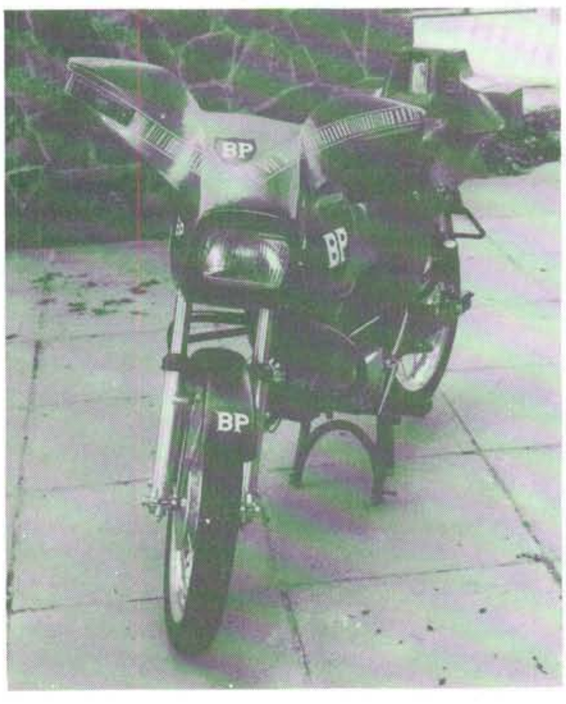
John Hill
King Edward VII College

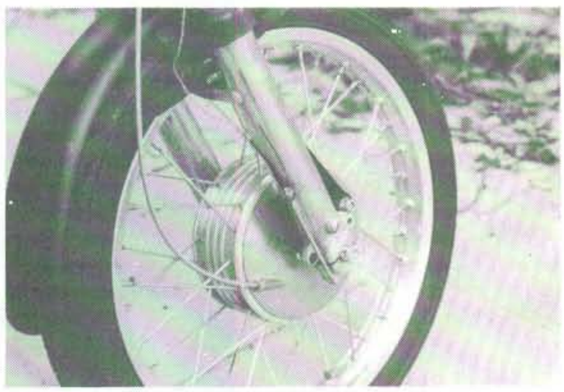
'Buildabike'

For the last seven years there have been ongoing and independent technical projects carried out within the Design Centre at King Edward VII College. Ongoing because they were largely open ended with no defined finishing point and independent of the laid down C.S.E./G.C.E. curriculum within the design department. Such projects have included schools karting, a large land yacht, a swing for the physically handicapped and in 1976 the B.P. Build a Car competition. Labour for these projects has come from any interested pupils who have been prepared to work at break-times, lunch-times, free periods and during School holidays.

The opportunity to enter the B.P. Build a Bike competition would be a new challenge. We would need to turn our talents to motorcycle building, thus leaving the safety of four wheels for the somewhat uncertainty of two. Hopefully we would have at the end a motorcycle which we could use for tuition in the Schools Traffic Education Programme (STEP) course which the College has been actively involved in during the past few years.

As a member of staff I felt that my role was to advise and to keep morale high while all the time insisting on the highest standards of construction and workmanship. I found myself, however, at times in the midst of swarf and soluble oil, scrambling around motorcycle breakers' yards, seeing what useful materials could be obtained from the College site and twisting suppliers' arms for that little extra discount. Although, like most educational establishments, cuts in capitation have not helped, our Principal has given us much financial assistance. Leicestershire County Council also directly contributed with help in the purchase of components. Without this help it would have been impossible to complete the project.





Left: General view of bike.

Right: Front Wheel

Design Development

One of the main problems facing any design team nowadays is that of being original. We are bombarded with all the latest ideas each being that little bit better than its predecessor. Motorcycles are no exception. All through history manufacturers have tried to build a perfect machine, perhaps all the possible design concepts have been explored? We at King Edward VII thought otherwise. Staff and students met and discussed, ideas were thrown out and endless sketches completed. Eventually we finalised our designs. We all agreed that the main criteria should be safety, rider comfort, appearance, ease of manufacture and cost.

