Steel Selection -
Closing the Gap with Offshore Tooling

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To be competitive, domestic mold builders need to consider that steel selection –although the smallest portion of the overall mold manufacturing cost –can be a vital component in competing against cheap offshore tooling.

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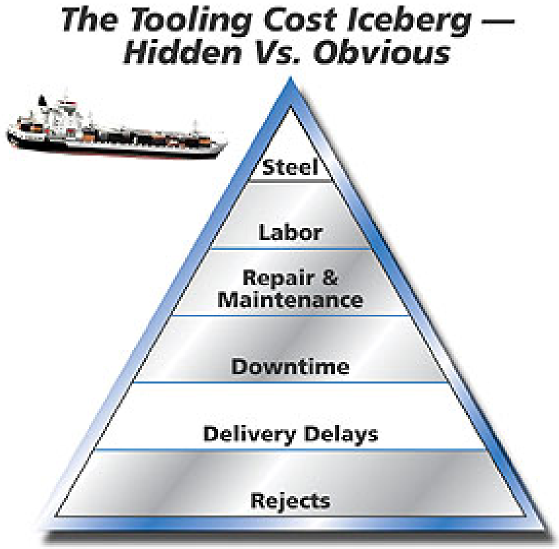

The most discussed topic in the mold building industry today is cheaper tooling from offshore competition. Most often these discussions revolve around unfair low labor costs; however, many mold builders fail to realize that steel selection can playa major role in closing the price gap with offshore tooling.

Too often, moldmakers only look at the cheapest price-per-pound steel and ignore the real savings opportunities available above the waterline labor costs.

Steels that machine faster, achieve superior machine finishes to reduce bench time, weld better to ease design changes or repair, do not require costly time off the machining for stress relieving and offer real labor (cost) saving. Fewer labor hours also mean improved lead times.

Real Tool Costs from Low Labor Cost Countries

Offshore tooling buyers focus on initial acquisition costs that are often well below half of the domestic quotes. These extremely low prices tend to come from Southeast Asian countries and China whose labor costs are extremely low. The buyers are willing to ship the tool to a North American shop to bring it to operational specification. There often are problems caused by miscommunication, lack of attention to detail or ignored specifications by the offshore shop.

One molder asked what grade of steel was used in his recently received tool. The reply from the Chinese tool builder was ‘yes”. However, these buyers of offshore tooling are willing to accept the additional costs. They believe that even if the additional costs double the original acquisition price, they still saved money. They fail to take into consideration the below the waterline, such as language, geography and quality will help to recapture lost business.

Lower Cost tooling from Higher Labor Cost Countries

Japan is another story. Japanese labor costs are now higher than ours. Japanese moldmakers build tools quicker an cheaper than we do –and make a profit. But how? The answer is in the steel selection.

The earliest molds in both countries were made out of boilerplate—or whatever carbon steel was available. As resins advanced and production runs got longer, changes in the steels used were required. North American shops went to chrome moly steels that could be heat treated—first 4140, then the more highly refined P-20 (4130 modified pre-hardened to HRC 26/32) and finally hardened tool steels such as A-2, H13, and S-7. Each step was made to extend the life of the tool, but at the expense of machinability, production time, repairability or required heat treatment.

Using steels to bring manufacturing costs and leadtimes to a more competitive level will do much to allow the domestic industry to concentrate more time on selling its built-in advantages—such as language, creative design, local service and quality.

Through the 1950s and 1960s, the Japanese zeroed in on JIS (Japanese Industrial Standard) S55C as its core and cavity steel of choice. S55c is a carbon steel supplied at a brimmell hardness of 220. They valued ease of machinability and the corresponding timesavings as well as ease of repairability over hardness. Adhering to strict preventive maintenance allowed the molders to successfully complete their production runs.

As the Japanese electronics and automobile industries began to ramp up, it became apparent that harder, longer-wearing pre-hardened steels would be required due to ever-increasing volumes. But the tool builders resisted any change that would add to mold building leadtime and the molders resisted any change that would make repair or modification more difficult. It became incumbent upon the Japanese specialty steel manufacturers to design steel grade that would satisfy both the mold builders and molders.

