The superb view towards Fife from the top of the south tower.

BRIDGING THE YEARS

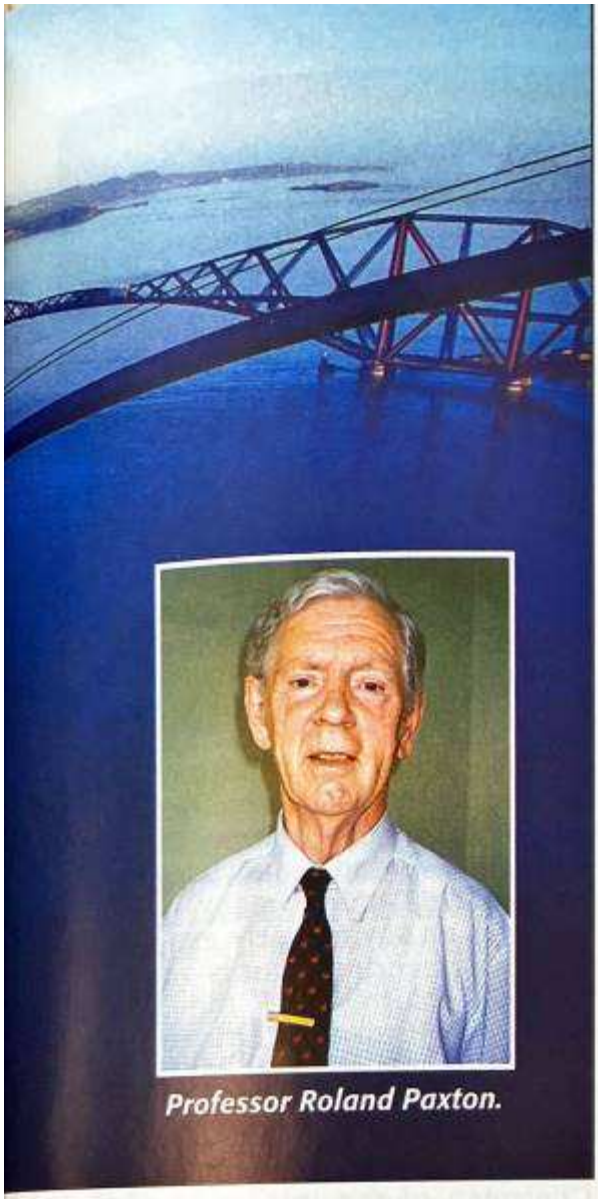
Bill Fyfe Hendrie

MIST shrouded the slender 512-ft-high towers of the new Forth Road Bridge on the morning of Friday 4th September 1964, as H.M. Queen Elizabeth and the Duke of Edinburgh arrived to perform the opening ceremony. Vast crowds, including thousands of pupils given a day off school to mark the occasion, had waited since dawn for this moment.

Happily, just as Her Majesty unveiled the commemorative plaque at the Bridge Control Headquarters on the Lothian side of the river, the sun broke through. It glinted off the royal limousine as it made the first official crossing of the £19.5 million bridge, for whose completion Scotland had waited decades.

I know because I was there. Now, to mark the 40th anniversary of "The Highway In The Sky", I was returning to meet the chairman of the Forth Bridges Visitor Centre Trust, and Scotland's leading expert on the history of civil engineering, Professor Roland Paxton, MBE, of Heriot Watt University's School Of The Built Environment.

Co-author and editor of *100 Years Of The Forth Bridge*, Professor Paxton, although born in England, is descended from a well-known Borders family and spent his career as a civil engineer in Scotland. As Senior Principal Engineer for Lothian Region, his responsibilities



Professor Roland Paxton.

included planning and traffic management of the Edinburgh City By-Pass. After retiring from that post in 1990 he was invited to join the staff of Heriot Watt University where he developed his interest in the history of civil engineering, conservation and, in particular, that of early bridges.

I asked Professor Paxton about some of his previous projects before becoming Chairman of the Forth Bridges Centre and learned of how he led the four-year-long campaign which he initiated in 1992, to save Scotland's first railway viaduct in Ayrshire.

