Topper Revisited

The story of how two injection moulding machines were linked together for the first time in the 1970s to produce the sailing dinghy "Topper" in polypropylene

This Booklet

This is a record of the talk given by Peter Bean, Financial Director of the North of England Plastics Processing Consortium (NEPPCO), on 16 March 2009 to the Manchester Polymer Group. It covers three years in the 1970s during which the technology was developed to enable two 1600 Ton injection moulding machines to be used together (ie. "twinned") to give the effect of a much more expensive 3200 Ton machine.

The Manchester Polymer Group

The Manchester Polymer Group (MPG) is a local society affiliated to the IOM3, focussing on meeting the needs of its membership with polymer interests in the North West. It exists to advance and develop all aspects of science, engineering, technology and design as applied to the development, processing, application and sustainability of polymeric materials.

The MPG also promotes and supports the education, training and practice in the polymer disciplines and disseminates knowledge relating to polymers within its boundaries. It aims to support its members in career development, provide opportunities for networking and promote the benefits of membership of the Institute.

See www.manchesterpolymergroup.org.uk

Good evening gentlemen. I was lucky enough to be part of the team that produced Topper and so I hope you will forgive me if I become so involved in the story that I revert to using "*we*" instead of "*the topper team*". This was one of the most interesting and involving periods of my industrial life and I am really pleased that your Committee's suggestion to re-visit Topper has inspired me to try and remember what happened during those three years and why.

That some of the detail may be missing or slightly off-correct will be quickly noticed by one particular person who is with us tonight – Dick Bebb. He took on the challenge of designing the moulds and over-seeing their manufacturing path. Dick has been involved with Rolinx — off and on to begin with, and then full time — since he designed the first pencil box mould in 1946 and until he retired from the company as Design Director in 1986. Thank you, Dick, for your support.

Since this whole sequence of events took place over a third of a Century ago, you will perhaps excuse some of the images looking a little the worse for wear and even some in glorious B & W; we're talking here of the age of Morcambe & Wise in their infancy! Sticking with the historical content — dimensions will be in "old currency".

The story of the production of Topper is really best prologued by the story of the company, Rolinx, that produced it. The iconic image of that Company is the pencil box that was the first product

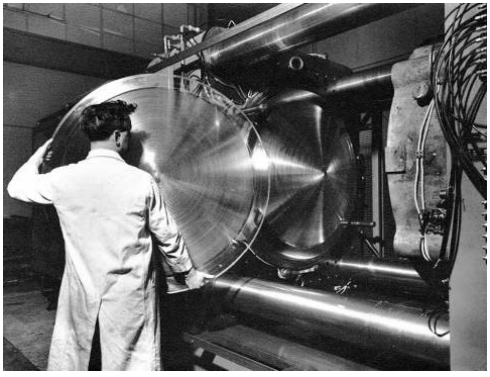
made for sale and which incorporated the butyrate roller shutter extrusion from which the Company took its name. From the production of the first complete pencil box in 1947, the philosophy of the founder/chairman was always the same:

- Firstly: analyse the injection moulding process — temperature control of the material and mould — the pyrometry — and control of the hydraulics and pneumatics
- Secondly: always stay ahead of the customer's needs — ie try to visualise where the customer was next going and have the expertise and machinery ready and available to satisfy that need.

This mantra worked fine for the first 25 years, through pencil boxes and their followers — paint boxes, card

boxes, geometry sets, cigarette boxes etc — to the more mundane items like railway ferrules, TV implosion guards, skydomes and many large-area pieces for the automobile industry, some of which incorporated soft-grain textured finishes like that Rover P6 parcel shelf.

Now, with our largest machine being a 1300T press, it was decided that the next step, to a 2000T-er perhaps, should be taken.



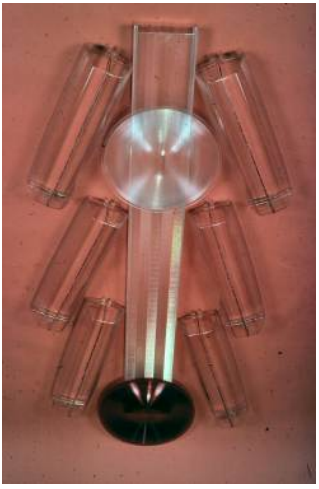
There was, at that time, plenty of work for this size of machine to justify its purchase but what was to be the next step after that? 3000T was the next threshold but that would have been beyond the pocket of all but the most wealthy corporations and, with the demand for components of that size in injection moulding quantities not around at that time, another scheme was born.