Beginning with Daido Steel's 1965 introduction of a steel grade named NAK80, followed by NAK55—a re-sulpherized version in 1975—and PX5—a low carbon- improved P-20 in 1989—that's exactly what they did. (See Chart 1.) Each mill marketed its own variation under proprietary trade names of steels designed to keep labor time and cost low for the moldmakers and repair costs low for the molders. None of these grades were, or are now, identified by JIS or AISI standard designations. They are sold under the producing mill's trade name, but as a group they are the dominant pre-hardened cavity and core steels used in Japan.

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How Paying More for Steel Reduces Mold Building Costs

Reduced machining time reduced lead time, lowers labor costs and improves machine use. You can build more tools in less time, creasing revenues. Hunt Machine (Tallmadge, OH) a leading manufacturer of molds for the plastic, rubber and wood fiber industries experienced what the modified P-21 grades could do to machining time firs-hand. Vice President Dave Hunt discusses a tool cost analysis he was asked to do in 1992 for the then Inland Fisher Guide Division of G.M.

"The G.M engineers were interested in NAK 55 for steering wheel molds because they could weld repair textured areas, re-texture and see no indication of weld on the molded part. But they were concerned about the cost effect of switching to a $4.00 per pound steel for these eight hundredpound molds. They came to Hunt Machine because we had built many of these tools our of P-20. We knew what we were doing and built the P-20 tools as fast or faster than anyone could. We built two tools of very similar geometry. We used the same 25 hp twin spindle machining centers and our best combinations of carbide, indexable carbide, ceramic and HSS milling tools. We were confident that our results would be an accurate comparison within 10 percent. We found that the feed rates were consistently better with the NAK material and due to the stability of the age-hardened steel, we could eliminate the dead passes caused by the tool spring of P-20. We machined the NAK tool in 115 hours—less time than the P-20 tool. With our shop rates at the time it was less expensive to build the tool out of the $4.00 per pound steel," Hunt explains. "With today's improved machining and cutting tool technology, the qualities of these steels stand our even more."

This was proved out in a machining demonstration conducted by Makino in 1999. Two Makino waves were machined –one out of P-20 and one from a modified, low carbon PX series from Japan. Today machining time for P-20 was 3 hours and 59 minutes: machining time for PX5 was and 57 minutes. (See machining data in Figure 1a and 1b.)

Makino Wave
(Photo courtesy of Makino)

Also stated in the Makino report was "The machining characteristics of the PX5 material compared to P-20 allowed for higher rpm and a much higher chip load for roughing and semi-finishing. The surface finish of PX5 is much better than P-20 even when only using air instead of liquid colorant."

Chart 1

	JIS	AISI	SUPPLIED HRC	DAIDO STEEL	AICHI	NIPPON KOSHUHA	MITSUBISHI STEEL	KOBE STEEL	SUMOTOMO	SANYO
CARBON STEEL	555C	1055	BHN220	PX2	AUK11	KPM1	MT50C	KTSM21	SD17	
CHROME MOLY QUENCH AND TEMPERED STEELS *P-30 MODIFIED*	SCM440	4140	HRC 30-33	PX3	AUK11	KPM2		KTSM3M	SD61	
AGE HARDENING STEELS *P21 MODIFIED*	-	-	HRC 37.42	*NAK55 *NAK80		KAP	*M524M	KTSM403F	*SHS100	PLM40

* VACUUM ARC REMELTED

Superior machine finish reduces or eliminated bench preparation for further processes. In the compression rubber mold industry, o-ring manufacturers have eliminated the need to polish o-ring cavities because of the machined finish they could obtain with the 40HRC P-21 modified steel. After the Makino demonstration one of Makino's engineers was asked why he had polished the PX5 wave and not the P-20 wave—neither had been polished.

