 27, 2000

in Computer Science. Time? Room 104

(Upstairs terminal room)

We give some background to study of computing on a degree and use of computers in simulating dangerous procedures.

We describe a railway accident involving 3 trains and a newly installed telegraph system (in 1861!). We divide pupils into 3 groups of about 5 in each group: those in one group sit at adjacent workstations. Under guidance they control trains & signals in normal operation. (3 are drivers, 2 are signal/telegraph operators.) Then they run the accident scenario. Finally come back together to discuss whether such models could help avoid accidents and what would make it more realistic etc.

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Railway Demo for ACE: suggested script

Welcome to DCS, names of us. These computers here usually being used by students studying for 3 years for a CS degree. If you do a degree in CS you learn in great detail how computers work and how to make them do useful things. Jobs/careers.

Everyone knows that computers can be v.useful …. What for …? E.g. controlling cars and aircraft. Modelling v.dangerous or v.expensive things. Often called 'simulation'. We're going to show you such a use: a simulation that is a bit special – it is distributed (shared) – like multi-user game but for real. It is part of research in a new way of modelling: this is a new demo in this form. We'll ask you some questions afterwards - feedback to help us improve.

When trains were new wealthy people could own one and take them out when they wanted to as we do now with cars. Accidents. Dangers of tunnels. Trying to think out ways of preventing accidents …..intervals and signals etc.

Simulating trains going through a tunnel using the electric telegraph (brand new in 1860).

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Team work on Clayton Tunnel …..What to do now …..first practice at controls of signals/telegraph and trains then try and run several trains through tunnel keeping to rules.

Reproduce the accident of 1861 by following 'script'.

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Had you used computers like that before? Anything that would make it easier to use? To understand? More realism?

Trains are better understood now (far from perfect), but maybe this sort of simulation could be useful for planning and controlling 'motorway trains' of the future? What else?

Our students use such methods and new ones they develop themselves for projects on a CS degree…..maybe you will ….

Setting up the Clayton Tunnel Railway Simulation (guide to team coordinators)

By way of background, each team coordinator should first become familiar with the scenario of the Clayton Tunnel Railway Accident and with the controls and rules associated with the drivers and signal operators involved in the simulation. (Note that in both phases of the simulation, the role of Brown will be performed automatically.) There will be two phases to the simulation process.

Phase 1: In the initial phase, pupils will be following the normal operational protocols of drivers of trains T2 and T3 and of the signal operator Killick in the vicinity of the Clayton Tunnel. Trains will travel from right to left through the tunnel according to a standard operational procedure.

Phase 2: When pupils are familiar with the protocols to be followed, the simulation will be reset to an initial state, and the pupils will attempt to recreate the scenario of the Clayton Tunnel Railway Disaster.

In Phase 1, the coordinator will *display Brown's view* to illustrate the role of Brown, *contrast God's view* with that of the individual agents, and *reset the simulation* in the event of crashes. In Phase 2, the coordinator will *initialise* the simulation, and *help to synchronise the interactions* leading to the accident.

The following instructions are intending for setting up the simulation environment for one team. They presume that six workstations of approximately equivalent specification are available, and that each is using the Solaris Common Desktop Environment. (It is essential that the server is on a high-performance workstation, and desirable that less powerful workstations are used as front-ends to more powerful workstations via *ssh* or *rlogin*.) It is convenient if the workstations are in line with each other and are numbered 1,2,3,4,5,6 in such a way that 1,2, and 3,4,5 are grouped together. There will be 15 guest codes in use for the pupils: these are associated with 2 or 3 teams, viz:

{guest1, ..., guest5}, {guest6, ..., guest10}, {guest11, ..., guest15}.

Each team is allocated a distinct channel number. These are 10, 11, 12 respectively. Each team will have a team coordinator who will be responsible for supervising agent interactions in Phases 1 and 2 and playing the role of God in preparing for the accident simulation in Phase 2. The coordinator may exceptionally be called upon to intervene (e.g. to reset the simulation when a crash has occurred).

Step 1: Attach agent names to the workstations using the prepared title cards, viz

1: Killick1 - the telegraph operator
2: Killick2 - the signal and flag operator
3: driverT1
4: driverT2
5: driverT3
6: God + Brown

Workstations 1 through 5 are for the use of a team of pupils, and Workstation 6 for the team coordinator. Becuase of their respective roles, Workstation 1 should be to the immediate left of Workstation 2. Workstations 1 and 2 need not be as powerful as Workstations 3-6. Note that workstation 6 takes care of 2 roles, each of which should be executed in a different workspace. It is helpful to rename the workspaces on the CDE to indicate the roles with which they are associated.