How about two 1500T machines placed side by side so that they could both usually be used as 1500T-ers and when the need arose they could be linked together to form a 3000T machine? It was from this acorn of a question that a great oak grew!

R.H.Windsor (by that time GKNWindsor) were our co-conspirators in this endeavour and together we laid plans — of which by far the most important was getting the platen sizes right — for the new beasts. By this time ICI fully owned Rolinx having bought the Company, effectively, as an extension to their injection moulding laboratory in Welwyn Garden City. Now, with the Plastics Division R & D Director, Tony Willbourn, as our chairman, it was decided that comparing large size twin screw and single screw injection units in a real production environment with many different materials, would be very contributory to ICI being able to sell large quantities of material. Accordingly, this was proposed as the rationale for Plastics Division main board approval for the capital for the second machine to complete the "twinning" experiment. That development twist, examining the rheology of the screws, seemed eminently understandable at the time but, as we were later to find out, did

give us an extra hurdle to clear.

Thus the scene was set — we built an 8000 sq.ft high-bay extension to the plant in which Windsors actually built the first machine because their factory at Chessington wasn't big enough.



For a year that machine plodded to and fro making large mouldings — 6ft acrylic light fittings and prismatic sheets, large water tanks, lorry mudguards, and it wasn't long before the second machine, this time built in the new Windsor plant in Frankfurt, was installed and took its place as the twin but, of course, served by a single screw plasticising unit. Its first production was a dustbin which it was fervently hoped did not presage rubbish to come!

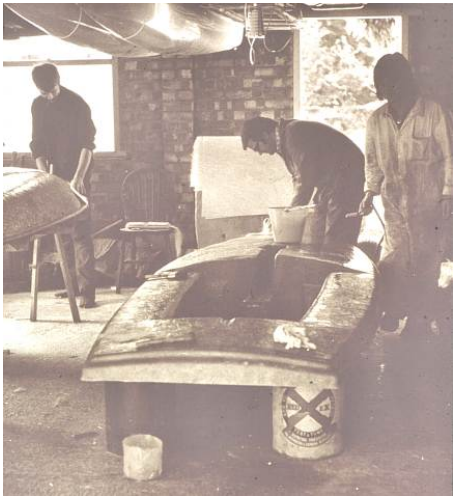
For a while the two machines worked side by side, each making its own mouldings, but at the same time the hunt was on to identify a component needed in large enough quantities to justify injection moulding, and which would demand 3000T of lock; this would mean that we could prove the whole concept of "Twinning" the machines and ICI could see their way to selling those dreamed of HUGE tonnages of material to large machine operators.

But what to make? Following the Rolinx philosophy of development in production, we were looking for a moulding to test the "twinning" concept and, at the same time, to be a saleable product. Ideas, of course, were legion. The Automobile industry, Building materials,

Bathrooms, Billiards tables, Beds — to name but the A's and B's.
Eventually the idea was developed that the leisure market was the best opportunity and that brought us to another B — Boats

It was for this reason that, in January 1973, an historic visit to the Earls Court Boat Show was made by Maurice Robin the founder, driving spirit and force behind Rolinx, and John Heasman a keen sailor. They each went their own ways round the show and on meeting up for lunch found they had both come to the same conclusion — it might well be possible to mould one of the highlights of the Show, the relatively new sailing dinghy "**Topper**".

This Ian Proctor-designed training dinghy was currently being laid up in GRP – a very messy, almost primeval,