Benching represents labor hours and additional costs. U.S. shops are striving to use machined finished cores. They are striving to get a machine finish that will allow them to go directly to texture without benching. In Japan, this has been common practice for years. Takashi Matsuoka, president of Matsuoka Special Steel Co. Ltd—a leader in steel distribution as well as semi-finished cores and cavities for large, automotive molds—and president of Shippo Molds—specializing in die cast and plastic injection molds in Nagoya, Japan stated in the following, "Without the proper steel, it would be very difficult for us to supply the lead time and quality that ou customers expect from us. WE cannot lose time due to wide variations in hardness—even in the largest blocks used for bumper molds. We view the added hand finishing this causes additional cost to be avoided. Hand spots would be equally destructive to our labor and cutting insert budgets. We depend on unattended machining to keep our costs down. Cutters breaking on hard spots is not acceptable. The cutters we use for high-speed finishing cannot tolerated hard spots."

Larry Taylor, vice president of technical services for Complete Surface Technologies, Inc. (Rockford, MI)—a national leader in texturing, polishing, gain repair and benching—agrees. "It has been our experience that the uniform hardness supplied by these Japanese steels does greatly reduce benching time. When technician has to change techniques due to hardness variations in the same block of steel, the hours can really start to add up. These steels have proven to be a more uniform in their properties. You really see outstanding performance when they have been welded. The head-affected zones (HAZ) stay close to the base metal hardness when properly welded and that really cuts down on the handwork."

Figure 1a. Makino Wave: Test Cut Report - P-5

Toolpath	Cutter	Coating	RPM	IN/M	Chip Load	Time
Roughing	¾" ball end mill	TiCN	9,600	236	.012	56 min.
Semi-Finishing	½" ball end mill	TiCN	14,000	315	.011	21 min.
Finishing	¼" ball end mill	TiCN	18,000	228	.006	100 min.

Total Machining Time: 2 Hours 57 minutes

Figure 1b. Makino Wave: Test Cut Report - P-20

Toolpath	Cutter	Coating	RPM	MM/M	Chip Load	Time
Roughing	50 mm face mill	TiCN	1,600	1176	.183	16 min.
Roughing	16 mm ball end mill	TiCN	6,000	3000	.250	91 min.
Semi-Finishing	12 mm ball end mill	TiCN	10,000	6800	.340	32 min.
Finishing	6 mm ball end mill	TiCN	18,000	6732	.187	100 min.

Total Machining Time: 3 Hours 59 minutes

Figures courtesy of Makino

Importance of Weldability to the Tool Builder and Molder

Design changes during tool construction are a fact of life. If the change takes place after texturing or polishing, the tool builder may have to start over. Welding on high carbon steels can cause a dramatic rise in hardness in the area adjoining the welded area—called the heat-affected zone (HAZ). If this hardness cannot be drawn back to a reasonable level (often it cannot), it is very difficult to match the texture or polish to the rest of the tool.

Dave Hunt recalls an early G.M. horn pad mold built from P-21 modified variation NAK 55. After the textured mold had been completed, designers relocated the bugles. Dave recalls the project engineer at the time, Paul Byran, stating "If we cut the cavity out of P-20, we would have had to start over." Pete Ruggerello, executive vice president of Complete Surface Technologies sees it this way, "Our customers expect the highest quality and delivery from our polish and texture repair service. The low carbon P-20 modified steels, such as PX5, are a tremendous aid in fulfilling our commitment to getting our customers back in business as quickly as possible. In most cases we can avoid the need to pre and post-heat the tool, as well as avoid the need for diamond lapping to get the original finish. The ability of our technicians to perform on-site repairs without pre-heating saves time and money, which are both very valuable commodities when the mold is out of production."

Time to Rethink Steel Selection

Our tool building industry is comfortable using P-20. We cut our teeth on it. It's been around since the 1950s, but these are uncomfortable times. Our domestic industry is competing in a world market, but we are competing against tool builders who are using steels designed to reduce labor costs in both tool building and maintenance. Using these steels to bring manufacturing costs and lead times to a more competitive level will do much to allow the domestic industry to concentrate more on selling its built-in advantages—such as language, creative design local service and quality. The playing field will begin to tilt back our way.

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