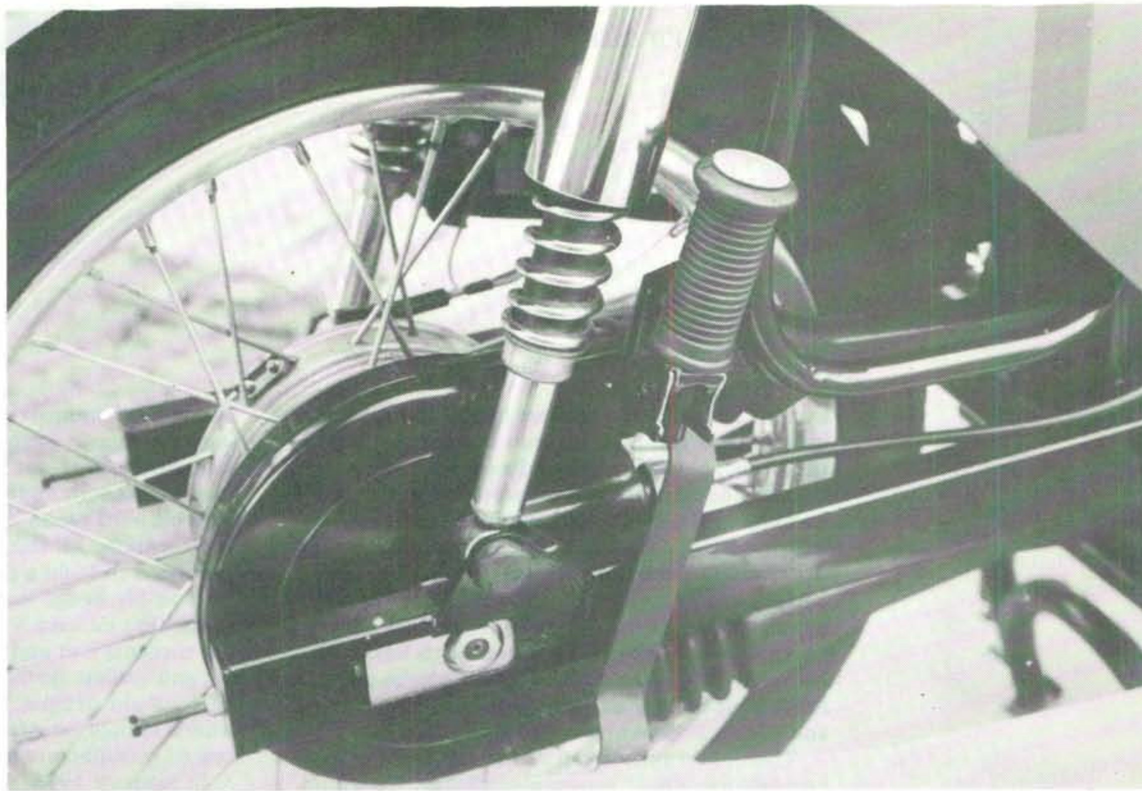
In January 1978, we started construction. It was felt that initially the best procedure would be to make a mock up motorcycle, test the various systems and then manufacture our entry. Fortunately our mock up proved so successful that we added a 50 c.c. Honda motor and saw it through to fruition.

Design development took place in four broad areas. The front wheel and suspension, the rear suspension and the frame layout, fairings and electrical features. Initially we thought that leading link suspension could be a good solution for the front wheel. Development was curtailed however due to economics and difficulty in finding a suitable damper/suspension unit that would fit in with our designs and which we could guarantee to work. For the mock up we used some commercial fork legs, in the 150 c.c. entry however we had some fork legs specially made to our requirements.

A similar story befell our design for the rear suspension. For our 50 c.c. motorcycle we used a mixture of motorcycle components and by making others ourselves we were able to incorporate a cantilever damper arrangement, although this gave the rear of the motorcycle a rather strange appearance with the suspension unit under the seat. In 50 c.c. form it provides good riding characteristics and we found it particularly easy to install. However calculations showed that in the 150 c.c. form this type of suspension would bring the centre of gravity rather high and thus affect the handling of the machine.