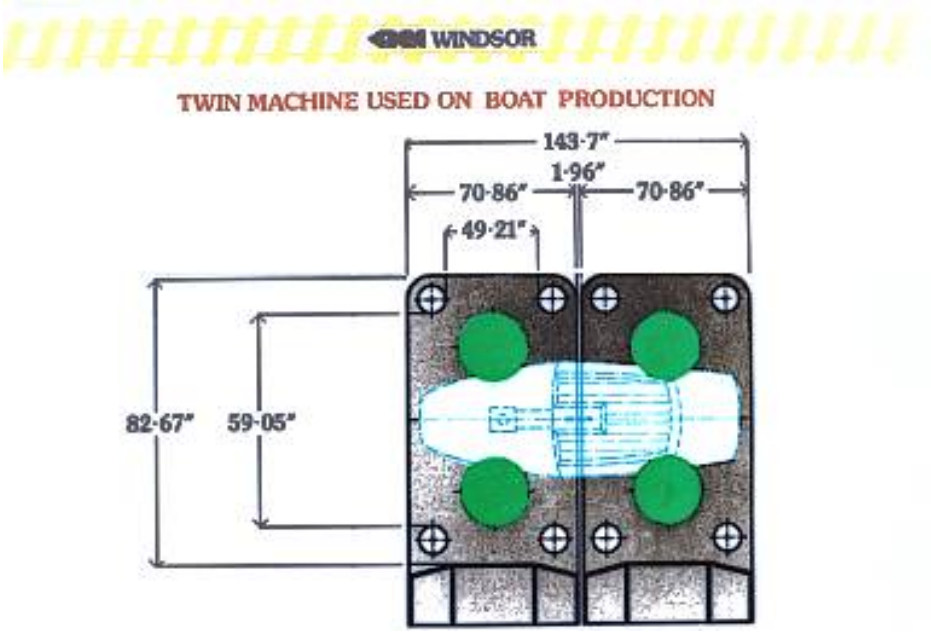


business and, of more relevance, it became clear that the production of 6-10 of these each week, in very much a cottage-industry environment, was not nearly enough to satisfy a market which was increasingly impressed by the performance of this new craft.

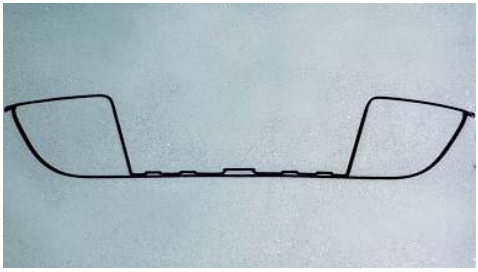
So…things appeared to be working out well enough to convince the enthusiastically optimistic team at Rolinx that the project appeared a runner, from the economics of production point of view. Of equal importance, the customer, JV Dunhill Boats Ltd., was a most willing participant as he fervently believed he had a market for at, least, 6/700 boats per month which he couldn't even touch in GRP lay-up.

Time now, before starting to design the tools and sourcing steel, to consider the list of basic engineering problems that were to be overcome; this was done by making reasonably founded guesses at what was needed and how those needs could, or would, be satisfied.

Topper was calculated to weigh 80lbs in polypropylene with a projected area of 5500 sq.ins. VERY fortunately, it looked as though a bolster which would just fit between the tiebars would also just accommodate the length and beam of the dinghy. A lucky break — or extra-sensory perception 2 years before! 5ft. vertically between the tie-bars was OK and, in fact, the machines had been assembled with about 15in. between platens so 13ft. was just right for the length of Topper!

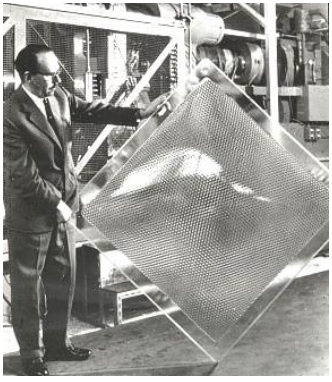


It was decided that, as an injection moulding, Topper could be moulded in two halves, deck and hull, which would eventually have to be joined together with a waterproof joint; just what sort of joint this was to be was another of those problems that would have to be considered and solved as a separate project.



It looked as though each half would be of similar weight (about 40lbs) and that, therefore, the combined shot weights of the two injection units, one of 20 and one of 30lbs, would take care of that problem.

However, we still had 5500 sq.ins. to hold closed with 3200 tonnes.Ten years previously Rolinx had moulded 46in square skydomes on a 1300 T press.



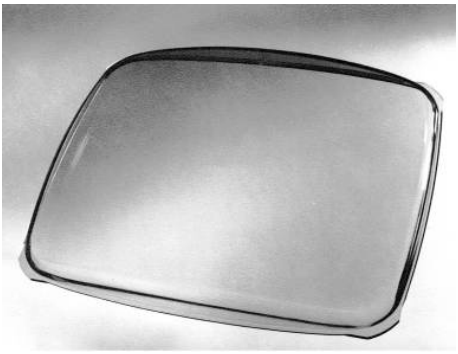
Thus, just about 0.6 T/sq.in was adequate for a 1/8th inch thick acrylic moulding with a central sprue. We now appeared to have available just marginally under 0.6T/sq.in for (probably) polypropylene (about 3/16th thick) moulded through a Hot Runner with at least three, and probably five, feeds.

