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Stephen Montague on DRI and leading Midrex Technologies

Market trends for tin, lead, lithium, graphite and scrap

MIDREX TECHNOLOGIES

Stephen Montague

'We want people who have the mindset to really love and serve others'

Midrex Technologies, owned by Kobe Steel Ltd of Japan, sets great store by the development of the major DRI and HBI production plants that it designs, supplies, and helps to maintain globally. President & CEO Stephen Montague tells Richard Barrett that he is passionate about the importance of people in his company's success and the attitude and focus needed to have a positive impact in a decarbonizing steel industry

When Midrex Technologies President and CEO Stephen Montague's colleague Robert Hunter – a long-serving, senior employee of Midrex and well known guru of all things HBI and DRI related – retired five years ago, the company's quarterly publication *Direct from Midrex* described Hunter as the personification of the business. The same could be said for Montague himself, with 34 years of service to Midrex and the experience of succeeding in multiple roles in the company – especially given his strong personal belief in the company's mission to love and serve others. He thinks as deeply about the human element as he does the technical implications of applying the company's technologies as the shape and priorities of the international iron & steelmaking industries evolve. His current focus and passion are to advance Midrex's technologies and people in a decarbonizing steel world, in which the attractions of and logic for EAF-based steelmaking and the direct reduction of iron are growing ever stronger.

He appeared as a modest, self-effacing leader during a mid-March interview with *Metal Market Magazine*. "I'm a blue-collar man in a white-collar job," he said with a smile and went on to recall that his first job with Midrex Technologies, back in 1987, came about as a financial necessity.

"I was in college and working for a metal fabricator, but that wasn't working out," he said. Unhappy with the job, he decided to leave.

"For a 19-year-old, that was a traumatic experience because I needed the money. When I left that job I didn't know what I was going to do. I was blessed to have an opportunity at Midrex to become a draftsman for the summer, and that got me started," he recalled. "Someone who knew me saw that I was struggling and gave me the chance," he explained.

'I think the role of DRI is changing and the importance of DRI is evolving as everyone is moving towards decarbonization'

Montague started working at Midrex during the summers while he was in college. "I did that for a couple of summers but bluntly, I needed a change and ran out of money," he said. "I left school and Midrex hired me full time. I worked for 2-3 years, learned a lot, and had some good managers," he recalled.

"A couple of them kept threatening to fire me if I didn't go back and finish my degree. In retrospect, I know now what they were doing, but it felt very serious at the time. It was the kick in the pants that I needed."

Taking their advice and a leave of absence, he returned to school and took "about a year" to ▶

R&D

Research and development are the lifeblood of any organization supplying technologies – both as a means of constantly improving existing processes for commercial advantage, and as support for clients looking to refine their plant's performance to suit their particular unique set of operational circumstances.

Midrex president and CEO Stephen Montague has personally helped develop new technologies at the company and he is co-inventor of several patents.

Much of the company's R&D efforts today focus on decarbonization. "Simply put, we are absolutely R & D-focused on lowering emissions," said Montague. "Not just the use of hydrogen, but also carbon capture and storage (CCS). Clearly, we have the technology to capture the carbon dioxide. We have to come up with economical solutions for what to do with it or where to put it," he explained.

"We additionally believe in merchant metallics *[see main article]*. I think there are a lot of opportunities to improve HBI and its application not only in electric steelmaking but also in the blast furnace and BOF."

He explained that electric steelmakers are looking for HBI that has, generally speaking, a higher metallization and an adjustable level of carbon: "Not always higher carbon, but the ability to vary the carbon in HBI depending on the amount of scrap they are using along with it." They are also looking for HBI that is stronger: "Something that will hold up even better to the rigors of shipping from location to location and will maximize the Fe yield."

There is an opportunity to look at lower-Fe feed materials (less than 67-68% Fe DR-grade pellets), to produce HBI that is better suited for the blast furnace and downstream steelmaking. "But there are a number of challenges beyond reducing lower-Fe material in DR plants, such turning the DRI into a quality briquette that can be sent to steelmakers – something we are working on," said Montague.

