AFRICAN FUSION
SAIW
AUGUST 2015
Journal of the Southern African Institute of Welding

CROWN
PUBLICATIONS

Published four times a year and mailed out together with Mechanical Technology by:

Crown Publications cc

Crown House
Cnr Theunis and Sovereign Streets
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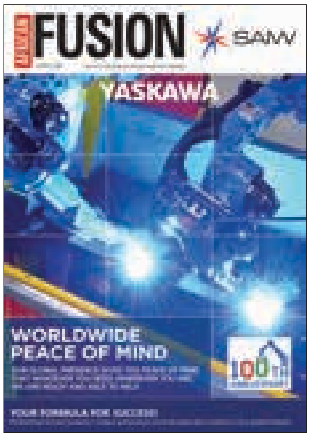
Cover design: Yaskawa

Production & layout: Darryl James

Circulation: Karen Pearson

Subscriptions: Wendy Charles

Printed by: Tandym Print



African Fusion talks to Yaskawa Southern Africa's Terry Rosenberg about the manufacturing challenges in South Africa and how the growth of robotic automation can help to improve global competitiveness, economic growth and employment prospects.

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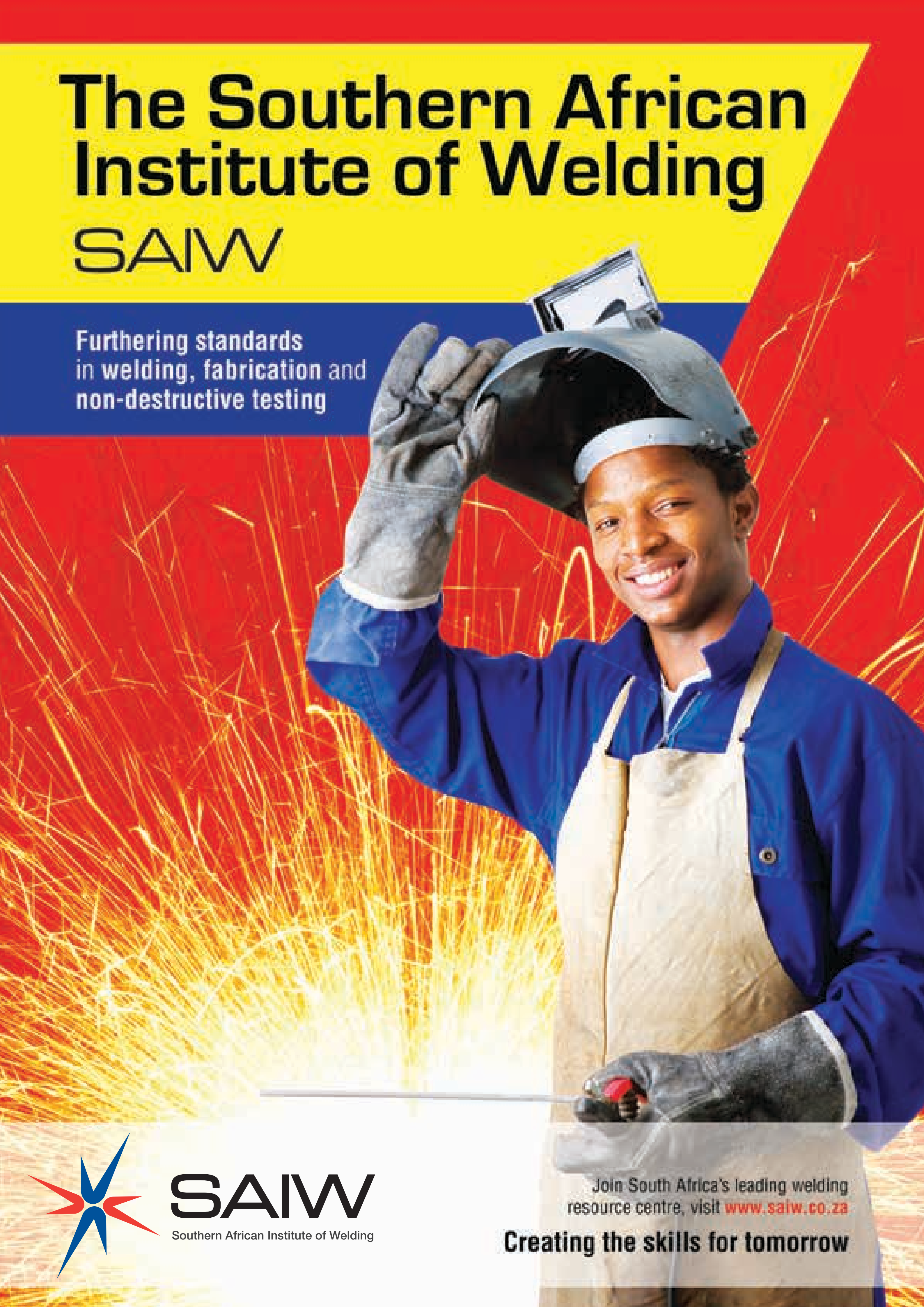
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SAIW
Furthering standards in welding, fabrication and non-destructive testing
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Jaco van Deventer, our 2015 WorldSkills candidate, has now returned home from São Paulo, Brazil. I think it is true to say that we have never had a better-prepared candidate. He performed well in all categories and was on track to earn the 500 points required for a Medallion of Excellence, but, at the last minute, he lost 15 points due to a leak in his pressure vessel. We know this was unlucky because, during training at the SAIW, he welded several leak-tight pressure vessels. If not for these points, Jaco would have achieved our best result ever.