Fortunately, just as it had been ten years previously, the Constant Volume Injection process was there to assist in this endeavour; so, although balancing the feeds might be tricky, it was considered that, from the lock point of view, this was not only possible but do-able! This rectangular skydome was, actually, more difficult to mould than the square one of 25% larger area.

The actual injection phase — moulding 40 lbs of polypropylene from two quite different injection systems of different capacities through a Hot Runner of, an as-yet-unknown number of drops — was seen as a potential real hurdle; this, you will recall, was before MoldFlow had really taken root. Once again, fortunately, we had

historical facts to come to our assistance.

Some 10 years before this, the moulding of the larger (23") TV guards had been made possible only by using a very basic form of injection speed control.



This TV screen is 450sq.in, edge-gated, about 3/16th in thick in acrylic moulded on an 800 ton press and definitely needed Injection Speed Control to keep the melt front moving at an appropriate speed.

Following that success, we had developed an electronic system controlled first by limit switches and subsequently by linear transducers; this work had been done in conjunction with Eurotherm who subsequently marketed the device as a "hang-on" for moulding machines and is now, of course, built into every new moulding machine the world over.

So now we believed we had a good chance with two engineering/moulding problems; we had enough lock and control over speed of injection which would be our method of keeping the melt front speed relatively constant.

The next (and we hoped final) fundamental machine problem was that of melding the output from the two different designs of screws. Experience with each unit on their own 1600T presses had confirmed that quite marked differences did, indeed, occur but it was accepted that dealing with the combination of the extrudates through the shooting pots and Hot Runner would have to be experienced and only then could it be conquered! Known colloquially as "Suck it and see".

Now, finally, we were just left with the small problem of making the moulds!

- who in the UK had the capacity
- what would they cost
- who would pay

The question of the cash involved, though an interesting story in itself, is outside the remit for this story, but mould manufacture is not! The moulds were totally fundamental to the production of Topper and, after many discussions, the thought process that

emerged was as follows:-

The understood assumption was that the moulds would be made in steel but the best lead time which we could extract was 1 and a half to 2 years - and that was a mouldmaker's promise, so it would be prudent to add at least 50% if not more, making 2 to 3 years at best, and possibly 4! Since the aim was to have Topper finished for the 1976 Boat Show, 21 months later, this was a complete non-starter.

Furthermore, it was known that these were the two biggest moulds that had ever been considered for manufacture in Europe and that there were only two toolmakers who had expertise and machinery large enough to tackle such a project. Given these two facts, the fundamental decision was taken that there would have to be an amalgam of suppliers — each a quality engineering specialist in his own field — to be brought together to achieve the final goal — which was two assemblies of carefully prepared metal each weighing 30 tons measuring 13ft x 5ft x 3ft.

Since that first meeting with Topper at the Boat Show, 15 months of design and production team deliberation in the possible/probable best ways of doing things and trawling the country for suitable suppliers had taken place. Finally, the £250K finance package was agreed, contracts were signed and, in the immortal words of John Wayne "Wagons roll".

In those far off days the starting point in any mouldmaking was a detailed component drawing for the model. On this occasion there were no drawings — only a GRP Topper from which templates were taken for models to be made at the first of our selected

suppliers, Press Patterns of Nuneaton.

One for the hull. And one for the deck, both of which included shrinkage allowances for both metal and plastic.

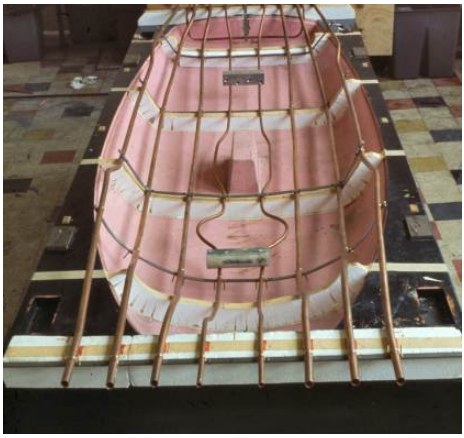
3 of the dramatis personae seen here were Albert Gutteridge, project secretary whose job it was to keep everyone keeping their promises, John Dunhill and Maurice Robin, founder and driving engine behind Rolinx from the beginning in 1946, and a man for whom, always, only the technical best

was good enough.

