THE ECONOMICS OF LONGEVITY

By Robert Hunter

Let's imagine. You buy an automobile. After five years, its maintenance and repair costs get really high and the car no longer performs well. Sounds like you didn't get a very good deal. What if it lasts for ten years, instead of five year? Well, that's certainly better, but nothing to brag about. And, what if it lasts for twenty years? That was a good purchase!

IRON MAKING VIA BLAST FURNACES

Now, instead of automobiles, let's think about reduction plants; plants that make iron from iron ore. Most of the world's iron is made in blast furnaces. People generally think of blast furnaces as lasting forever because they do last for a very long time. According to Vdeh (Stahlinstitut Vdeh - Verein Deutscher Eisenhuttenleute), there are over 850 functional (operating or being held in reserve) blast furnaces in the world. Of these, Vdeh has data for about 640 showing the age of the furnaces. 175 of them are over 40 years old. The other 465 were built since 1971. Most of the currently operating blast furnaces were built in two surges of capacity addition, 1965-80 and 1995-present. The latter surge is primarily the building of many furnaces in China and also quite a few in India.

But, from time to time, blast furnaces must be relined, and often a relining is a major project tantamount to building a new furnace. Today, it might cost from $100 up to $300 million to reline a furnace. The cost of a blast furnace reline is comparable to the total cost of a direct reduction furnace, so, obviously blast furnace owners strive to reline as rarely as possible; that is, to extend the life of each campaign. As recently as the 1970's, blast furnace campaigns typically lasted only about five to seven years. But, today, with improved maintenance techniques and improved materials, campaigns easily extend beyond twenty years.

The oldest blast furnace in the United States is at RG Steel (the old Wheeling-Pitt) near Steubenville, Ohio. It was built in 1904, but relined as recently as 1987. The only parts of the furnace that dates back to 1904 are portions of the foundations. Similarly, the oldest operating blast furnace in the world is the Ural Mining and Metallurgical Company (UGMK) furnace at Serov in Russia. Though originally built in 1897, it was most recently relined in 2006.

Vdeh lists eight blast furnaces worldwide that predate World War II, but only one operating with a lining older than 1971. Incidentally, of the two dozen oldest blast furnaces operating worldwide, twenty of them are either in the United States or in Russia.

Figure 1 is a chart of the operating blast furnaces in the world plotting the annual capacity of the furnaces against the year they were built. A few points are obvious; first, the dearth of furnaces from prior to 1940. This is not because there were not furnaces then. Actually there were more than there are now. When US Steel was formed in 1901, it alone operated 78 blast furnaces. But, as one might suspect, those furnaces were old and small, typically only about 100 thousand tons per year each and they were built and operated with what is now antiquated technology. The second point is that there was a huge surge of capacity building in the late-1960's and throughout the 1970's. Then there was an absence of new capacity added as the aftermath of the oil crisis struck the steel industry and it almost completely stopped growing. A second surge occurred as the Chinese steel industry grew at unforeseen rates. Today, China produces more than half of the world's hot metal, and more

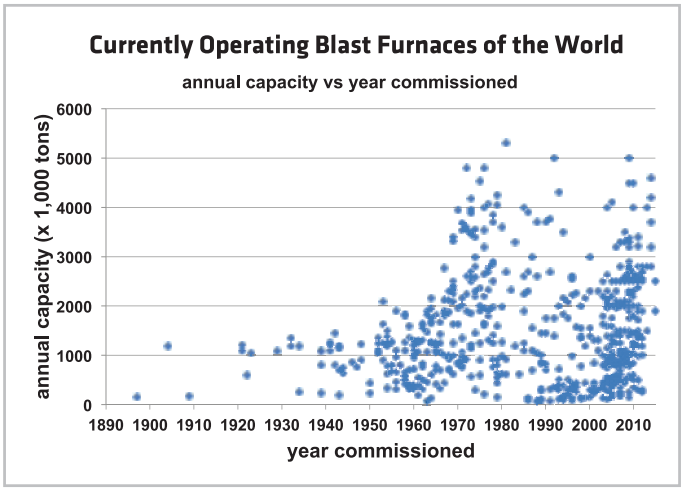

FIGURE 1 *Operating blast furnaces of the world*

than two-thirds of the world's hot metal is produced in four East Asian nations, China, Japan, South Korea and Taiwan.