Step 2: In each of the workspaces to be used for the simulation, set up a terminal window and change to the appropriate directory, viz:

~~~sun/dtkeden/railway~~ ~wmb/public/projects/Simulation/railway-Sun

Step 3: Confirm (and if necessary ensure) that $PUBLIC and $PATH variables are appropriately set, so that PUBLIC is **~wmb/public** and PATH includes **~wmb/public/bin**. Also good to ensure that the screen variables are set via CDE to switch off the automatic locking and the screensaver options.
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Step 4: Set up a dtkeden client-server network in which Workstation 6 designated *WS6* is the server, and the other workstations are clients. Each team has a different network, and operates on a different channel number, designated *ChNum* below. To this end, this set-up sequence should be followed exactly:

a). in the God workspace, set up the server by executing the command
dtkeden -s -c *ChNum*
and (using the options in the tkeden input window) include / accept the file God.

After step a) is completed, carry out b), c) and d), in parallel if desired:

b). in the Killick1 workspace, set up a client with login name Killick1 via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file Killick1.
c). in the Killick2 workspace, set up a client with login name Killick2 via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file Killick2.
d). in the Brown workspace, set up a client with login name Brown via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file Brown.

After steps b), c) and d) are completed, carry out e), f) and g), in parallel if desired:

e). in the driverT1 workspace, set up a client with login name driverT1 via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file driverT1.
f). in the driverT2 workspace, set up a client with login name driverT2 via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file driverT2.
g). in the driverT3 workspace, set up a client with login name driverT3 via
dtkeden -a -c *ChNum* -h *WS6*
and (using the options in the tkeden input window) include / accept the file driverT3.

It is a good idea to use the full screen toggle at the top right corner of the screen to maximise the displays.

The role of the Team Coordinator during the simulation

During Phases 1 and 2 of the simulation the Team Coordinator combines supervision of pupil activity with operation of Workstation 6.

Phase 1 - normal operation

In Phase 1, the God workspace is used to monitor the corporate interaction of agents. Note in particular that a train driver is unable to see any train other than their own, and trains inside the tunnel are invisible to the signal/telegraph operators. Should a crash occur, the simulation will stop, and the whole simulation must be reset by invoking **init_game();** in the tkeden input window of the God workspace. The reliability of the treadle is initially set to 1 (i.e. entirely reliable), but can be reassigned if appropriate to have a probability of failure, e.g. by specifying **treadle_reliability = 0.8;**

It is instructive to display the Brown workspace at some crucial points in Phase 1, e.g. to illustrate how the actions of the telegraph operator Killick1 are communicated to Brown, and to reveal the automated protocol executed by Brown.