These models were adjusted and agreed by Ian Proctor — the boat's original designer — and many features were incorporated which weren't possible in the GRP version and were improvements to the overall design.

The deck moulding, for instance, was designed to incorporate textured areas because it can be extremely painful shifting wet skin from intimate contact with a smooth plastic surface. Also, we needed both decks and hulls on their own to stack to two inches to optimise transport to assembly locations both in the UK and abroad.

It was for the first of these reasons, coupled with our previous experience with cast-to-size, zinc-alloy dies, that Kirksite was chosen for all 4 die-blocks. Our chosen supplier, Albany Jig and Tools, had experience of this sort of work for panel tools for the motor industry and, although they had never



tackled anything for the plastic industry, they persuaded us that their (very secret) process could undertake the pouring of the 8 tons of alloy that was needed, to very close tolerances and with little or no porosity.

Each of these four accurately sized castings had to have cooling facilities: two complete circuits of copper pipe for each half of each mould: four for the hull, and four for the deck.

All of which had to be made and suspended accurately above the sand before pouring. In the end these had to be made at our factory in Wythenshawe. Initially, we had a few problems in this area, but this was experience which proved a great teacher and, in the fullness of time castings began to emerge from the foundry. This is the deck presentation face being surveyed happily by Lew Grew (the foundry manager) and Dick Bebb (who had conceived the whole operation).

Meanwhile, bolster fabrication was taking place at F.H.Lloyds of Darleston. At that time there was a European-wide steel shortage and so, to save time and money, flat plate, which was fortunately available at Lloyds because of a cancelled order, was used, gusseted

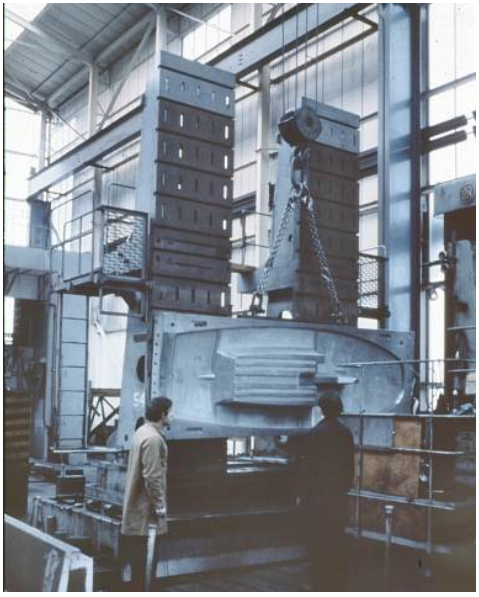
and welded together.

After annealing, these fabrications went on to be machined at Shrewsbury Tool & Die, yet another supplier who had never before had anything to do with injection moulding tools, so that they could accommodate their appropriate castings.

The machining and assembly project

was supervised by Derek Wainwright, at Shrewsbury, with an occasional visit from NRDC, and many, many visits from the Rolinx team.

(It was subsequently calculated that, throughout the mouldmaking part of this affair, Rolinx engineers had travelled 60,000 miles to all the various suppliers!)

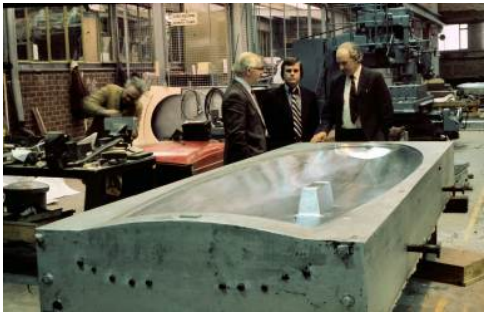


The deck casting had, by this time, arrived at Shrewsbury for machining prior to fitting into the bolster and was subject to an interested inspection by John Davies and Alan Tait who were getting their first look at an Injection Moulding tool. There was a good deal of straight machining to do and, in addition, the non presentation shut-out faces had to be profiled from the presentation face so as to produce a completely matched mould.

