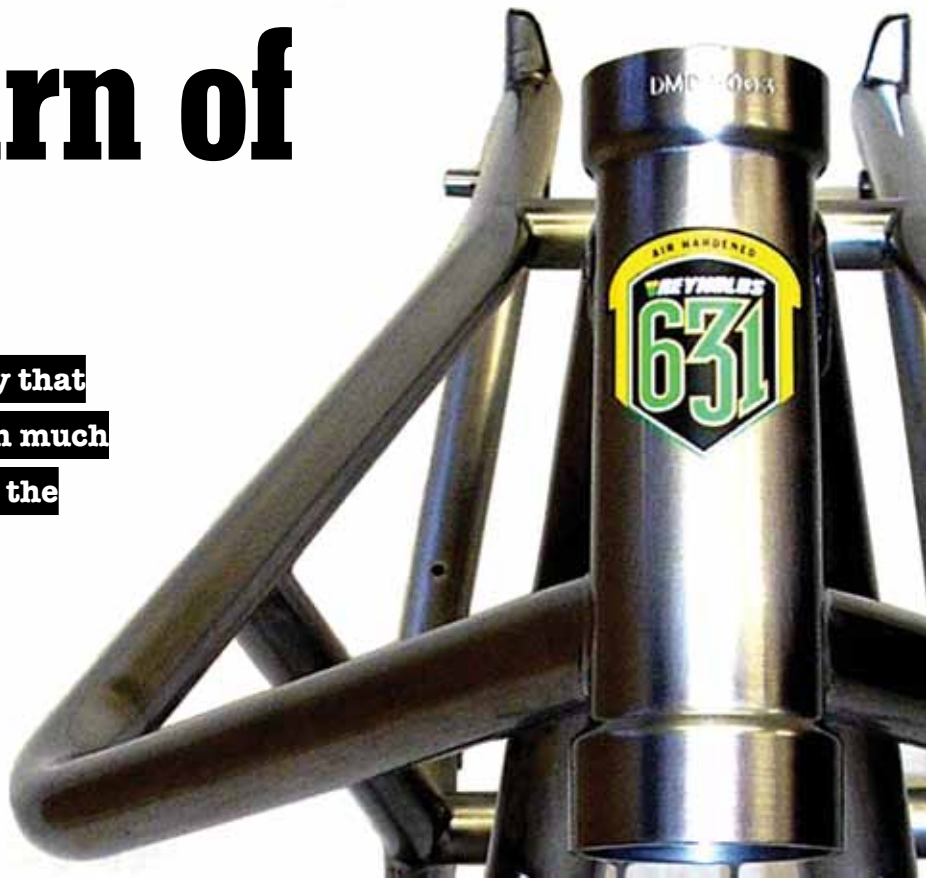
The Return of Reynolds



Reynolds Technology has a history that stretches back over a century with much of it in the motorcycle industry as the supplier of steel tubing for frame manufacturers. Having left the industry a while ago, it is now planning a return with some high-grade material that fits with its image as a high-performance engineering company as PETER JONES reports.

For something as apparently mundane as steel tubing, Reynolds Technology has a somewhat celebrity status in motorcycle racing history. Bronze welded Reynolds 531 frames were the de facto choice for many top racers up until as recently as the 1970s.

Introduced as a manganese alloy tube in 1935, Reynolds 531 tubing was the stock in trade for motorcycle frame builders including, of course, the famous 'feather-bed' frames of Norton. Reynolds was well known in its own right for manufacturing motorcycle frames, with perhaps its most famous frame builder, Ken Sprayson, being responsible for making frames for many top racers, including one for Mike Hailwood to help cure the handling of the infamous Honda RC181.

Reynolds' backing for its frame building went as far as offering an annual frame repair service at the Isle of Man TT for many years.

Along with many other British companies, Reynolds suffered badly in the 1980s and through into the 1990s from the general decline in the British manufacturing base until it was subject to a management buyout. That same management team, led by the ever enthusiastic Keith Noronha, is still the basis of the company today, with its manufacturing roots remaining in Birmingham.

In the last 10 years Reynolds has invested significant time, money and effort in developing its material technology for the tubes it manufactures today. This approach has certainly paid dividends in its increasing share of the cycle frame market, and its 'air hardening' steels have played a vital role in improving cycle frame fatigue life in line with toughening EC legislation.