"If the world decarbonizes and everyone wants scrap, there will not be enough of it and they will need other sources of metallics, such as DRI," he said. "If users turn to DRI in a much stronger way, where will all the high-Fe pellets come from to satisfy the demand? DR plants need to have the flexibility to process lower Fe feed materials."

finish his Bachelor of Science degree in mechanical engineering at North Carolina State University. Returning to Midrex, which has its headquarters and R&D Technology Center in Charlotte, NC, it was not long before he got a taste for the excitement and challenges of working on-site at a plant location.

"I've always considered myself a technical person – not your PhD type but someone having a good aptitude for understanding the technical side – and that led me to really understanding how plants operate," he explained.

He said that one of the turning points for him was moving from the office environment, where the plants are designed, "to actually operating the plants and helping to get them up and running. When you have to work through issues and troubleshoot problems, your mind starts to see ways that things could be done better and before you know it, you're in technology development or R&D."

Life-cycle satisfaction

Montague said that the highlights of his career have come through the life-cycle satisfaction that planning and delivering plant projects offers. "You start with the dream, you design it, you build it, you start it up, you operate it, you see the mistakes, and then you fix them… and of course, there are the people you encounter along the way – that is the pay-off," he said.

He likes seeing how the pieces fit together, and he appreciates that "Nothing is really linear, you go around and around."

One of the earliest opportunities to experience that satisfaction came from a one-year posting to work on a project in India in 1994-95. "There was a lot of trust placed in me," he recalled. "I was a twenty-something responsible for the commissioning and start-up of a new MIDREX® plant in a place where at that time there was literally just a rice paddy between the river and the mountain. Now when I go back to JSW Dolvi they make about 5 million tonnes of steel each year, and you have to search to find the DR plant among all the other equipment."

He is also proud of the benefits that plant has brought to the local community in terms of well-paid employment. "We have a colleague working at one of our other facilities in the Middle East, who said that he was a boy when the Dolvi plant was built and his father, who worked in a nearby town, got a job at the steel mill. Because of that job, his father was able to put him and his siblings through school, which he would not have otherwise been able to do. He and his siblings have become quite successful – he is now a manager of a Midrex Plant."

Montague acknowledged that his current day job is pretty calm compared with working in the field, but he draws motivation from such memories: "When things really get tough and you wonder why you are doing the things you are, it is those real-life events and stories of the people you have met and worked with along the way that push you a little harder."

Reaching his present role as president and CEO was a further 23-year journey along a path that encompassed both technical and commercial roles, including engineering, operations, technology development, and sales. He was promoted to president and COO in 2016, and was named CEO the following year.

New steelmaking landscape

Montague acknowledged that the landscape for steelmaking has changed dramatically during his career, and that DRI plants have seen substantial increases in their annual production capacities.

"When I started as a draftsman, we were working on a state-of-the-art plant for Venezuela that was rated at 1 million tonnes per year (tpy) – amazing at the time! Within 6-7 years of that 1 million tpy

plant, we were seeing plants make close to 1.5 million tonnes. Last year, the Tosyali plant in Algeria set a world record, producing more than 2.23 million tonnes," he noted.

But the biggest factor in global steelmaking – the enormous growth in China's steelmaking capacity since the turn of the millennium – has had a relatively small and indirect impact on the DRI sector up to now, Montague observed.

"Clearly, the impact that China has had on the steel industry is unimaginable from what is was back in 2000, but most of that production is by traditional integrated mills. DRI is a niche material – or let's say it has been a niche – particularly if you look back to the turn of the century. I think it is safe to say that 'as EAFs and electric steelmaking go, so goes DRI.'

"Although Chinese steelmaking growth has had an impact on the steel industry, it has not had as big an impact on DRI per se. The impact that we've felt has been collateral, in the sense that the DRI-based steelmakers that we deal with have seen their business affected, and some now capitalize by providing merchant HBI to China. But I think the role of DRI is changing and the importance of DRI is evolving as everyone is moving towards decarbonization."