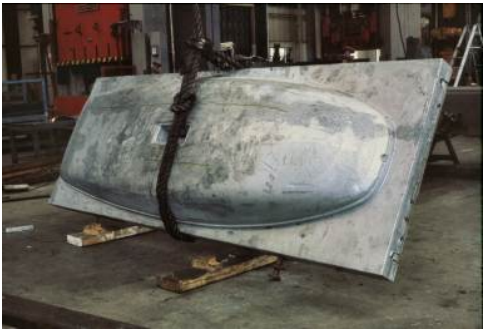
That's an enormous Droop & Rein capable of producing left and right-handed boats at the same time if needed. Perhaps paving the way for catamarans to come!

Following machining, the dies had to be finish fitted on a try-out press of similar scale.

Each of these castings now weighed 7 tons and that's a man-sized try-out press by injection moulding standards.



Meantime — back at the foundry — the hull presentation face has emerged before going to Shrewsbury where the first operation was to check that this hull master fitted the deck master — which it did and this confirmed that Albany had produced 2 castings, each of 8 tons and of quite different shapes, that had been cast to within 0.100 in. in 12 ft. — not at all a bad effort in precision casting!



The hull non-presentation face now arrived at Shrewsbury to be 3D-machined to its mate and it seemed

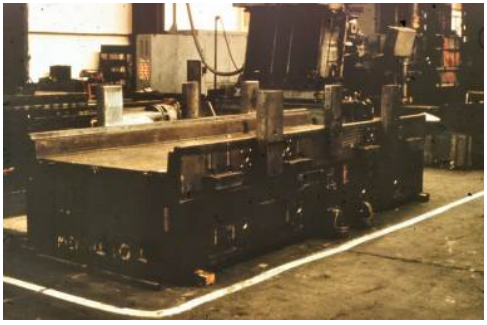
that, with the arrival of this fourth and final casting, light was appearing at the end of the tunnel. However, a nasty hiccough occurred when it was revealed that, on a night shift, the cutter path had gone awry by half an inch and some of the copper pipes cast into the metal had finished up too near the surface of the Kirksite.

Incidentally, those deep gashes in the metal were subsequently machined out intentionally to check the depth of all the pipes in the interest of gaining maximum knowledge for future work of this sort.

Of course one of the advantages of using Kirksite is that, like a thermoplastic, it can be melted down

and re-used, but it was a set-back from the time point of view — and it was back to the pipe-building again.

By this time the first bolster was ready to receive its casting — but the casting wasn't yet ready to go in!



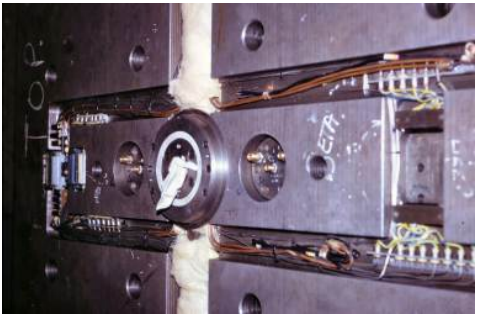
In a way, this was heaven-sent because, although Rolinx were used to big tools, these two were going to be twice as big as usual and, with time in hand we thought a rehearsal in threading the tool through those 8 tie-bars on the machine would be prudent.

Pick it up, lower it on to a specially built table, and pull it in!

There you are — it just fits!

The five point hot runner with its associated hot and cold sprues, heaters and thermocouples was also available for test fitting into the bolster and this whole operation was carried out exactly as it would be 2 months later including the checking out of all the 28 heater circuits and 34 thermocouples when the runner was in place and being controlled.

These rehearsals demonstrated that from the tool point of view there were a number of "I's" to be dotted and "T's" to be crossed and a de-briefing session picked holes in the dummy run and decided on a number of features to be incorporated to assist and speed up what had, in fact, been a fairly hairy operation.

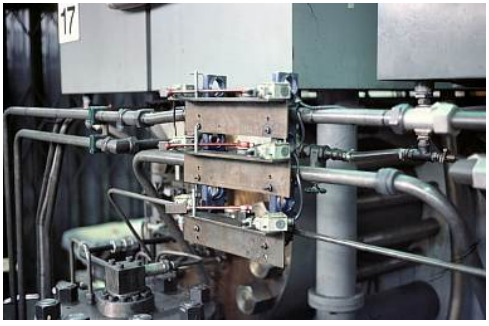


Additionally, of course, it was one which, in the event, would have to be carried out as speedily and efficiently as possible since, even in those days tool-changing was a wasteful operation and, in this case particularly and not unusually with a new tool, it looked as though the planned time between delivery of mould to moulder and moulded product to customer — in this case the Boat Show in 3 months time in early January — was already dwindling to an impossibly low figure!