Considerable thought went into the design of the rear swinging arms. Instead of a thin pressing or tubular frames the swinging arms were manufactured

Rear wheel, enclosed chain, suspension and foot rest.



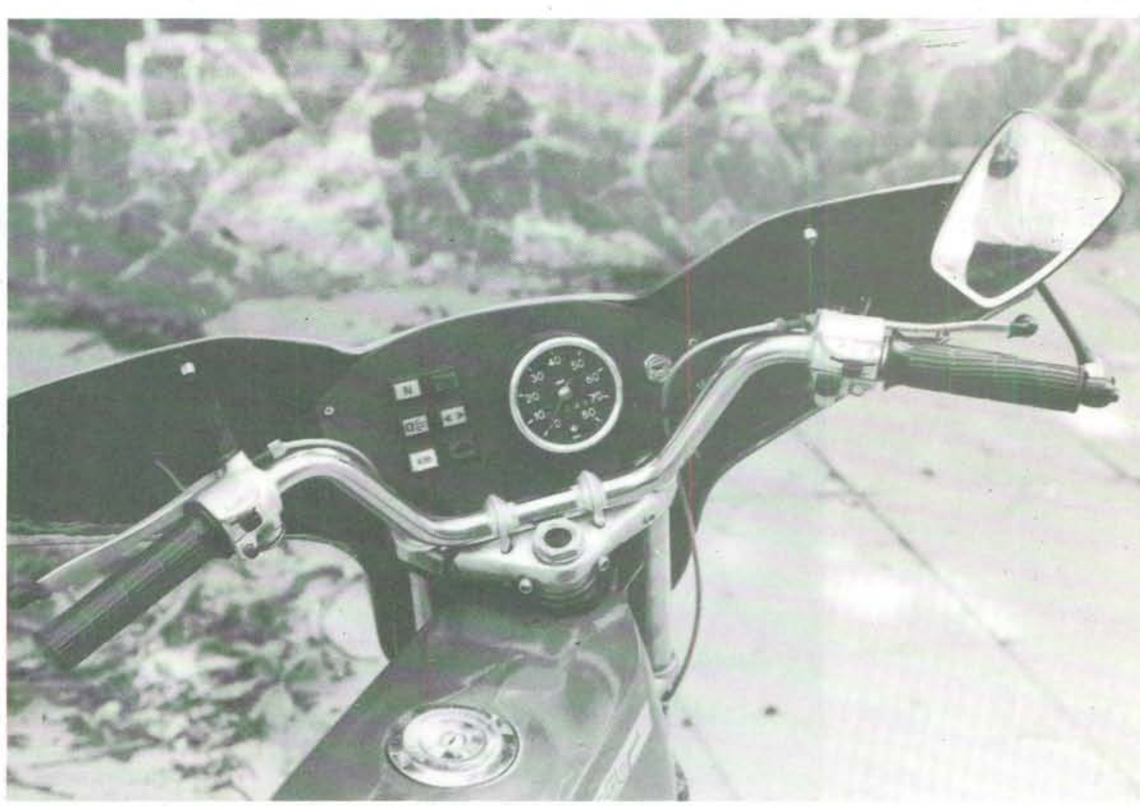
out of rectangular tube 50 x 25 with the wheel spindle running in two aluminium blocks each a slide fit in the rectangular tube. Adjustment of the rear wheel is more simple and the whole installation is considerably more rigid and has proved very reliable.

Electrical Circuitry

The electrical circuitry of most motorcycles can at best only be described as rather crude. The generating unit, driven directly by the crankshaft, charges the battery, and then from the battery power is drawn. Most units provide an output of around 60 watts. At night this is far too low and thus the motorcyclist suffers from a dimmed headlight after a few miles.

We researched this problem and found that while many generating units have a capability in excess of 150 watts few actually return this to the battery. In practise only about 74 watts are available to charge the battery, the other 75 watts are lost in the form of heat within the generating system. Knowing we would require to run off the battery we knew that we would have to improve the efficiency of the standard system. Eventually after much reading around the subject we came across an enthusiast with an electronic device that would ensure a much more efficient output. Our motorcycle was thus fitted with this piece of silicon chip technology. With the increased output we are able to run the various pieces of electronic gadgetry. On a summers day, a total of 75 watts is the maximum load on the electrical circuit. On a dark foggy winters night, however, a motorcyclist needs 75 watts plus a nice 60 watt headlight, a 20 watt rear fog lamp

Controls, inside front fairing, instruments.