IRON MAKING VIA DIRECT REDUCTION

With that background in mind, how long does a direct reduction furnace last? *Figures 2* and *3* are charts showing the lifespan of the two major direct reduction processes. These two processes represent more than 99% of last year's gas-based DRI production.

Figure 2, MIDREX® Direct Reduction Plants, shows clearly that a MIDREX Plant continues to operate, almost without end. The two original demonstration plants built for Oregon Steel Mills at Portland, Oregon ceased operating after the cost of natural gas to the plants rose to more than ten times the original cost. Similarly, the oldest full scale plant at Georgetown Steel, now ArcelorMittal Georgetown, stopped operating when the price of gas rose to a multiple of original costs. Even though it is now dismantled, much of the plant and equipment from Georgetown continues to operate at sister ArcelorMittal MIDREX Plants (for instance, the reformer tubes were moved to a sister plant). With the exception of the two plants in Nigeria which are located on a site that is economically very difficult to operate (no vessel larger than 5,000 tons can dock at the site), every

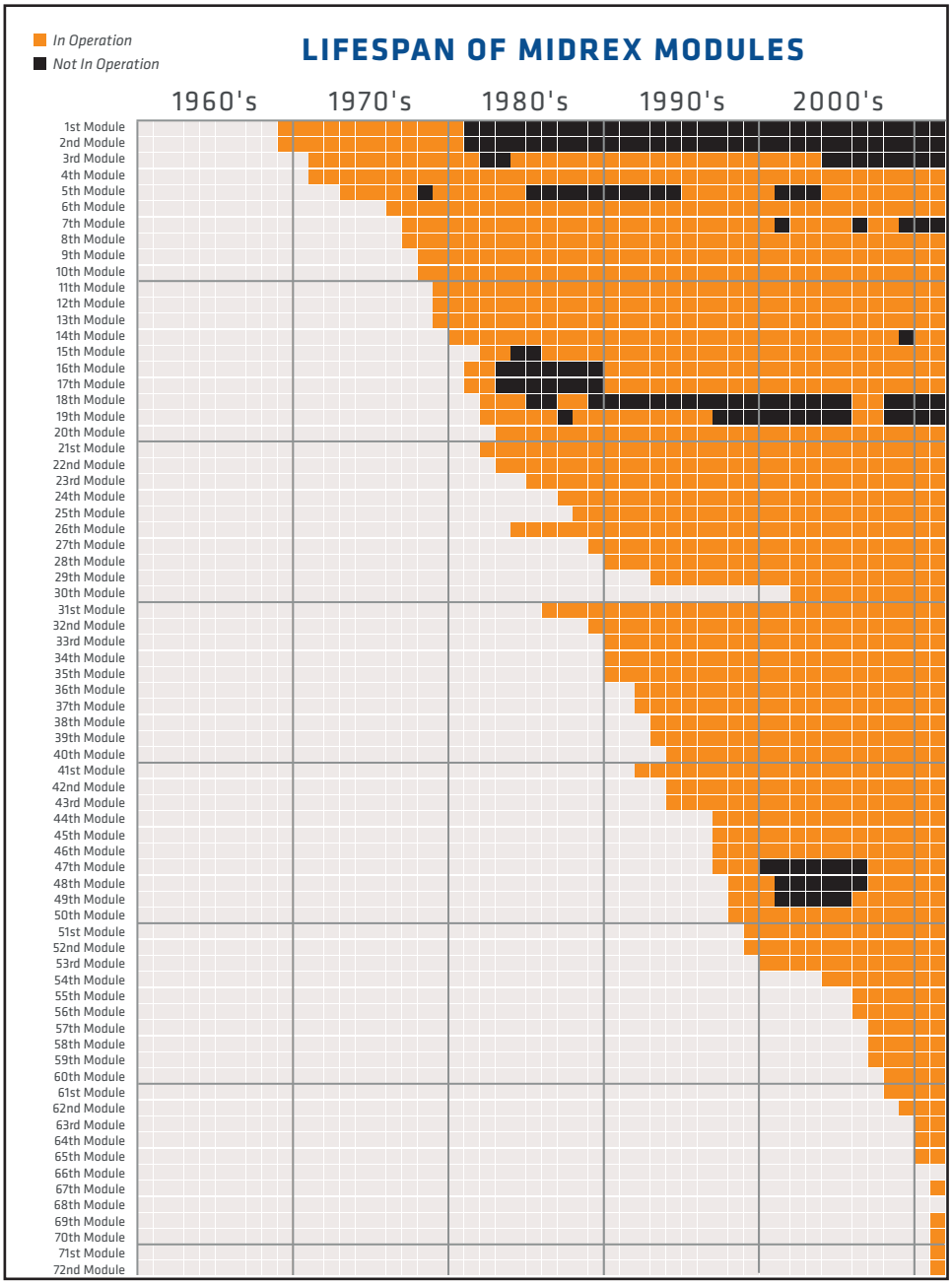

FIGURE 2 *LIFESPAN OF MIDREX MODULES*

FIGURE 2 NOTES:

- Two modules ceased operations when the cost of their natural gas exceeded ten times the cost when the modules were constructed. They were later scrapped.
- One module ceased operation when its gas supply got to eight times original cost. It was later used for parts at sister plants.
- One module is idled because the steel works has two modules but is no longer producing at a rate sufficient to require both modules to operate simultaneously.
- Two modules were moved from Germany to India.
- Two modules were constructed in an uneconomic location where vessels no larger than 5,000 t can navigate.
- Two modules were moved from Scotland to the U.S. and then moved again to Saudi Arabia.
- One module was moved from the U.S. to Trinidad.