"The stone-built Laigh Milton Viaduct dates from 1811 and was first used to carry horse-drawn wagons mainly laden with coal, but some transporting passengers, over the River Irvine at Gatehead on the railway line from Kilmarnock to Troon," the Professor told me. "Later in 1816 its owner, the Duke of Portland, was the first to introduce steam locomotives on a public railway in Scotland, including his famous engine called 'The Duke', which travelled at 10 mph.

"Unfortunately, its weight and the action of its wheels broke the rails and it was sold to the Earl of Elgin in 1824 for use at his extensive lime quarries and coal workings in Fife. Until then the Ayrshire steam train journey was very much the wonder of the age. It became a popular day outing to the seaside for many of the townsfolk of Kilmarnock, with the crossing of the viaduct very much one of the highlights."

Professor Paxton then went on to tell me how he initiated a charitable trust to raise funds to save this Ayrshire landmark, which was bought for £1 from the farmers who owned the fields on each bank of the Irvine. In the end, the work to preserve it and ensure its future cost a total of £1.1 m. and the Professor explained how during this project he helped develop an innovative radar scanning site investigation technique.

"The radar scanning later had an interesting spin-off, in a joint Heriot Watt University, Radar World Plc. exercise.

"We were able to use it to prove that the old tale about a horse-drawn cart tumbling down the inside of one of the thick concrete-walled piers of the Loch-nan-Uamh Viaduct on the Fort William to Mallaig line in the late 19th century, was definitely true. Our device produced clear images of the skeleton of the poor beast still harnessed to the cart, exactly where it had become trapped.

"This same technique may also in the near future be adapted to provide a low-cost method of checking for corrosion in the suspension cables of the Forth Road Bridge."

Other historic bridges in whose preservation the Professor has been involved included the proposed, but so far never implemented, Brig-O-Dee widening scheme in Aberdeen, the Dean Bridge over the Water of

Leith in Edinburgh and the Forth Rail Bridge.

"The Dean Bridge was particularly interesting because, although built solidly of stone, the use of a strong hollow box form of construction by the engineer Thomas Telford helped to minimise its weight."

Professor Paxton is particularly proud of the work he did to re-open the 570-yard-long tunnel on the disused Edinburgh to Dalkeith railway line, under Holyrood Park, as part of a now-popular cycle path.

"The line was constructed originally to bring coal from collieries in Midlothian right into the heart of Edinburgh, and the conservation project also included saving the oldest iron railway bridge in Scotland," he told me. "Power on this early horse traction railway line, which at the height of its use carried more passengers per mile than the famous Liverpool and Manchester railway, was originally provided by a stationary steam engine. A five-inch-thick rope was used to pull the wagons up the final one-in-30 incline and through the tunnel into St Leonard's goods yard in the shadow of Arthur's Seat.

"There is a similar railway tunnel deep below Dundee Law and although part of the roof has caved in, it could still be saved."

Meanwhile, Professor Paxton has been asked to advise on another Dundee restoration project, as the city's Civic Trust is trying to save Scotland's oldest iron bridge at Linlathen on the eastern outskirts, not far from Claypotts Castle.

"East Linlathen Bridge was constructed around 1804 by estate owner Thomas Erskine to carry the driveway over the Dichty Water to his mansion," commented the Professor. "It therefore predates the iron bridge which I helped save on the Dalkeith railway line and is clearly worthy of restoration."