Dick Bebb, Terry Ogden, David Cowley

and guess who, spending money on modifications which were put in hand immediately so as to run parallel with the completion of the tools.

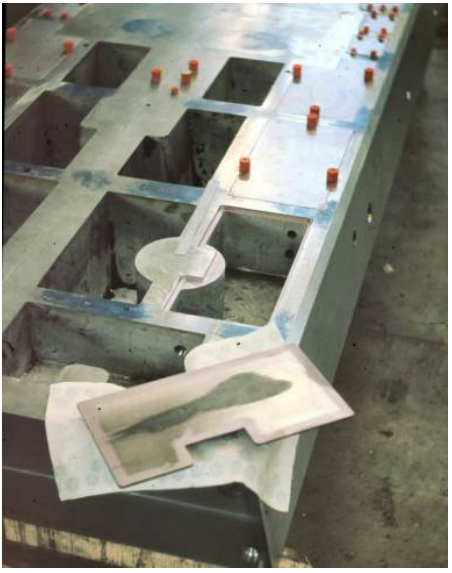
In addition to making sure that the tools fitted the presses we needed to take the opportunity to check out the operation of the presses as a twin unit. Remember the twin moulding machines? You may have forgotten that these were the object of the original exercise! For this, once the bolster was in position, we had to change over the hydraulic link valves and re-route the auto-circuits through the Selectro Board system to confirm that the designers had achieved the impossible and that we could, in fact, operate the presses in tandem and make the change-over from two 1600 tonners to a single 3200 ton press in under 5 minutes.



But now back to the tool — the replacement hull punch casting had now appeared but it, too, had water-pipe problems.

Here we are ultra-sonically checking the depth of the pipes in the casting and discovering that two pipes had fractured during pouring; they had

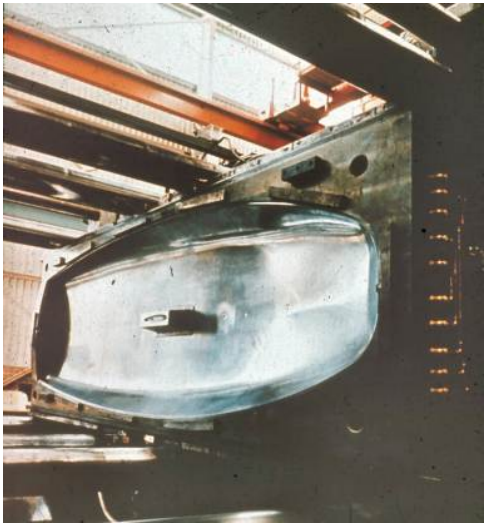
filled with molten metal rendering that run of cooling system unusable. There was no time for yet another casting and so it was decided that these core holes would have to be used



to aid the cooling; they were machined out, interconnected and plates stuck on the back — using a silicon rubber glue which had been specially developed for the NASA space programme.

Once this was done, and a number of fingers crossed and prayers said, the punch was sent for 3D-machining, followed by the try-out press to confirm the cavity thicknesses and, hey presto, we were nearly at the point of loading the first tool onto a lorry — up the motorway — and then onto the machine.

We appeared, at last, to be ready to press the button!

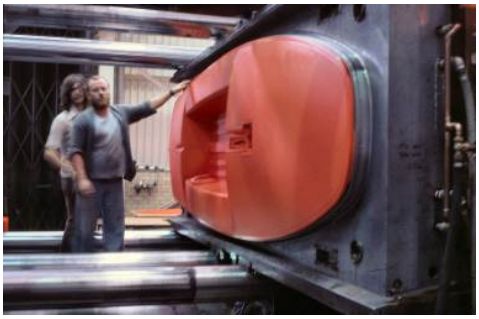


At this stage there were a lot of long, deep breaths being taken, and everybody is privately reviewing the difficulties left to be surmounted — Material out of two quite different plasticising units and the very act of moulding 5500 sq.in. (which now seemed so much greater than it had 18 months before) through a 5-point Hot Runner with only 3200 Tons of lock!!

Anxious moments with hopes and bets running high.