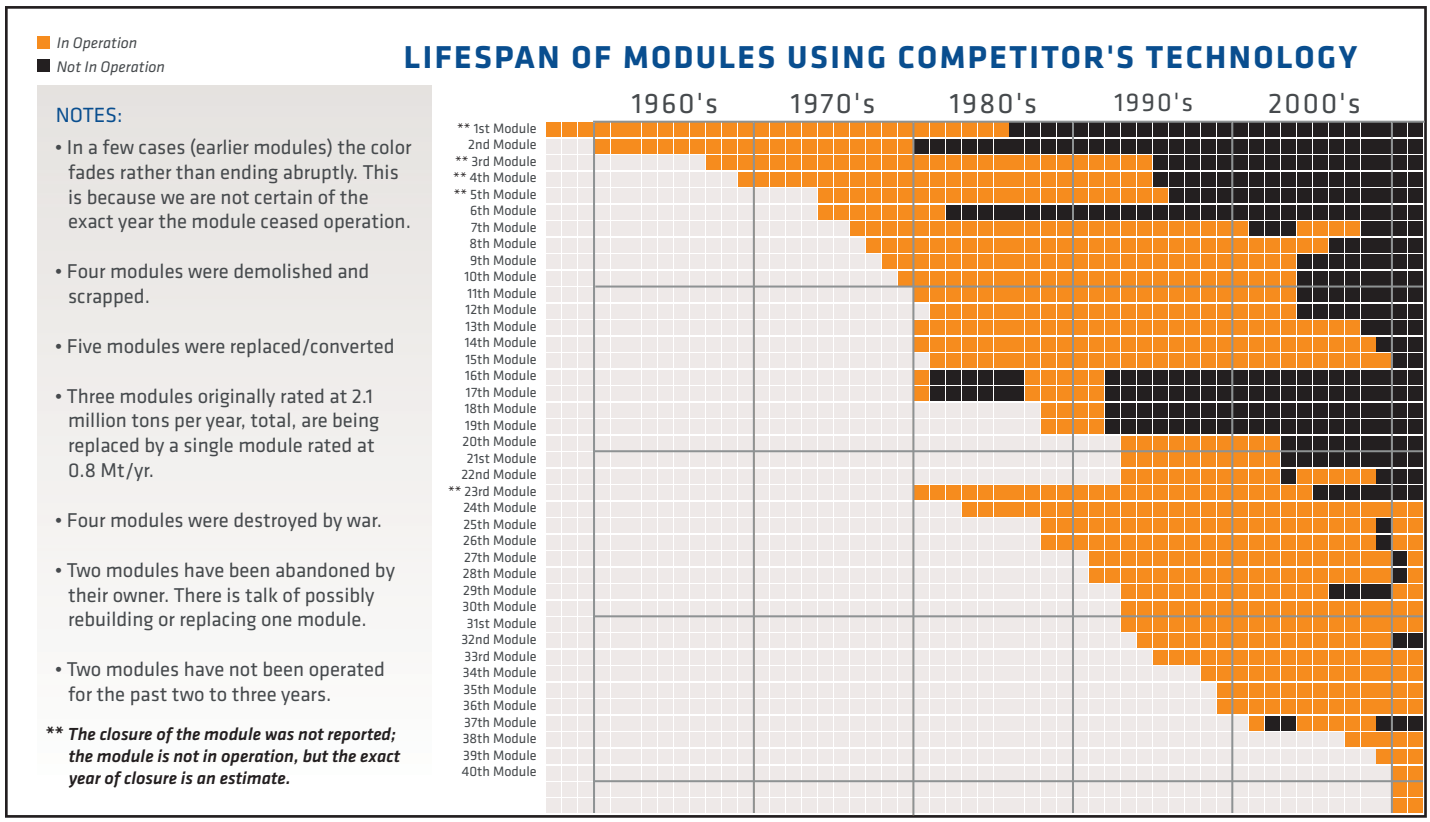

FIGURE 3 *LIFESPAN OF MODULES USING COMPETITOR'S TECHNOLOGY*

other MIDREX® Plant ever commissioned is still in operation. In fact, in a few cases, when gas prices have risen too high, MIDREX Modules have been moved to other sites and continue to operate. There are seven cases of MIDREX Modules being transported to other sites in order to take advantage of more favorable economic conditions. Two modules were in fact moved twice! Originally built for The British Steel Corporation at Hunterston, Scotland, after the gas price rose by four-to-one, they were transported to Mobile, Alabama in the U.S. where they were operated by Corus Steel, but again relocated when the price of gas rose multifold. The modules are now in operation at Dammam, Saudi Arabia where they produce MIDREX Iron for Al-Tuwairqi Steel.

The oldest MIDREX Module in operation (or reserve) is the one at Hamburg, Germany run by ArcelorMittal Hamburg. Commissioned in 1971, it has been in operation for more than 40 years. First designed to produce 320 thousand tons per year, it was later expanded by the addition of two reformer bays to make 400 thousand tons per year. To date, it has made over 13.5 million tons of MIDREX Iron. That is not the maximum production by a single module. Being relatively small compared to more modern modules, the Hamburg facility has been surpassed by at least 13 other MIDREX Modules. Currently the record holder is the module at Acindar in Villa Constitucion, Argentina which is approaching 25 million tons.

In sharp contrast, the modules built by the major competitor shown in *Figure 3* have not shown the same ability for long lasting production. First commissioned in 1957, none of the modules built prior to 1980 remain in operation and only four of the sixteen modules commissioned in the 1980's continue to run. Altogether, out of 39 modules commissioned by 2011, 25 have been shuttered. It is completely opposite of the situation where MIDREX® Plants, when confronted with difficult natural gas costs, tend to be moved, these plants, once old, tend to be abandoned in favor of replacement with new modules and/or conversion to incorporate newer technology.

So let's return to the automotive example. In case of Blast Furnaces, technically they could last forever; however, there may not be a single original part left after a certain period of time. If a BF was a classic car it might still look the same and perhaps perform even better with these overhalls, but at a significant cost. And sometime down the road (sorry for the pun) you'll have paid to keep the vehicle a few times over depending on