The modern evolution of the Reynolds 531tube is the 631 alloy, along with its heat-treated relative 853. The 631/853 alloys have been developed to suit modern manufacturing methods and can be TIG welded without the problems traditionally associated with the previous 531 alloy – although they can both still be bronze welded without a problem.

The cold drawn, seamless, air hardening steels gain their

strength at a welded joint without requiring water quenching to obtain a stronger but ductile bainitic phase of material. This quality is vital in producing a high-strength material structure right through the base material, heat affected zone and the weld itself. The inherent strength at the weld joint enables the use of thinner wall tubing reducing the risk of stress in the material exceeding the material's UTS or Yield strength at the areas of highest stress.

Graph 1 below clearly shows the typical relative strength of 631 in the weld area, compared to the Reynolds 525 Chromoly tube joined by the same technique. Whilst the yield strength through the 631 weld joint remains above 800 MPa the yield strength in the equivalent Chromoly joint is reduced to 550 MPa. The advantages of such a strong joint for a frame builder are clear.

In addition to the advantage of the air hardening properties, Reynolds also offer 'butted' variants for its 631 and 853 tubing. This process, invented by Reynolds in 1898, no less, uses a die and mandrel to manufacture tubes with a constant OD coupled with a variable ID. This enables the designer to have the material where it is more needed – at the butted joints – whilst the centre of the tube can have a thinner wall thickness. If does, of course, offer another possibility to the frame designer – flex without failure.

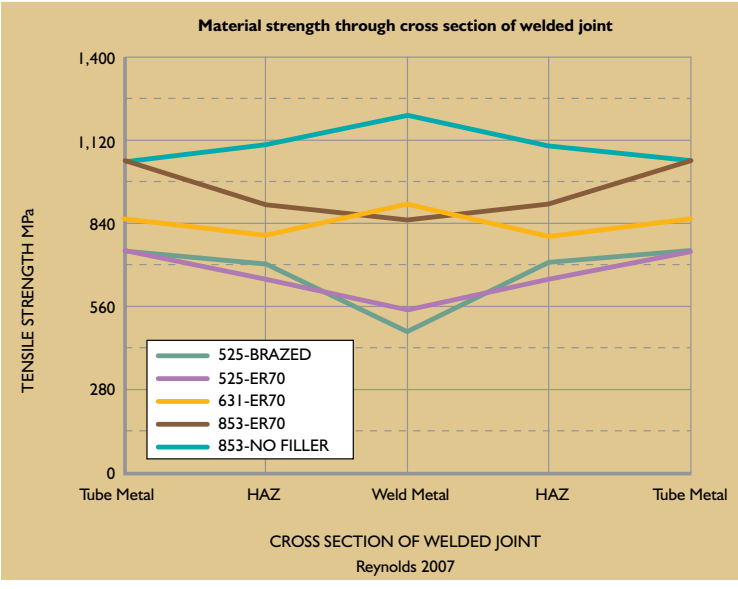
Sizing up the motorbike market

Having firmly re-established itself as a supplier of premium grade tube to the cycle industry, Reynolds has now embarked on developing new markets for its tubing. In the case of motorcycle frames, it is seeking to re-establish itself. Other industries currently developing lightweight structures and components with Reynolds are from industries as diverse as speed skates, lightweight car chassis and suspension components and sports wheelchairs.

The embarkation by Reynolds into new markets has neatly coincided with a resurgence of chassis building for racing motorcycles, initiated by the creation of the new Moto2 class for the World Championship and national series. Classes such as ThundersportGB, supermono and classic motorcycle racing also offer good opportunities for tubular frame builders, predominantly where the racing is not limited to production based race bikes.

It was with these markets in mind that Reynolds approached a number of development partners in early 2009 who were making tubular motorcycle frames. The aim was to obtain feedback on the suitability of the proposed thin wall tubing direct from frame builders, and also to establish the range of tube diameters required to support the market. The three development partners who responded enthusiastically were Davies Motorsport, Tigcraft and Bottpower.

Davies Motorsport builds and races classic Honda twins in the British Classic Racing Motorcycle Club (CRMC) championship. Whilst the tubular TAB and Drixton replica frames it used were already reasonably light, the opportunity to remove a small but significant proportion of the bike's weight was enough to interest the company. Additionally it was looking to move from the traditional route of bronze welded frames to TIG welding in order to improve joint durability and also lose weight from the frame. This fitted perfectly with the 631's air hardening properties already outlined and thus the world's first Reynolds 631 motorcycle frame was born.



