The Castrip® Advantage

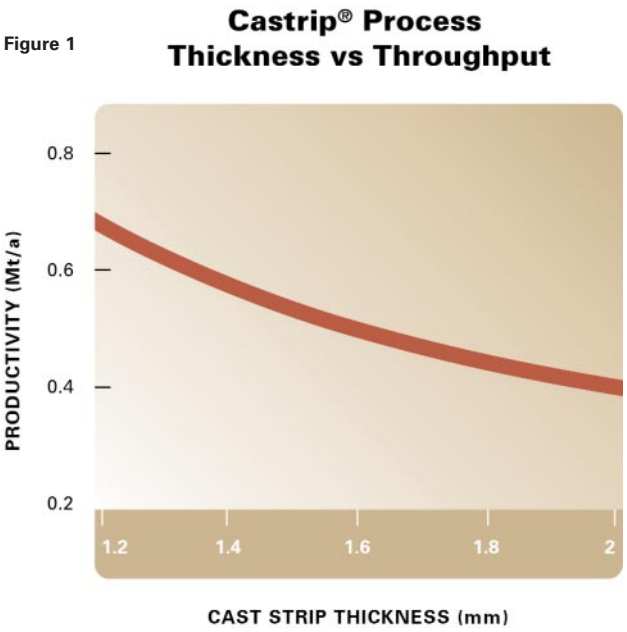
Faster. Smarter. Thinner. Better. These words capture the spirit of the Castrip process. They signify the advantages that the Castrip process offers to steel consumers and producers around the world.

FASTER

Production & Delivery

One of the significant findings of Project M was that the Castrip® process operates most efficiently when casting thin products at high speeds. In fact, the thinner the product gauge, the faster it can be produced. This counter-intuitive reality means that the actual tons produced per hour increases as the gauge of the as-cast material decreases. This is opposite to virtually every other steel processing method. (See Figure 1.)

Figure 1



This characteristic results in a faster production line and a more responsive order and delivery timeline for Castrip products, allowing customers to maintain an as-needed inventory, increase their own efficiencies and reduce storage costs.

Another significant consideration in any large operating facility is machine availability time. Again, Castrip holds a considerable speed advantage. The technology is based on a patented roll cassette design, which facilitates rapid roll changes between casting sequences.

Castrip plants are also able to quickly change the properties and thickness of the finished products, due to the nature of the caster and the critical mechanisms that monitor and control production. In fact, the unique microstructure produced by the rapid cooling ratesthrough solidification provides greater opportunities for variation in final properties. Therefore, customers will be able to order and receive steel for their specific applications quicker than ever.

SMARTER

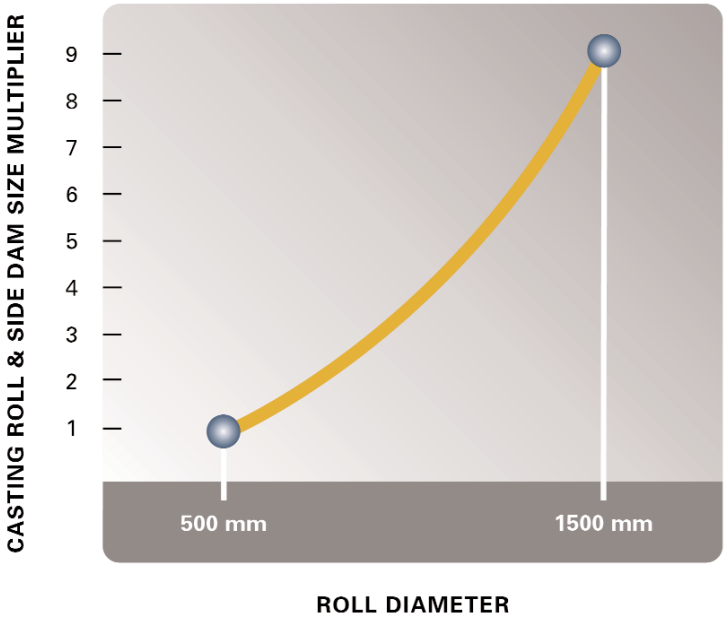
The Financial Perspective

As is the case with any casting technology that produces material at true "near net shape" dimensions, the Castrip® technology offers considerable savings in capital outlay, completion and delivery times and energy costs.