"It is critical that we really look at ways to move ahead together, as an industry," Montague observed. "I look at the trends and we are absolutely going to see the growth of electric steelmaking. We are already seeing that in China, as well. We have to push for lower emissions and find ways to make high-quality steel lighter and stronger.

"If you start to put those pieces together, they really point to DRI. I don't know how you get there with scrap alone – there is not enough of it, and even if you could get it, it is not always of the quality you need. It really is a driving force behind DRI use," he declared.

'We have to push for lower emissions and find ways to make high-quality steel lighter and stronger'

He said that he thinks that decarbonization is the biggest challenge to face the iron & steel industries in decades. "In my career, I have experienced the steel business cycles. Having to manage through them and now Covid-19 has been hard. But looking at the challenges ahead to decarburize the industry, it is going to be an even harder journey. It is not like a light switch that you just flip and everything is okay – it will require companies to transform how they think and their production facilities and everyone must be prepared to help. That is a role that DRI is going to play."

Hydrogen-based steelmaking

The global steelmaking industry's efforts to decarbonize production lie at the heart of the future for DRI production, and so they are also fundamental to the future of Midrex. Consequently, Montague sets out the case for expanding DRI production, stressing that solutions provided by existing and future DRI technologies offer a flexible transition from today's iron & steelmaking processes towards much lower carbon-emissions production.

"There is a reason why iron and steelmaking is one of the biggest producers of carbon dioxide emissions [about 7-9% of total emissions] and it comes down to the fact that making iron is energy intensive," he began. "Whether we make iron in a blast furnace or a DR plant, it's still energy intensive. But there are more options to select lower CO_2 energy sources for DRI production," he added.

In his view, there is no quick and easy fix. "We have leaders with an entrepreneurial mindset, which is fantastic because it gives us a vision of where to go. But the downside can be wanting it all and wanting it now. In many cases that can be self-limiting because it can become more difficult to take the first step.

"I see real challenges trying to make decarbonization happen on a significant scale in the very near term," he noted.

He acknowledged that there are some pioneers "who can really put together the right ingredients to make smart projects geared towards 'green' steel." For example, he believes in the next 5 years there will be some large-scale projects to make DRI from hydrogen, moving closer to 'green' steel, but "there will not be a long list of those."

Montague observed that at the opposite end of the industry's opinion spectrum "there are naysayers who think that the hydrogen technology is so far off and unaffordable, etc. and that we should talk about it in 2040. That's the wrong conclusion," he stressed.

Supporting the journey

Montague does not underestimate the scale of the task ahead: "There is an enormous transition that steelmakers are going to have to undergo – it's a journey. I think DRI is part of this journey for steelmakers. Our aim is to help with that journey through providing a technology that uses a wide range of iron ore feed and lower CO_2 energy sources. We will continue using high-Fe feed materials in MIDREX plants, as is traditionally done for EAF steelmaking, and begin using lower-Fe feeds to make a product that is more suitable for a blast furnace or even for a new kind of melter – one that is electric-based but optimized for lower-Fe DRI.

"All the while knowing that when hydrogen becomes available, we start using it. If hydrogen is not available, we use natural gas, but we do it in a location where there is going to be affordable 'green' electricity in the future to produce hydrogen. We can bring carbon dioxide emissions down 50-60% relative to BF/BOF by making high-quality steel from a blend of scrap and DRI. When we transition to hydrogen, just think how much better we can do over time," Montague said, adding, "Why not start moving that way with the technology that we already have?"

The vision and message are clear, but are steelmakers listening?

"There is a groundswell of momentum that is pushing this way. It's unbelievable. Each steelmaker has a unique situation for their mill and they are all in search of lower CO_2 solutions," he replied.

He is sympathetic to the challenges steelmakers face wanting or needing to transition to other ironmaking processes: "I can really appreciate the deep traditions that come from making iron at an integrated mill on a particular site for a really long period of time. I understand the social implications of making that iron differently or maybe even choosing to not make iron at that site but to become an importer of iron and not just iron ore."