So pleased were Reynolds with the results that showed its frame weighing in at 6.9kg, a full 1.5kg lighter than the previous one, that it was taken to the 2009 Manx GP for public display. Everyone who picked it up 'overlifted' it and was very surprised by the weight, or lack of it.

The Drixton 631 frame is currently in the process of being built into a complete Honda 500 twin and will compete in selected rounds of the 2010 CRMC Series. The 631 TAB frame was built in March and will also compete is selected CRMC rounds and some races in Continental Europe.

The Davies Motorsport project also provided the first opportunity to analyse a frame with Penso of Coventry, Reynold's CAE partner for lightweight structures. Having been provided with the frame as CAD data and a set of load cases having been agreed Penso went about meshing the model, applying the load cases and checking the stress levels in the new frame, whilst comparing its stiffness to the thicker walled variant it had replaced.

The results showed that 1) the predicted levels of stress were all well within 631's yield strength and 2) there was a corresponding 10% loss of frame stiffness by moving to a thin wall tube without any change to frame geometry, as had been expected. Penso then strategically added a small amount of tube to the frame in critical areas to demonstrate that the stiffness could be regained with only a small addition of weight to the frame. Unfortunately the rules within classic racing prohibit changes to frames, but it was an excellent opportunity to show what could be achieved using CAE for frame analysis should circumstances allow.

Tigcraft is Dave Pearce. A frame builder who in his time has manufactured in excess of 200 motorcycle racing frames, he has a wealth of experience in frame design and build. Hence Tigcraft presented a perfect opportunity to get some forthright feedback as to how the 631 tube 'worked' for a frame manufacturer.

Having overcome some initial scepticism of working in thinner wall tubing, using sample pieces in project frames, Reynolds provided Tigcraft with sufficient material for the manufacture of a number of frames. The first of these, a Moto2 type frame for a Triumph 675 engine running in the Thunderbike GB series, was completed just before Christmas 2009.

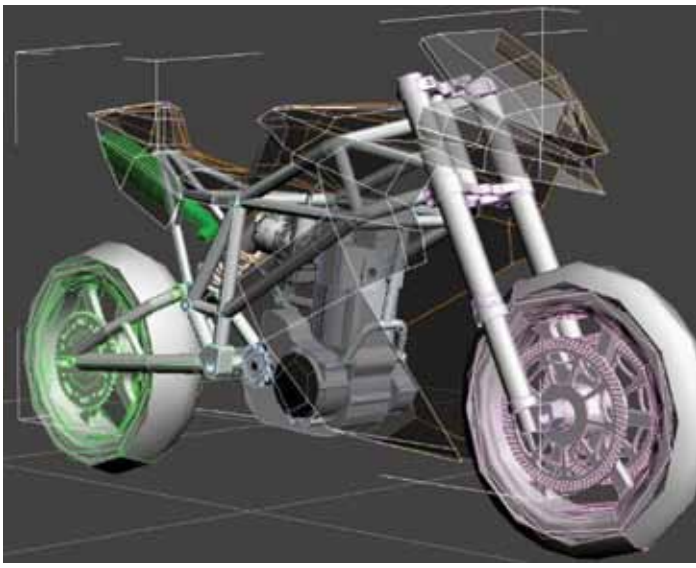
Dave was extremely pleased with the resulting frame and has since also built a 631 tubed frame for a Suzuki SV650, at a mere 7kg, and is currently embarking on a Moto2 frame which will carry a Honda CBR600RR engine and a 'Moto3' project using a Yamaha YZ250 motocross engine in a lightweight tubular chassis. All the bikes will be out competing on track this year and the feedback from riders will be invaluable to Reynolds in terms of developing the tubing range.

Bottpower is a partnership between David Sanchez and Jose Contreras in Spain. Having seen Bottpower's Moto2 project on its website, Reynolds contacted Sanchez to see if he would be interested in using 631 tubing for his project. As with Tigcraft, sufficient tube was supplied to enable Bottpower to build a number of frames, mainly with a view to developing the initial design to a lighter weight version as the project progressed.