General view of bike.

and light on the riders back, the total rises rapidly to a maximum of 155 watts. Even with this loading the battery is still charged with a 14 volt input. At the back all the lights are incorporated in the one piece top fairing. Our designs dictated that we used a rectangular head lamp and this is complimented either side by rectangular direction indicators fixed to the front fairing.

Black ice is a motorcyclists nightmare. To help him we have incorporated a low temperature detecting system which will illuminate a bulb if the external air temperature falls to a dangerous level.

Consideration was also given to the problem of motorcyclist's hands becoming numb with cold. We looked into the possibility of including electrically heated gloves, however we felt that if possible, it may be better to duct air heated by the engine towards the hands. In the end, time dictated that this facility would need to be accomplished by the front fairing.

Of particular note is the design of the anti-theft alarm. After research it was found that none of the commercially available alarms were really effective. Our parameter was simple, design a unit which would be activated if the motorcycle is ridden, tampered with, or wheeled away. After much discussion it was decided that the alarm would need to operate when the rear wheel was revolved, the centre stand raised or the seat sat upon. A magnetic switch is fitted to the rear wheel, the non moving half of the switch being attached to the frame. A tilt switch is concealed in the centre stand and an air operated switch positioned under the riders seat. Also the circuitry is such that if any connecting wires are out the alarm is automatically activated. All these are linked to a circuit which operates a siren concealed under the top fairing.

Chassis Construction

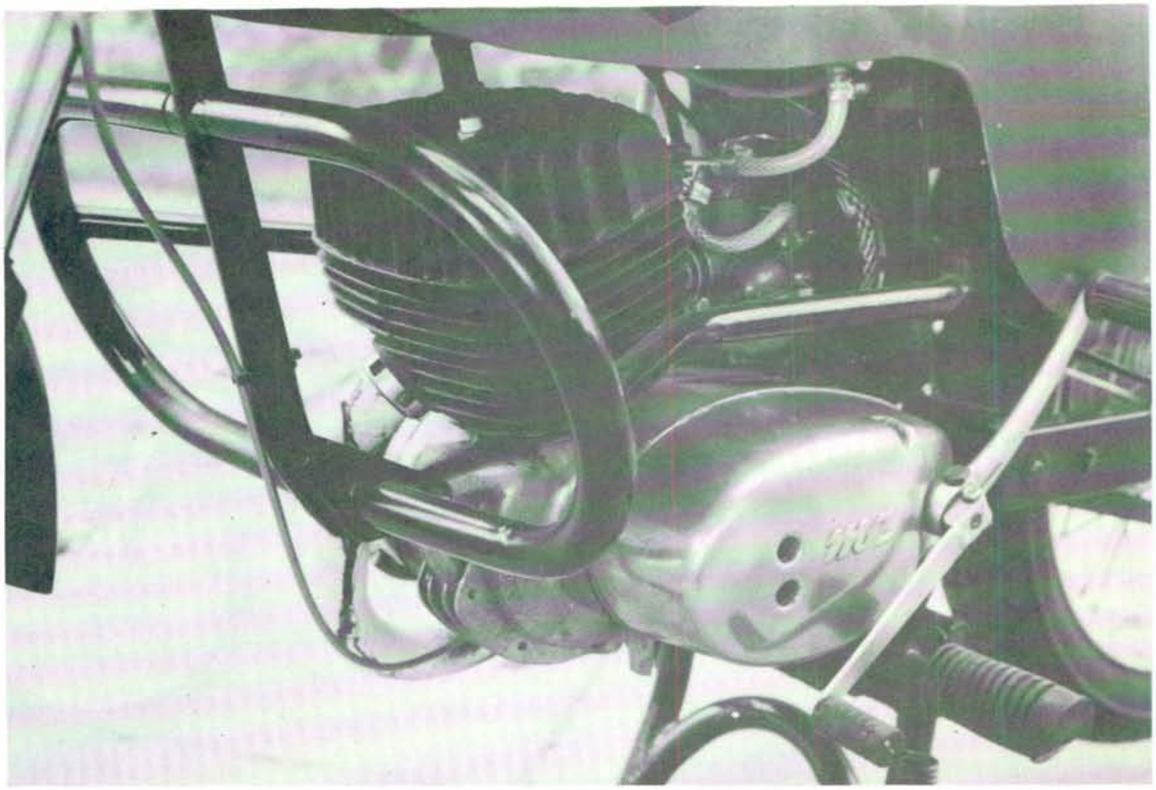
Much of our design thought was concerned with the frame layout. Most motorcycles consist of a mass of tubes meeting at the steering and rear wheel pivots or some rather crude mild steel pressings spot welded together and prone to serious corrosion within a few years use. Our 'Spine' design is simple yet has proved rigid.