He said that there is a real dilemma facing steelmakers: "DRI really aligns well with where the industry needs to go in the future; the best location for DRI plants is where they line up with the iron ore and the energy sources today and tomorrow; and there are different ways to look at all of this.

"If integrated mills today want to move towards electric steelmaking but also control some of their own iron production, and they start thinking about making DRI on site, what does that look like? Are they really in a location where the energy is at the right cost to make it happen now and in the future? Are they really in the location where, from the capex point of view, they get the biggest 'bang for their buck' by putting a plant there? Should they build a small-scale or a large-scale plant," he said, using the gap between finger and thumb to represent the former, and a much larger one between the palms of outstretched hands for the latter to emphasize the point.

"When I look at this, I really start to favor a solution where a lot of steelmakers could benefit from not just importing iron ore but by moving towards electric steelmaking and importing low

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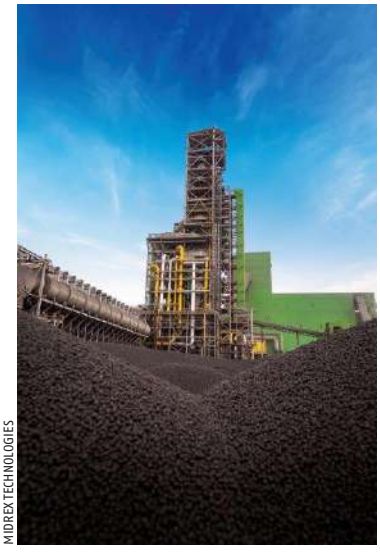

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The Tosyali plant in Algeria produced more than 2.23 million tonnes last year

CO_2 metallics produced in favorable locations at scale with MIDREX technology, using the energy source that is available today and operating with a wide range of iron ore quality, knowing that they have the flexibility to change to hydrogen as it becomes available.

"Could steelmakers benefit from clubbing together to share the offtake from these larger plants that produce at scale in the right locations? You bet!"

Location is key

Just as in the real estate business, it is often said that the three most important things to consider when buying a house are "location, location, and location." Montague said that his best advice to anyone looking to build a DR plant is to remember that, "the most successful DR plants are built around those kinds of notions, where any time you can align your iron ore source with your energy source and your market, it's boom time. The companies that find the best sites become the lowest-cost producers.

"There are some very special locations, even today, where you can align direct reduction with renewable electricity sources to generate hydrogen and start moving towards 'green' steel."

He also acknowledged the question of whether there has been enough progress made in hydrogen technology for there to be a lot of such locations to be available soon.

"Another factor is governmental assistance – how badly do governments want to make it happen? Does government assistance exist globally today? No, but the situation is changing rapidly and there are a few places where some pioneers will start showing the way. Those pioneers are moving sooner than people think," he added.

"But it doesn't mean that everybody else should sit on the sidelines and wait. This is where we really are missing the possibilities with DRI," he opined.

Combining those views with Midrex's own strategy, he said the company's vision is simple. "We have a technology platform that is ready to produce DRI using natural gas today, hydrogen if it is available, and increasing amounts of hydrogen as it becomes available in the future. We have the ability to make hot DRI available on-site for electric steelmaking and to make merchant HBI to ship to steelmakers. This lower CO_2 direct reduced iron is relevant not just to an EAF but also on a merchant basis, in the case of HBI, to the blast furnace and BOF to help with their transition," he explained.

For example, Midrex Technologies recently signed a contract with Mikhailovsky HBI for a plant in Zheleznogorsk in the Kursk region of Russia designed to produce 2.08 million tonnes of HBI per year, with start-up of the plant expected in the first half of 2024. By replacing natural gas with 'green' hydrogen there is potential to decrease carbon emissions in the future. The contracted plant is capable of being converted to use up to 100% hydrogen as a reducing agent. The feed for the new HBI plant will be pellets produced from Mikhailovsky GOK iron ore.

By its own estimates, MIDREX Plants annually produce more than 60% of the world's DRI, as cold or hot DRI and HBI. According to data compiled by Midrex and audited by World Steel Dynamics, global DRI output increased to 108 million tons in 2019, which was a nearly 49% increase over output just four years earlier.

