



Thousands of people lined the banks of the River Tyne on Monday 20th November 2000 to see one of the world's largest cranes lifting the world's first tilting bridge into position. The £22m bridge was designed to be the centrepiece of a joint application by Newcastle and Gateshead Councils in a bid to become the holders of the prestigious title 'European Capital of Culture' in 2008. The bridge also received lottery funding from the Millennium Commission.

The design needed to be special, so Gateshead Council chose the unique tilting bridge now installed in the Newcastle skyline. Fairfield Control Systems were awarded the contract to design a control system capable of operating the bridge within very strict design parameters.

The 850 tonne bridge has a total span of 126 metres and turns on a pivot on each side of the river supported by two concrete piers incorporating 19,000 tonnes of concrete with 650 tonnes of steel reinforcement. Each pier hides the three hydraulic rams, five pumps and a control panel required to operate the bridge.



The curved bridge deck incorporates an inner pedestrian and an outer cycle lane separated by a stainless steel fence with built-in benches that also act as a windbreak for walkers. Access to the two lanes is through gates installed at each end of the bridge.

The operation of the bridge utilises an Allen Bradley ControlLogix PLC in the north pier control panel that communicates with a similar control panel in the south pier through a dual redundant ControlNet network. An operator desk on the south pier is also connected to the same network and incorporates Allen Bradley Flex I/O modules and a PanelView 1000 HMI.

The north and south piers each house five 55 kilowatt pumps, four of which provide the hydraulic power required to lift the bridge. The fifth pump is held in a standby state, allowing any pump to be removed from service for maintenance purposes. The role of the standby pump is regularly rotated between all five pumps to ensure that the standby pump is always available for use.

Each set of pumps provides a design pressure of 220 bar to the three hydraulic rams through fixed creep and proportional flow valves. The gates are closed and the bridge is raised by increasing the proportional flow using an 'S' profile to a flow demand of 500 litres per minute. The flow to both sets of rams is modified to ensure that the difference between north and south ram extensions does not exceed 16mm.



The Control Desk

The critical nature of the algorithm required to achieve this result had been highlighted at an early stage in the project. No historical data from any other bridge control system was relevant since the Gateshead Millennium Bridge was to be the first of its type. The algorithm was the result of numerous computer simulations, followed by the assembly and total system test of the control panels, pump skids and rams. Site trials subsequently proved that the algorithm actually limited the difference in ram extensions to 2mm.

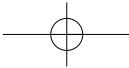
The load presented to the rams is at its maximum at the start of the lifting cycle and gradually reduces to a minimum when the bridge is fully raised. This is achieved by introducing back pressure into the control system sufficient to restrain the bridge but not to allow it to stall. The algorithm required for this task limits the full bore pressure to 50 bar whilst also responding to the dynamic wind loadings experienced by the bridge during the raise cycle.