As you can see from the photographs of the frame 75mm and 25mm Reynolds 531, tubes are hung to the engine and rear wheels and at the front the steering head. As well as keeping the frame light, this method of construction is relatively simple to jig up for mass production, while for one off production we were able to set up the tubes easily using suitable materials and a large marking out table.

The steering and swinging arms pivot on taper roller bearings. The bearing arrangement for the swinging arm is not unlike the 'bottom bracket' on a bicycle. We had hoped that the small upright 75mm tube could be filled with a filtering material and form an air filter for the carburettor. However on final assembly this proved awkward. The engine is hung off two plates with a stabilizing tube at the front. The engine can be removed from underneath by removing the three engine bolts and disconnecting all the cables and pipes. By using an MZ 150 c.c. motor we gained the advantage of cheap parts, spares, a totally enclosed chain and easy rear wheel adjustment. The motorcycle centre stand is situated in a position which allows front and rear wheels to be removed without the need of any extra support.

Under-seat alarm, air alarm switch.

Engine, front crash bars.



To the frame is added a triangulated tube arrangement to take the top mounting of the suspension units and the seat.

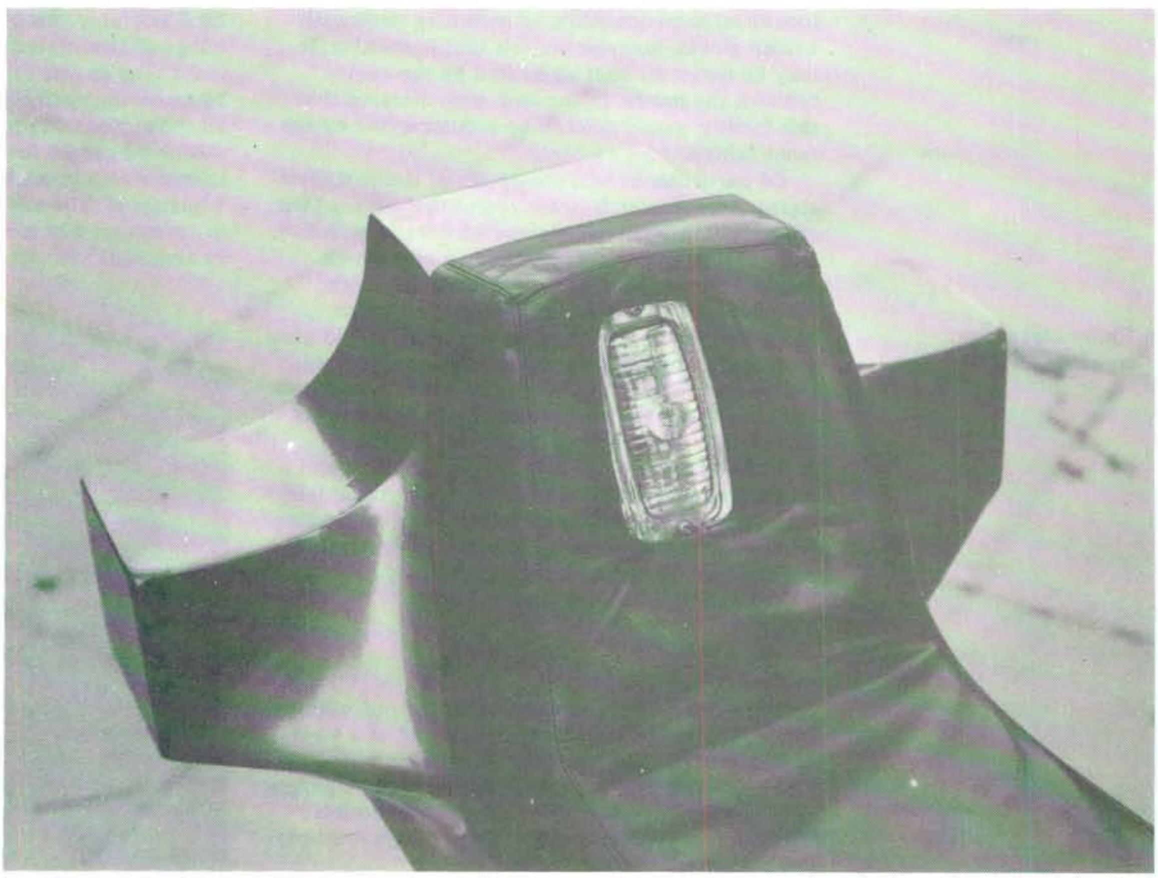
Three important criteria which would attract any motorcyclist are the attention paid to safety, rider comfort and maintenance. Safe handling has proved inherent in the design. The spine concept performs very well. Rider comfort is catered for in the form of an all enclosing top and front fairing, specially designed seat and various electronic and electrical aids.