One aspect of the process that represents a capital cost savings is the size of the casting rolls. With more than a dozen years of theoretical and practical investigation, BHP, IHI, Nucor and Castrip LLC have determined that the optimal diameter for casting rolls is around 500 mm. These rolls are cheaper and much simpler to manufacture, maintain and refurbish than unnecessarily large diameter rolls.

The diagram shown in Figure 2 indicates the relative size of the casting rolls and side dams as a function of diameter. For example, tripling the diameter from 500 mm to 1500 mm results in casting rolls that are 9 times larger in volume - translating into higher material and manufacturing costs of the rolls.

Figure 2 **Relative Casting Roll & Side Dam Size**

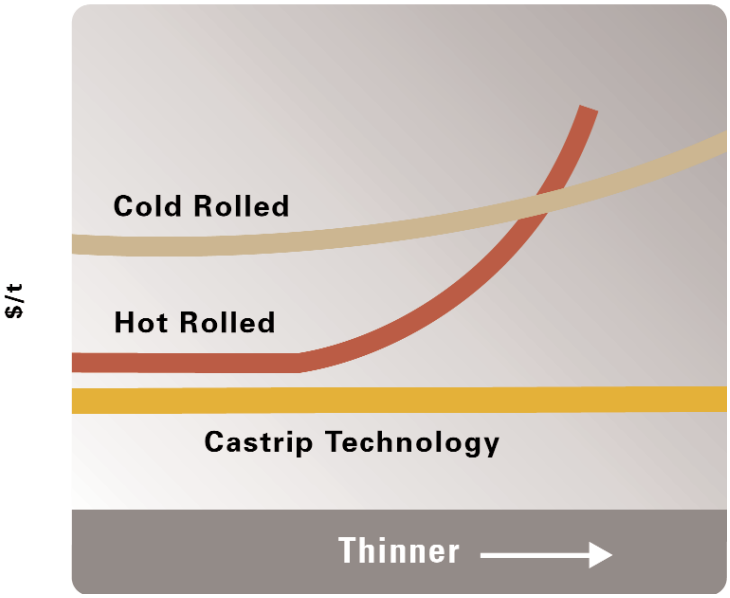


Ideally suited for production levels of approximately 500,000 tons per year, the cost of a Castrip unit is equivalent to thin slab casting on a cost per annual ton of installed capacity basis. Thus, the requirement for capital outlay to enter the flat rolled market is drastically reduced.

The Castrip process also makes economic sense for smaller mills, allowing producers to better manage expansion and capital risk. Since a Castrip mill can operate very profitably producing 500,000 tons per year, it represents a significantly more advantageous scale of operations compared to integrated mills, which must produce 4 million tons and mini-mills which must produce 1.5 million tons to achieve profitability.

Operating costs are another key advantage of the Castrip technology. Due to its higher productivity as cast thickness decreases, the operating cost curve is expected to be flat. (This advantage is represented graphically in Figure 3.)

Figure 3 **Relative Operating Cost**



Add to that the fact that light-gauge products are generally higher priced, and the Castrip process has the potential to yield very high margins.