Phase 2 - the Accident Scenario

In preparing to enter Phase 2, the following set up commands should be input via the tkeden input window in the God workspace: **treadle_reliability = 0.0; init_game();**

Killick2 should set the signal to ALL CLEAR prior to the first train T1 setting off. The scenario that results in the accident is as follows:

1. Train T1 travels past the signal without resetting the signal. (The alarm sounds.)

2. Killick1 and Killick2 now **prepare** to perform the following duties in sequence:

   reset the alarm
   telegraph OCCUPIED to Brown (to be done as train T1 enters the tunnel)
   reset the signal (not be done until the **next** train - Train T2 - has passed the signal)
   Note that the signal reset was physically a slow process involving winding a cable.

3. The scheduling of train T2 should be such that
   it follows Train T1 at an initial distance of about a tunnel length behind
   BUT travels rather faster than T1
   it reaches the signal before Killick2 has had time to reset it

4. Train T1 travels rather slowly through the tunnel, so that it still has some distance to travel in the tunnel at the point when T2 enters the tunnel.

5. When Killick2 has reset the signal (after T2 has passed it), he waves the RED flag at T2 just as it enters the tunnel. At this same point in time, Killick1 telegraphs (a second) OCCUPIED to Brown.

6. Train T2 brakes hard on entering the tunnel (driver has seen the flag). When it has come to a stop in the tunnel, it reverses very slowly towards the tunnel entrance.

7. Train T3 sets out at about the same time that T2 enters the tunnel.

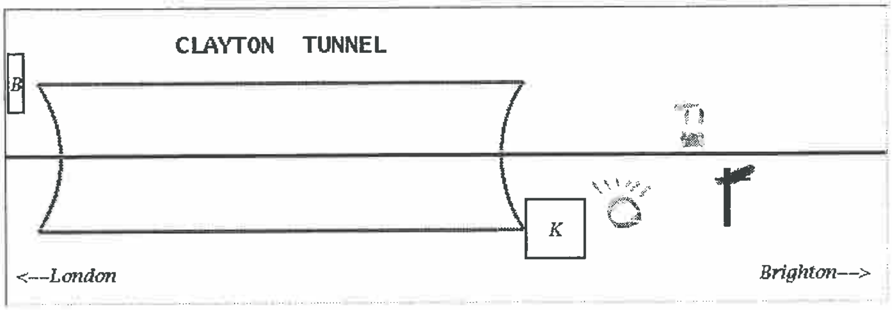
8. Killick1 telegraphs an IS CLEAR? to Brown. This action must occur prior to the emergence of the train T1 from the tunnel.

9. Train T3 is now approaching the tunnel entrance on caution, awaiting a WHITE flag from Killick before entering.

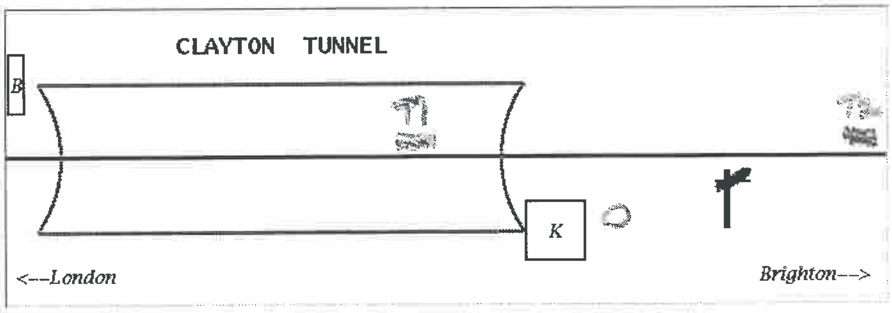
10. Killick1 receives a CLEAR signal from Brown as train T1 emerges from the tunnel.

11. Killick2 waves the WHITE flag to clear train T3 to enter the tunnel.

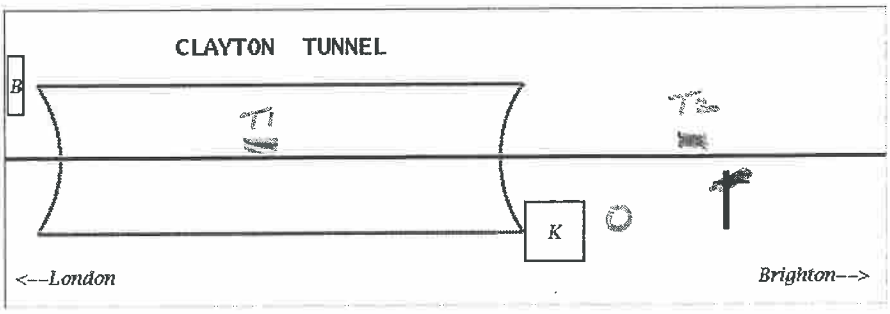
[Useful to use introduce the names, context and fates of the principal agents in the accident scenario at the outset. Killick working 24 hours, nightmares for the rest of his life. Anonymous driver of Train T1 escapes without being aware of his role in the accident. Scott, driver of Train T2, serious back injuries. Gregory, driver of Train T3, killed in the accident, along with the guard on Train T2 and 23 passengers.]



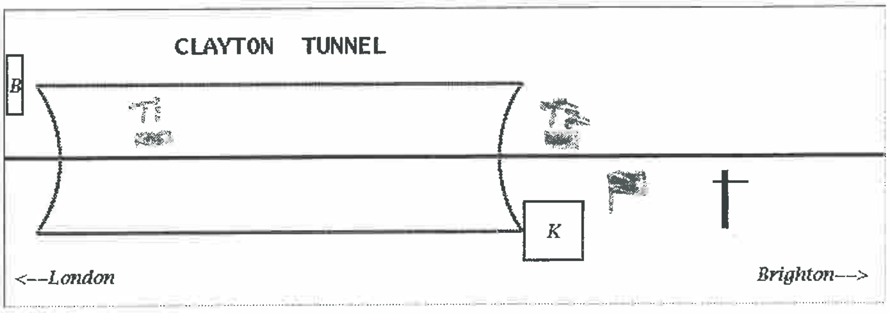
See 1 & 2



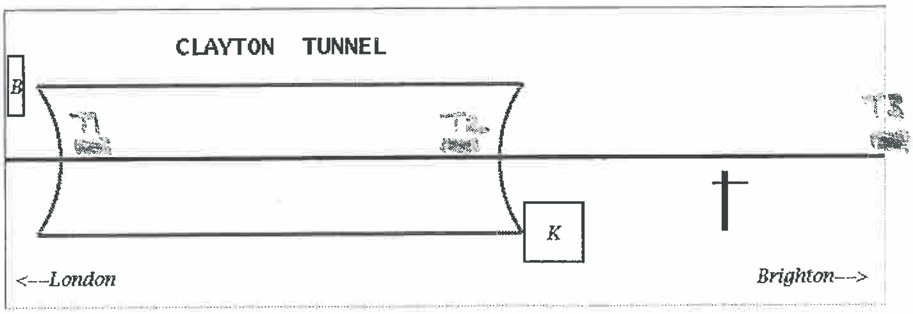
See 3



See 3



See 5



See 4, 7 & 8

Train Drivers:

Controls:

Button to introduce and start a train (START) and reset a train (RESET).

Button for choosing forward (FW) or reverse (RV).

Sliders for ACCELERATION and BRAKE.

Speedometer to observe the speed.

Actions:

If the signal is at CAUTION, proceed slowly and wait for a WHITE flag at the signal box before entering the tunnel.

If the signal is ALL CLEAR, proceed normally.

If you see a RED flag at the signal box apply full brakes.

Under normal procedure run the train at the recommended speed for this section of track (40 mph).