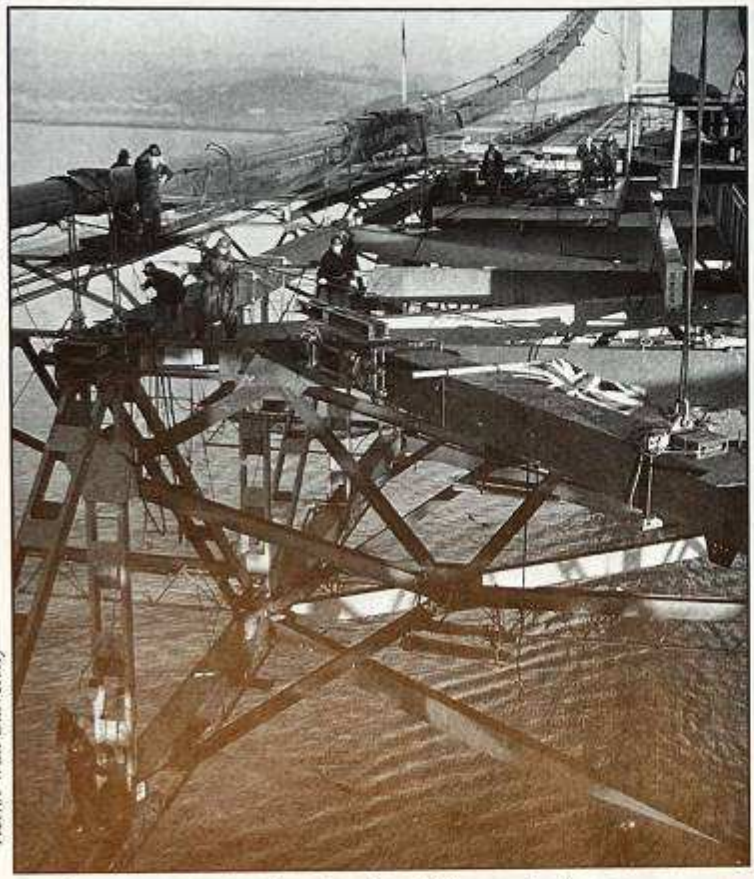
Professor Paxton explained that at the beginning of the 19th century, when the Linlathen bridge was constructed, as a result of advances made during the Industrial Revolution, iron was cheaper than wood and far less heavy than stone, the weight of which often caused problems with foundations.

"As a modern-minded, progressive landowner, Erskine chose this versatile, newly-available material for the bridge. Neo-classical in style, the East Linlathen Bridge is also of great importance because of its innovative cross-trussing arch which is 36 feet wide on the inside. Thomas Telford used a more robust version of this concept at Bonar Bridge, but not until 1810, so the Dundee bridge is of particular significance."

Professor Paxton's interest in Scotland's civil engineering past stretches back to 1975, when he was first invited to join the Institution of Civil Engineers' Panel for Historic Engineering Works, whose chairman he became in 1990. Since then he has led a team of experts assessing, recording and advising the government and many funding agencies on saving early examples of civil engineering works and has become chairman of the London-based Historic Bridge and Infrastructure Awards Panel. He is also a Fellow of the Royal Society of Edinburgh, a Trustee of the James Clerk Maxwell Foundation and Chairman of the Institution of Civil Engineers' museum in the grounds of Heriot Watt University.

As well as many research papers, Professor Paxton is the author of several books. They include *Bright Lights*, in which he tells the story of the famous Stevenson family of engineers from 1752 to 1971 and all about the lighthouses, which they built not only around the coasts of Scotland for the Commissioners of Northern Lights, but also on foreign shores, as far away as Japan. His other volume, *100 Years Of The Forth Bridge*, was published in 1990 to mark the centenary of its official opening in March 1890 by Edward, Prince of Wales.

"His Royal Highness travelled out to the middle of the mighty cantilever bridge by train. There he descended to the track to ceremonially drive home the last of the 6,500,000 rivets. It was claimed to be made of gold,



Heriot Watt University

Engineers carry out the closing of the central gap, joining the north and south sections of the bridge.

but by then expenditure on the bridge was in danger of going over budget, so one made of brass was substituted and the prince was never any the wiser," Professor Paxton chuckled.

Now money is again on the professor's mind as he prepares an application to the National Lottery Heritage Board for funds to update the exhibits in the Forth Bridges Visitor Centre to commemorate the 40th anniversary of the Road Bridge.

Inviting me to look round the display, the professor showed me the centrepiece, which is an impressive large-scale model of the Forth estuary at the point where it is spanned by the two bridges, of which the centre also offers panoramic views.

"Nowhere else in the world is it possible to admire two such bridges in such proximity, each a classic example of the civil engineering prowess of the age in which it was designed and built," commented the Professor.

"The idea of crossing the Forth where it narrows at Queensferry was probably first considered by the Romans. They may well have thought of using boats lashed together to form a floating pontoon crossing at this point."