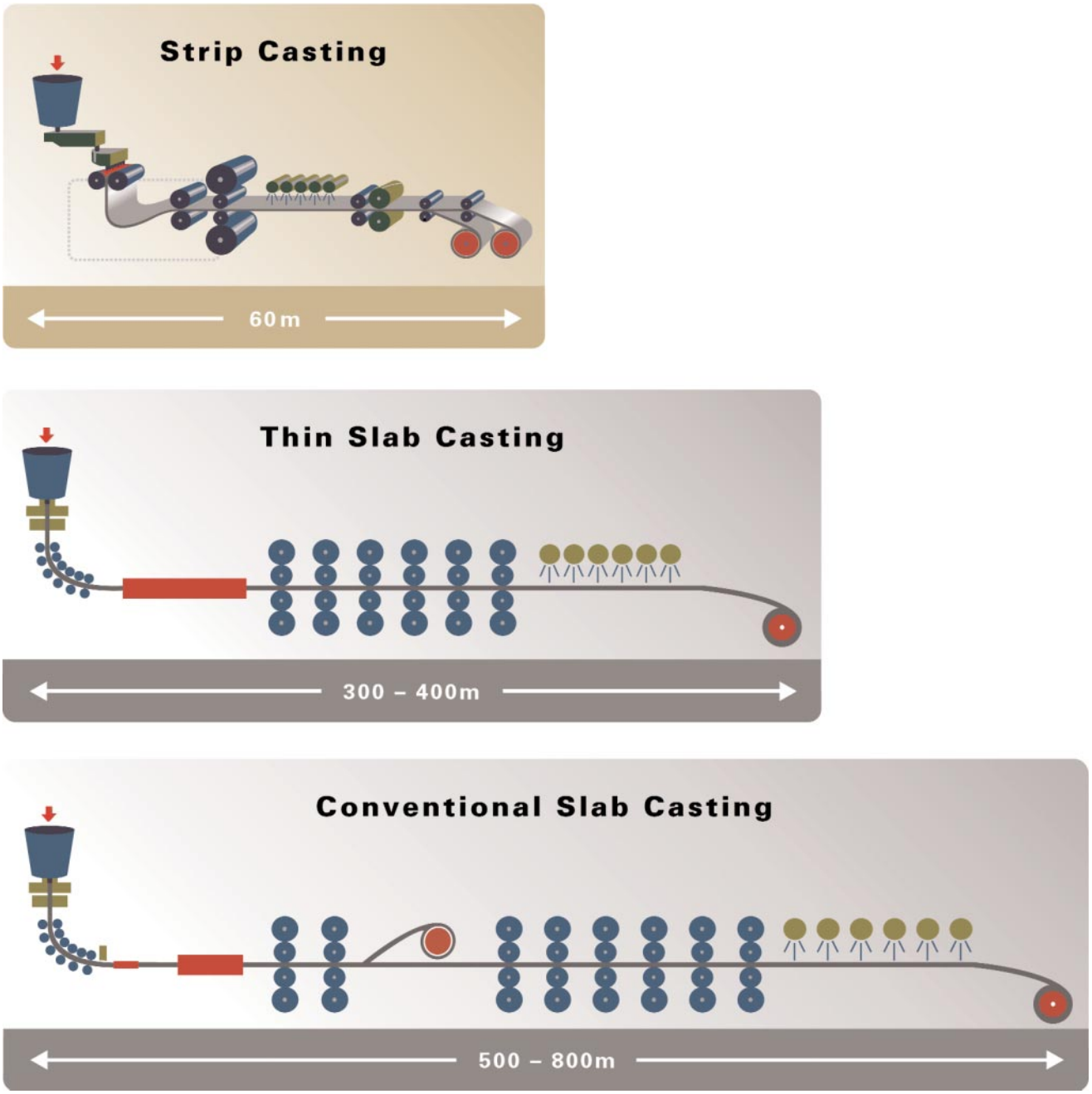
SMARTER

Minimized Environmental Impact

One of the most striking differences between the Castrip® process and conventional slab casting is the scale of the operations. A Castrip plant requires 10% of the land used by mini-mills and only 1% of the land required for a conventional integrated mill.

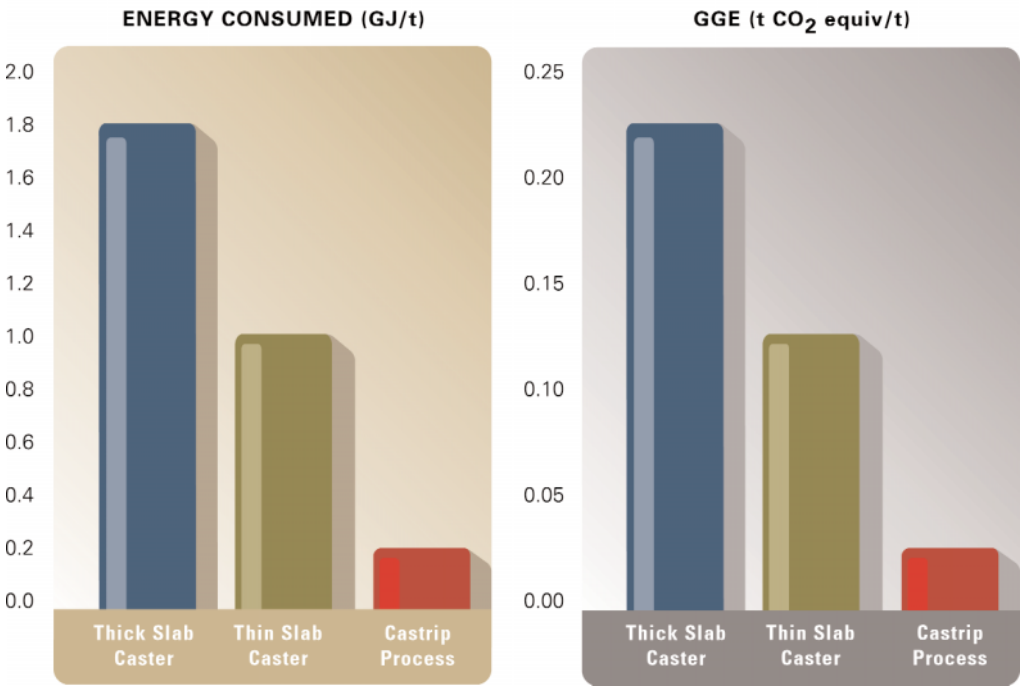
A conventional integrated steel mill that produces flat rolled products via blast furnaces and oxygen steelmaking requires 2,000 hectares (5,000 acres) of land and produces approximately 4 million tons per year. Mini-mills utilizing electric arc furnace (EAF) steelmaking require 200 hectares (500 acres) to produce approximately 2 million tons each year. By comparison, a Castrip facility requires only 20 hectares (50 acres) of land, with an expected annual capacity of 500,000 tons, making the technology ideally suited for micro-mill steel production from a greenfield site. The significantly smaller land requirements minimize environmental impact as well as capital costs for a new facility.