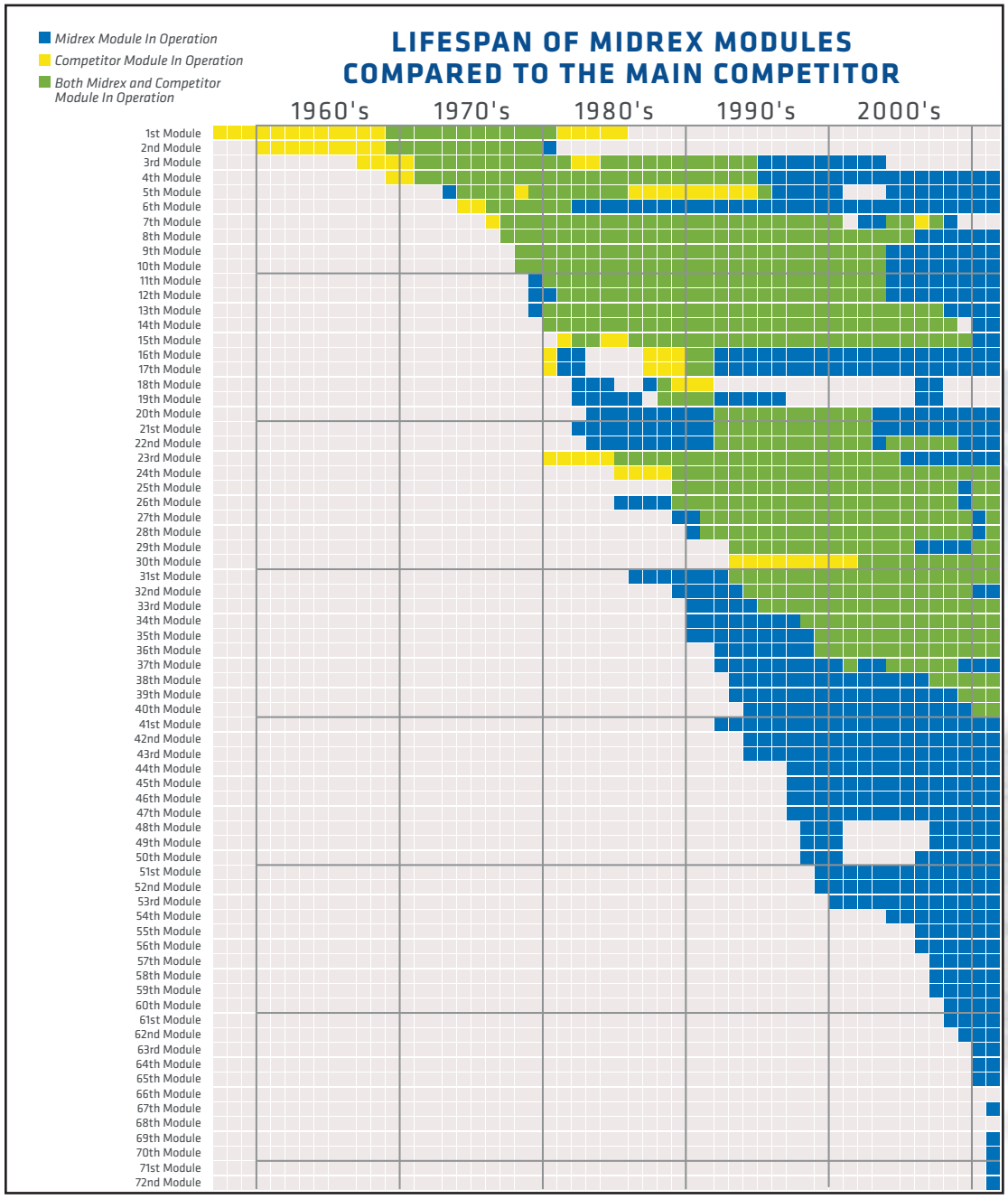

FIGURE 4 *LIFESPAN OF MIDREX MODULES COMPARED TO THE MAIN COMPETITOR*

long you do run it. If DR Plants, were automobiles you'd see variance just like with many makes and models of cars today. All would require regular maintenance to run well, but you will notice that some cars depreciate and need to scrapped sooner than others. Others apparently never seem to die. Put on some new tires, replace the 8-track with satellite radio and a few of these cars will last for generations.

People will continue to buy ironmaking plants for various reasons. Some may be for looking for short term opportunities, other looking for many many years to come. In the field of direct reduction, MIDREX® plants top annual production every year and more remarkable than that is that there are MIDREX® Plants that are more than 40 years old and in many cases can outperform newer competing technologies- **that is the definition of a good deal.** ■