Fairings

I think that perhaps the design of the fairings proved most interesting and stimulating within the department. It proved the link area between engineering metalwork, wood, plastics, graphics, fashion and art areas. Perhaps a detailed look at the design process for this section of the motorcycle design would prove interesting.

There is, if you spend time researching, information available on the mechanical side of motorcycle design. Our design team, staff and students could thus research for the basics, e.g. 62 degrees has proved the most suitable steering angle, why differ? The fairings however are far more open to discussion. It is perhaps a good thing that I am not a motorcyclist. The majority of the designs would have to come from the more motorcycle minded students.

Light in rear of seat.

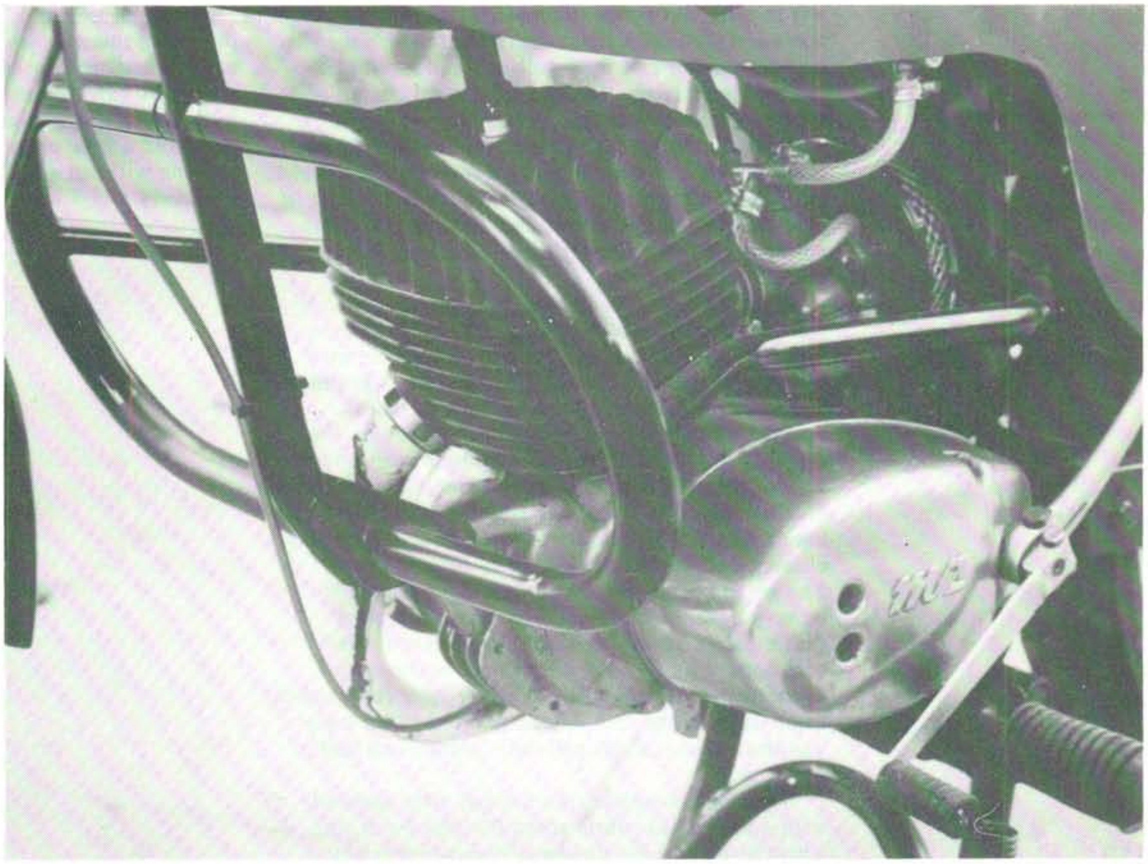


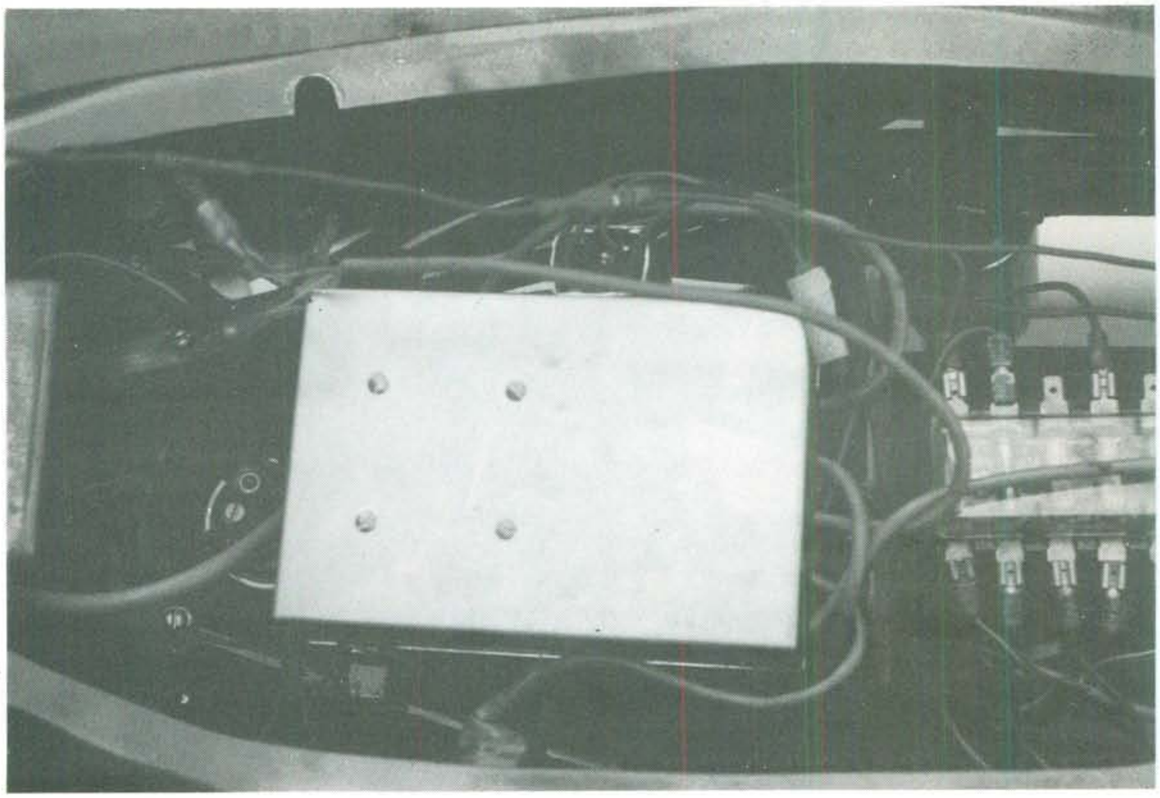
Rear lights.