Finding the sweet spots

Montague said that places where natural gas is cheap today and will be cheap for some time into the future are the best locations for DR plants, but also where 'green' electricity is expected to be available and affordable as time passes. "Places where we can use low-cost natural gas today, with the prospect, in the same location, of using hydrogen from low-cost 'green' electricity in the future are ideal. Then we have everything that we need," he summarized.

He believes that as the major components of the hot end of integrated steel plants inevitably wear out, their owners will be forced to make tough choices. "Let's say you're an integrated steelmaker today and you have a blast furnace or a coke oven, and maybe even a sinter plant, and it's time for a major overhaul, which is a huge investment, what do you do? Where do you go to borrow the money for that capital-intensive project? Do you continue to invest in that technology for another 20 years with the way the world is pointing? I think the answer is 'no'."

He does not think that steelmakers are inclined to make those choices right now, nor that financial institutions are of the mind to invest in those types of conventional processes, but he pointed out that the same requirements will be there for the alternatives, and if it is not those, then "What is it?" he asked.

"If the answer is 'let's go to electric steelmaking,' realizing that there is not going to be enough scrap, then what can you do? There also has to be an investment in low CO_2 metallics.

'The attitude you bring to how you serve is just as important as the act itself'

From that point of view, you have to invest in a technology that allows you to make the right products today, at the desired quality, at a reasonable price, and with a lower CO_2 footprint, but also having the ability to get to zero carbon dioxide emissions over time. That is what Midrex offers," he explained.

"MIDREX plants are designed to run 40 or 50 years or longer, but no-one is building a DR plant today without knowing they have the ability to change, even if the plant starts with natural gas, to hydrogen over time. I think that is a very smart way to go forward from where we are today: acknowledging our constraints while having a solid plan for the future without grinding to a halt with the mentality that I have got to have it all and have got to have it now," he concluded.

To love and serve

Montague said that Midrex was not as deliberate about stating its management philosophy in the past as it is today, but he added that his management predecessors "were very much geared in the same way, and I am a product of that."

"We have two bottom lines: people and profits. If you just focus on the money side and do not take care of the people – and I mean our teammates, our customers, our community, and their families – then what have you gained? At the same time, you can't take care of people if you don't make a profit.

"It may surprise you, but at Midrex our stated purpose is to love and serve others. It is a recognition that most people will talk about serving customers and the notion of service, but the attitude you bring to how you serve is just as important as the act itself. We are a service company and that's where we really put our focus – serving people," he explained.

He added that the company philosophy is not a pager-turner for Midrex. "I think it is what we have been about for a long time. We are just being more deliberate and upfront about saying. 'You know what, this is who we are, and this is what we believe.' Maybe some CEOs might see it as a weakness, but it is really our strength. We do things for the right reasons and, you know what, things seem to fall into place."

Amongst CEOs, he is not alone in declaring that a company's most important assets are its people, but at Midrex, Montague sees it as "what gets the job done. It's what drives project and technology development – the minds behind where we go and how we get there – and for those reasons, we want people who have the mindset to really love and serve others."

A noble philosophy, certainly, but how is it encouraged and manifested in Midrex's people from recruitment through to retirement?

"I think it really starts with integrity," said Montague. "Integrity is a cornerstone you can build from and putting people in an environment where they see it being practiced by those all around them is certainly a huge encouragement.

"From the very start, when we are talking about a new person becoming part of our team, we want people who are ready to walk in, act honestly and fairly, and do what is for the good of all people," he added.

Just as for the steel business cycles of the past few decades of Montague's career, no doubt the steel industry will present more opportunities and challenges for all the businesses and people active in it as the journey continues along the road towards substantial decarbonization. When the two aims of taking care of people and of profits occasionally conflict along the way, it is then that very senior managers like Montague will draw on all their experience and integrity to get the balance right. "It's the hardest issue to deal with for a management team that cares," he concluded, but one that he and his colleagues are determined to handle effectively.