The Raised Bridge



The Inner Pedestrian Walkway



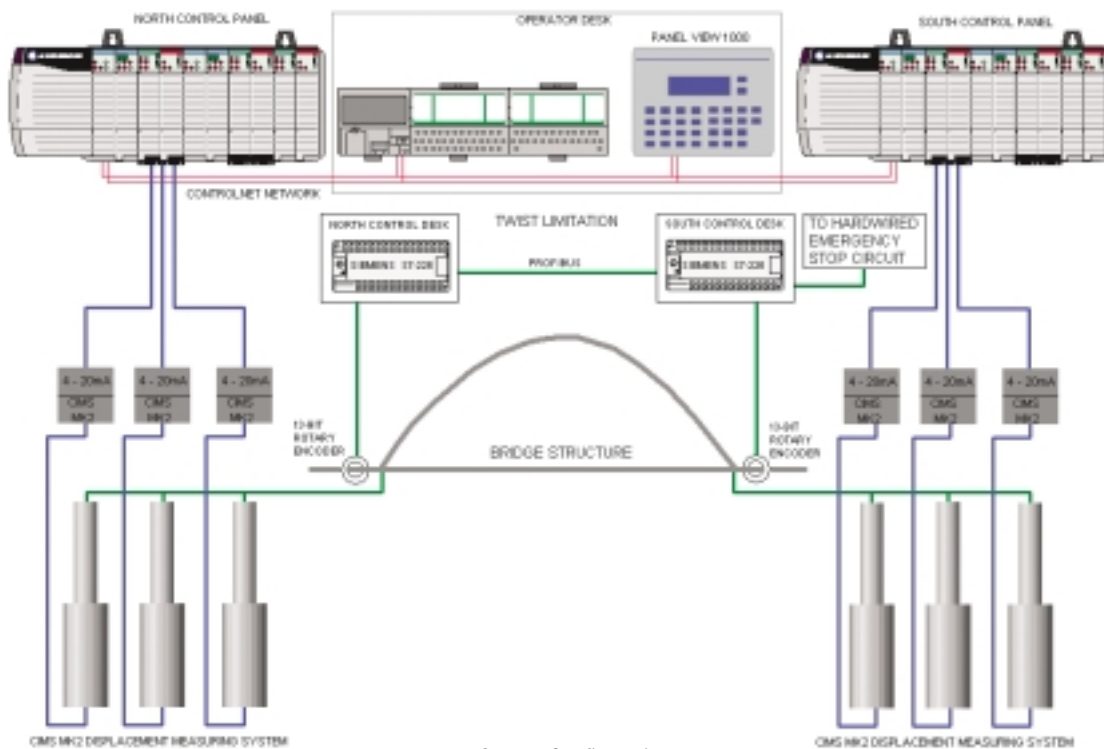
The requirement to prevent the bridge from over-balancing in adverse wind conditions was also identified at an early stage in the project. In contrast to the flow algorithm it was only possible to prove the back pressure algorithm on site since this was the only stage at which the bridge was connected to the control system. Site trials again proved successful by achieving a minimum ram full bore pressure of 50 bar.

The bridge is lowered using the flow algorithm and a similar 'S' profile to a flow demand of 420 litres per minute. The rams act as dampeners during the lower cycle to bring the bridge to a controlled stop onto its bearings. The gates are opened and the bridge is re-opened to the public.

The physical demands of the bridge operation require that a twist of no more than 0.23° is allowed between the north and south sides of the bridge, despite the fact that the north and south have independent lifting systems separated by the River Tyne.

A 13-bit rotary encoder monitored by a Siemens S7-226 PLC measures the angle of rotation on each side of the bridge. The two PLC's are connected in a Master/Slave configuration on a Profibus network with the Master PLC monitoring the difference in rotation between north and south banks. An emergency stop condition is generated if the twist exceeds 0.23° .

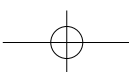
The innovative design of the Gateshead Millennium Bridge has generated much interest and on 24th May 2001 the BBC arrived to film a segment of its popular science programme - Tomorrow's World. This episode was broadcast on May 30th 2001 in 24 countries worldwide and provided an excellent showcase for the engineering expertise of Fairfield Control Systems.



System Configuration

System Specification

PLC	Allen-Bradley ControlLogix PLC Siemens S7-226
I/O Count:	600 Points
Communications:	Dual Redundant ControlNet
Networks:	Profibus CIMS MK2
HMI:	PanelView 1000



Business Activities Include:

- SPECIFICATION
- CONSULTANCY
- HARDWARE DESIGN & BUILD
- SOFTWARE DESIGN
- INSTALLATION
- COMMISSIONING
- TRAINING

● SERVICE SUPPORT

Service support is your insurance against prolonged plant outages, which could cost you vast sums of money. Because we understand control systems and work with them daily we have been able to build up a vast expertise, which enable us to quickly diagnose and fix faults, sometimes without even attending the site. Our service Support Contracts are flexible and designed to meet our client's particular requirements up to and including immediate callout responses available twenty four hours a day, seven days a week.

NOTES**Fairfield Control Systems**

The Old Rectory
Main Street
Kirton
Newark
Nottinghamshire
NG22 9LP

Tel: +44(0) 1623 835350

Fax: +44(0) 1623 835375

Email: sales@fairfields.co.uk

www.fairfields.co.uk