By the time we started to look at the fairing designs we had nearly completed the rolling chassis. From the chassis a student completed the scaled drawing with the chassis outline wheel and engine positions. This we then printed off on A4. Each metalwork and drawing student was then given the opportunity to take one of the outlines and asked to complete the motorcycle with the fairings, panniers, controls etc. Working within each group staff discussed with the students the latters' ideas, and produced composite drawings of the groups ideas. These compositions were then put together and the design team of staff and students looked at the ideas. It was at this stage that interest really began to accelerate – whose ideas would be used? Many interesting concepts had been thrown into the melting pot. Of particular note was the idea of having a light in the seat back. This is aimed at the riders back, thus at night following drivers will see an illuminated back while oncoming drivers will see the riders distinct outline.

The next stage was to build up a card and hardboard full size profile which could be taped to the rolling chassis. Once completed, we spent two weeks showing all the groups of students, asking for comments, cutting and reshaping. The rear end containing the lights, backrest and storage unit proved the most controversial. From the profile

Engine, centre stands.





Area under seat, burglar alarm, fuse block, voltage amplifier.

a wood backbone frame was cut, this would provide the basis for the mould. Dimensions were of prime importance. The fairings would have to fit over the chassis tubes and engine, while allowing full movement of the steering. On to this wood profile were attached ribs, placed at intervals and shaped accordingly. This was then covered with wide tape and the shape reassessed. We could now sit a rider and check for general comfort on the fairings and dimensions.

With the tape removed the ribs and profile were covered with hardboard and plaster and then shaped accordingly. The surface was smoothed and sealed with furane resin, highly polished and, finally release agent applied. The mould was then laid up with GRP, left to cure, cut down the middle and removed from the wood former. A flange was added to bolt the two halves together and then polished and assembled for the final lay up. The mould was gel coated and then two layers of 1½ oz matt interleaved with carbon fibres added. Once covered the mould was carefully split and the moulding removed. It proved excellent and after trimming it was time to try it in place – perhaps the most nerve racking time in the whole project. Luckily it fitted and looked very pleasing.

Work now started on the complimentary front fairings, production following in a similar manner. Light positions were fixed and apertures cut into both fairings. An aluminium seat base was produced and after much thought a foam base cut and sculptured to shape while on the motorcycle. A group of girls then covered the base with a very neatly sewn leathercloth cover. Meanwhile the art area had been working on a suitable colour and logo scheme. The colours of green and yellow were chosen, being school colours and BP colours. The green fairing at the rear and sides proved to be very conspicuous, however research proved that most accidents to motorcyclists are frontal collisions – how could we give our motorcyclist more frontal conspicuity? The graphics department came up with the idea of a simple but interesting banding system, asymmetrically placed and highly effective.

Solutions complete, the fairings were sprayed with a bright but subtle green metallic paint, the lights fitted and the yellow reflective asymmetric banding and logo 'ROADRIDER' added. The fairings and by now the mechanics, chassis and electronics were complete.

Everybody was pleased with the final motorcycle. It rides well, is quiet and has proved mechanically and electrically very reliable.

Conclusion

BP organised an excellent weekend competition. The 'ROADRIDER' covered 45 miles round the Crystal Palace stadium complex, all we adjusted was the slow running. The police commented on its handling and ride. It proved the fastest, at 78 mph, gave fuel consumption of 98 mpg and such a low emission level that it only just came onto the scale.

No small tribute is due to BP Oil Limited, for providing the spur which encouraged the students to become engineering orientated. The competition generated enthusiasm for discussion of ideas followed by practical experimentation. The whole period of the Build a Bike project was very invigorating, proving without any shadow of a doubt that it had been very worthwhile.