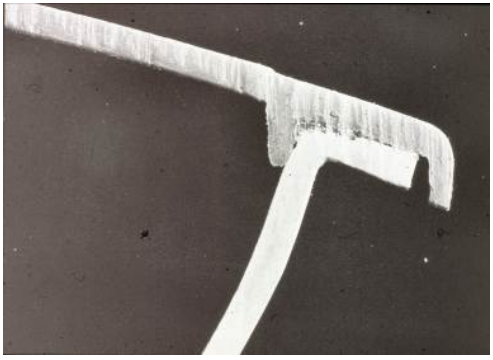
Now was the time to call on the melt speed modulation feature which was indicated by 6 short stroke linear transducers round the periphery of the mould to observe the eccentricity of mould opening; a number of trial shots and, a number of gallons of midnight oil later a hull appeared and, a week or so later when the deck tool

had arrived, and a similar period of mould mounting and trials had taken place a deck had been moulded and was ready to be mated with the hull with a water-tight joint strong enough to withstand the flexing and hammering forces imposed as Topper



moved at speed over a choppy sea.

18 months previously a test tool had been made in order that various different methods of fixing the mouldings together could be evaluated.



Mouldings from this tool were put through all the adhesion hoops and, eventually a system of fusing the two shells together using a tape of braided polypropylene monofilament and copper wire, woven by Thomas French in Wythenshawe, was decided upon.

Now was the moment to prove those

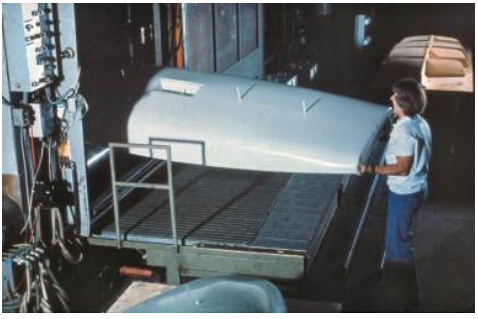
experiments and here is the deck in the clamping jig with John Hancock who master-minded this part of the operation. Expanded polystyrene blocks to aid the stability of the monocoque (and, in a crisis, buoyancy) are stuck in place, the braid is laid in the “track”, the hull component is clamped on top and two large

crocodile clips are connected. Frankenstein’s assistant switches on the power and, 7 seconds later, a small puff of smoke indicates that watts have been released and the result – 2 days

before Christmas — 1 car-topped Topper with 5 days to spare for a triumphant, if somewhat breathless, appearance at Earls Court on Jan 2nd!

Also available — Double-decker car-topped Toppers.

In production a batch of hulls...



...are moulded, followed by decks. Now

we can begin to see the solution to John Dunhill's original problem of only being able to make 5% of what he could sell — the weekly output has moved from 8 to 200 assembled boats.

This is a load of 180 decks nesting snugly and all ready for shipping to the assembly line which had been established in Liskeard where they are

welded up in exactly the same way as the original testing which had proved

so successful, fitted out with toe-straps, dagger board housing, tiller fittings and mast lock on a production line basis, popped in Aircap and polythene sleeving.

… and there is even a drive-it-away yourself system operating.

It is also said that some people, in the know, even sail them away, westward no doubt, and as the sun sinks low over the horizon we may ask ourselves what was achieved and was it all worth it?

Well, the ultimate vindication of the twinning proposition was that, for the next two years, those machines were used for 9 months of the year as 1600 ton units and, for 3 months, making Topper shells.

On the processing side, certainly the manufacture of a useful, saleable component composed of the two largest injection mouldings in the world at that time, moulded on a twin machine, was an undoubted achievement. Additionally, on the way to that achievement, and a very fundamental part of it, manufacture of the two largest injection moulding tools in the world using a combination of disciplines that had not been used before by engineers who, in the main, had been taught (by Dick Bebb) the nuances of making moulds for the injection moulding industry must, together, rank as having been very worthwhile.

In hindsight how does it strike you? What lessons, if any, were learnt that have proved useful to the processing industry in the meantime? If we were setting out to make a Topper today, how would we do it? And, for me, one of the key questions — Why, perhaps, did the polymer industry not pursue the development of a material that could be used to make really large mouldings for the automobile industry and many other industries? After all, it had been clearly shown that it wasn't always necessary to have very large tonnage presses, with their accompanying high capital costs, and probable limited use of their large tonnage capabilities, to mould large area components; and so the moulding industry had another, very useful, weapon at their disposal.

Peter Bean and Dick Bebb

Booklet produced by
Clockwise Data
Sale
Manchester
M33 4JA UK
www.clockwisedata.co.uk

Clockwise Data