Figure 4



The illustration in Figure 4 also indicates the magnitude of the extra equipment required for both thick and thin slab casting. Because of the extra equipment and the time and energy required to reduce slab thickness, conventional methods utilize vastly greater amounts of energy. In fact, as illustrated in Figure 5, the Castrip process uses up to 90% less energy to process liquid steel into hot rolled steel sheets. In addition, the Castrip process will reduce greenhouse gas emissions by up to 80%. The environmentally friendly nature of the Castrip process should also facilitate easier and shorter environmental permitting.

Figure 5 **Energy and Emissions (ladle through hot band)**



A final positive environmental impact associated with the Castrip process is the ability to make better use of scrap and recycled steel. Due to the high rates of solidification inherent in the Castrip process, segregation of residual elements in the steel does not occur. This means that steel cleanliness requirements are not as restrictive and that scrap supply to a Castrip facility can be of lower overall quality. As a result, recycling and reuse of steel scrap that would normally not be suitable for sheet steel production is now possible.

THINNER

Ultra-thin Gauge Products

In sheet steels, thinner is more valueable. Thickness of as-cast product from the Castrip® process is less than conventional hot rolled products. With the single stand in-line hot rolling mill, ultra-thin products of less than 1.0 mm can be produced. The long-term goal is to produce ultra-thin cast strip as thin as 0.7 mm (0.028"). It is interesting to note that as the cast thickness is reduced, the productivity of the process actually increases.

Because the Castrip process operates best when making thin products at high casting speeds, exciting opportunities are now being created for new sheet steel product categories. The potential exists for the Castrip product to be used in many applications that were not previously possible for hot rolled material. Several market segments that could initially benefit include structural decking, purlins and light-gauge steel framing, as well as tubular goods and structural applications such as racking.

Due to its thinness, the Castrip product can also be used as a direct replacement for cold rolled material in many applications. Short term plans include the production of galvanized products directly from the caster without the need for further cold rolling.

The dimensions of Castrip product and the resulting emerging product categories can be attributed to the use of smaller diameter casting rolls and their unique ability to cast thinner strip. As the roll diameter decreases, the contact time between the solidifying strip and the roll surface also decreases, producing a thinner shell. The 500 mm diameter rolls utilized in the Castrip process are ideal for casting strip thickness down to 1.0 mm.

BETTER

Product Quality

The Castrip® process results in a high quality, as-cast product with excellent mechanical properties - virtually eliminating the need for further hot or cold rolling. The surface quality and formability allow direct replacement of cold rolled sheet steel in many applications, particularly as a substrate for metallic coating.

In addition, the high cooling rates achieved during solidification result in a unique set of properties that allow the Castrip product an unprecedented flexibility in product range and capabilities compared to conventional casting and hot rolling methods. Research has demonstrated that the Castrip technology is capable of casting both austenite and ferrite stainless steels.

In addition, the smaller casting rolls used in the process yield a better edge quality because they require smaller side dams. These refractory pieces are set against the ends of the casting rolls to contain the melt pool. Refractory materials are utilized for these side dams and are consumed in the process, which makes it easier to prevent freezing along the ends of the rolls.

Greater control over distortion also contributes to improved shape and dimensions in the cast strip. As the casting rolls heat and cool through each revolution during the casting process, thermal stress can lead to distortion of the casting rolls, but BHP and IHI experience has shown that thermal distortion is more easily managed when smaller rolls are utilized.