The professor then went on to tell me that a regular ferry service was established by the 12th century and that its boatmen landed their passengers at the Binks Rocks on the shore beside St Mary's Church in South Queensferry. The Queensferry Passage became the busiest ferry in Scotland, but there were many complaints about its operation, from the unavailability of boats to the drunken ferrymen.

"As early as 1805 there were proposals for an alternative means of crossing the Forth by digging a tunnel from Queensferry to Rosyth," continued the Professor. "The scheme received serious consideration for two years, but in 1807 it was abandoned, probably more for financial reasons than doubts about its practicability.

"Later, in 1818, a chain suspension bridge was proposed. Detailed plans drawn up by Edinburgh engineer, James Anderson showed that its 2000-ft-long main spans were to have been constructed of wrought iron. American oak was to have been used for the 25-ft-wide carriageway which was to have been surfaced with a mixture of gravel, sand and chalk bound together with pitch and tar. There were also to have been two similarly-surfaced footpaths on either side of the roadway. Anderson's design was too ambitious and was put forward at a time when the country was still impoverished after the Napoleonic Wars so nothing came of it."

The right course at the time was to

improve the existing ferry service. An Act of Parliament passed in 1809 for the first time appointed trustees to manage the crossing and from then on this vital transport link was run in a more businesslike fashion.

The new trustees appointed one of Professor Paxton's distinguished predecessors, civil engineer John Rennie, to build ramped piers on both sides of the river so that ferries could land their passengers at all states of the tide.

> *In 1964 the Forth Road Bridge was the largest suspension bridge in Europe.*

As well as those at the Hawes at Queensferry and at Town Pier at North Queensferry, a third was constructed on the south side of the Forth at Longcraig. Known as the Catch Pier, this was a safety measure in case the sailing boats used in those days were swept downriver by the currents and the tide.

Professor Paxton then described how the ferry became even safer and more reliable with the introduction of a steam ferry in 1821. It was appropriately named *Queen Margaret* after the monarch credited with first establishing the crossing in 1069 while journeying to the Scottish royal court at Dunfermline.

Equally appropriately it was another vessel called *St Margaret*, one of the electric paddle ferries which maintained the service for 30 years from their introduction in 1934. This vessel was given the honour of completing the final crossing when it transported the Queen and Duke of Edinburgh after they had officially opened the new Forth Road Bridge.

"In 1964 the Forth Road Bridge was the largest suspension bridge in Europe," Professor Paxton proudly informed me as we looked out at it through the windows of the Visitor Centre. "Together with its approach viaducts the bridge is over a mile and a half long and its central span between its two tall main towers is 3300 feet in length," he continued. "An important landmark in its construction was closing the gap in the steel framework carrying the roadway at mid-span on the morning of 20th December 1963."

Around the brightly-lit centre other exhibits provide further details of both bridges, including their respective heights above river level. The twin tracks of the rail bridge are 158 feet above high water mark, while the carriageways of the Road Bridge give a clearance of 150 feet at the towers rising to 161 feet in midstream. Equally impressive is the display of a full-scale model of a two-foot diameter suspension support cable, with its 11,618 high-tensile steel wires.

"Since the bridge opened the permitted weight of commercial vehicles using roads in Britain has been increased from 24 to 44 tonnes," the Professor informed me. "In order to cope with these much heavier loads as well as the increase in the number of vehicles using it, parts of the structure have been strengthened and I can assure you that the bridge has many years of life left in it."

Professor Paxton's work has been recognised in many ways: from the Association for Preservation Technology International, naming him College of Fellows Lecturer for the year 2000, to the award of the Institution of Civil Engineers' Robert Alfred Carr Prize. He was until recently a member of the Royal Commission on the Ancient and Historic Monuments of Scotland.

He has also recently travelled to Tennessee to receive the American Society of Engineers' prestigious Civil Engineering History and Heritage Award which, according to the citation, is presented to "Those persons who, through writing, research or other efforts, have made outstanding contributions to a better knowledge of, or appreciation for, the history and heritage of civil engineering."

This is indeed a fitting tribute to a man who has done so much to bridge the years.