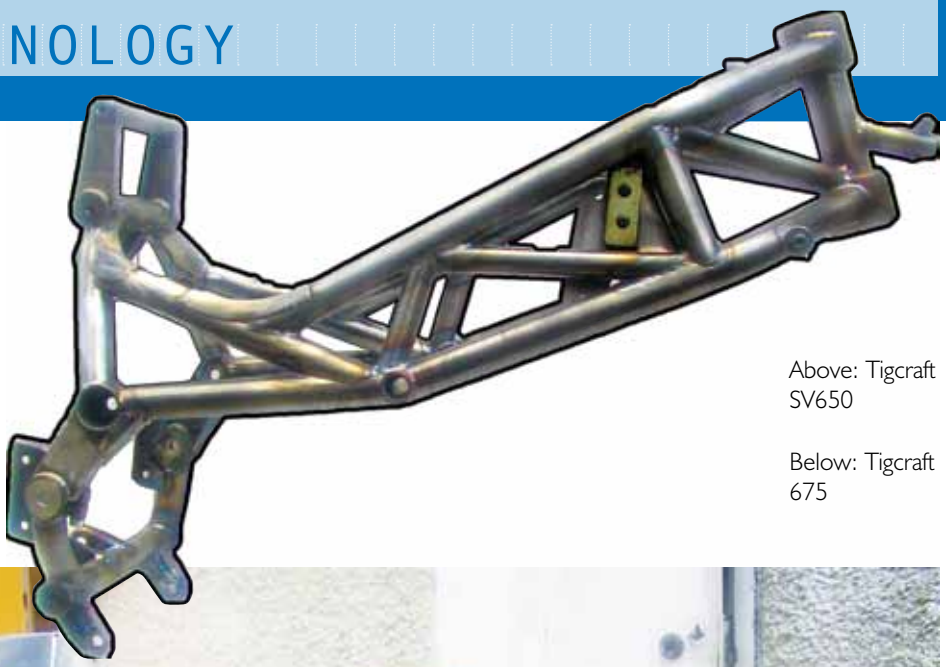
The Bottpower Moto2 project is extensively covered on its webpage with the first frame having been built. The bike is now a rolling chassis, rapidly progressing towards being a complete bike for this year's Spanish CEV Buckler series in which Moto2 bikes were first run last season and in which Sanchez was involved in the Championship winning Kawasaki Team with Kenny Noyles on board.

The contrast in the working methods between Tigcraft and Bottpower has been ideal for feedback. Tigcraft hand builds frames using a jig, hand butted joints and bent tubes for the main spars. Bottpower works in Solidworks CAD and has the tubes laser cut off CAD models, into short, straight tube lengths which are then welded together in a jig. The two different routes to the same result have provided excellent feedback and to date no problems have been reported.

The next steps are for Reynolds to help further develop the potential of the Tigcraft and Bottpower frames, to show what can be achieved in terms of frame weight reduction using advanced CAE techniques. This element takes its lead from



Coventry University Supermono (top) concept and (above) the bike being tested at Mallory Park



Above: Tigcraft SV650

Below: Tigcraft 675

work Reynolds has already successfully completed in the cycle industry and with Westfield Cars as part of the lightweight structures programme.

The Bottpower frame will be developed using in-house CAE whilst the technical limits of the Tigraft frame will be explored as part of a Masters Degree by a student from Coventry University. In the case of the latter, the current Tigcraft frame will be digitised and modelled in CAD in order that the base geometry can be retained whilst the frame structure is optimised using advanced analysis techniques. The result from the exercise will be used to develop a revised frame using thin wall 631 & 853 tubing, with the potential use of butted tubes to remove frame weight further without compromising the frame stiffness.

Ultimately Reynolds expect to see experienced frame builders using its 953 maraging stainless steel to develop the worlds' lightest and strongest metallic frames in the coming year. The 953 alloy has been used for superlight cycle frames and Olympic level ice speed skates but the manufacturing challenges of this alloy are not be taken lightly due to the incredibly high yield strength (> 1600 MPa) and wall thickness around 0.7mm.

As a result of the last year's development, the current range of tubing offered by Reynolds Technology for motorcycle applications all utilises a 1.2mm wall thickness (approx 18 gauge) and covers from 19.02mm (7/8") up to 31.75mm (1 1/2") in 1/4" increments in the same wall thickness. Other diameters are under consideration to meet the needs of particular frame building markets.

Davies Motorsport Drixton Frame – the world's first 631 motorcycle frame