Jaco had the right mindset and was dedicated and hardworking throughout the process, starting with the Young Welder of the Year competition earlier this year; during training at Steinmüller and in our Welding School; and at the WorldSkills competition. We would also like to acknowledge Steinmüller for the excellent support afforded to Jaco throughout the entire process. We have been on a continuous improvement path with respect to this competition and we are more determined than ever to continue along this path.

Clearly, the economy needs to boost employment and in particular skilled employment. Welding is a scarce skill that can help significantly in this regard. The SAIW is determined to renew its efforts to develop welding skills.

But we can't do this alone. A multi-faceted approach is needed that has to include government, industry and welder training Institutes and Academy's across the country. The SAIW welding school has pioneered the International Welder (IW) programme in South Africa and we are willing to co-operate with any of our country's stakeholders to promote and spread the use of this internationally developed and recognised welder-training programme. We believe it is well proven that this programme can produce good quality candidates in a relatively short period of time.

Welding is a skill that can only be developed via practicing specific tasks and set-ups that mimic, as closely as possible, the conditions involved in the field. My favourite quote comes from Gary player, who once said: "The more I practice the luckier I get." This speaks directly to what is required for welder training, well targeted practice. And that is where the IW programme is strong. It focuses on specific skills, such as welding around corners and in multiple awkward positions.

Related to this drive, I am also pleased to report that the SAIW Foundation board is now fully constituted and we have held our first meeting. The Foundation is about upliftement of previously disadvantaged people and offering them opportunities in the welding field. Our first four Foundation students are currently progressing well and should be qualified as competent IWs by the end of this year.

We have seen encouraging numbers of graduates passing through our Inspection courses this year. So much so that we will now have to have three graduation ceremonies in Johannesburg, one in Cape Town and two in Durban.

And talking about Durban, I am pleased to report that we are establishing a permanent facility in Westville, Durban, which should be fully operation by October. It will be very well equipped with two classrooms and a multi-purpose NDT training laboratory, which will enable us to offer a wide range of SAIW training courses.

I look forward to seeing you all at the SAIW Annual Dinner and Awards on September 11. We have some exciting entertainment planned and it is sure to be a good opportunity for the welding fraternity to relax, socialise and network.

Sean Blake

Fabrication in SA:
adopting world-class standards

In this article, executive director of the SAIW, Sean Blake talks about fabrication in South Africa compared to other countries of the world and makes some suggestions as to how we can do better.

"South Africa has the potential to be a world class fabricator of all steel products, but we are not yet paying sufficient attention to skills development and state-of-the-art quality management," Blake begins. "The rest of the world has moved ahead of us in these respects," he adds.

Generally speaking, Blake believes that South African fabricators have always been able to do a reasonable job. "But what we are doing today is often based on what we used to do in the past. Modern industrialised countries have moved on. They are now using modern technologies, not only to automate welding, but also to monitor and control welding processes – in real time," he points out.

Recently returned from the 68th IIW Congress and International Conference in Helsinki, Finland, Blake says that Finland has embraced modern-technology solutions across its industries. This contributes significantly towards making Finish industries – such as Metso, Outotec, Outokumpu, Kone, Cargotec and many more – globally competitive and successful. Notably in the welding industry, he lifts out Pema Welding Automation/Pemamek and Kemppi as world-leading adopters of modern technologies for welding. Pema automatic welding systems were installed by several South Africa-based fabricators for producing membrane wall panels for the Medupi and Kusile boilers.

"In a presentation by Kemppi, the presenter advocated moving the welding industry from '3D', dirty, dull and dangerous, to '3C', cool, clean and clever. This involved utilising digital technologies to improve weld quality and monitoring. In addition this would also aid in attracting the young generation to the industry," Blake recalls.

On the fabrication side, Finland has a very successful specialist ship building industry. Arctech Helsinki Shipyard, for example, builds icebreakers and other Arctic offshore and special vessels and is a forerunner in developing and applying technological innovations. About 60% of icebreakers that operate today were built in Finland.

"Modern overseas fabricators apply detailed quality management and they use technology to monitor and control the quality of fabrications in real time throughout the process. They also maintain high levels of traceability and identification, not only of product components, but of the personnel involved, the equipment and the consumables used, along with records of the monitored parameters applied during welding," Blake reveals.

While many South African companies have implemented systems such as ISO 3834 to manage weld quality and traceability, they haven't fully embraced modern technology systems in the ways we are seeing overseas, where communication technologies on the shop floor, real time monitoring and systems analysis are routinely applied to ongoing work," he says.

Step changing skills levels

Another step change needs to be made at the grass roots welder level, Blake argues. "We need a much stronger focus on improving skills. We know this is a problem because we have so few local welders that are able to produce the high-quality welds at the top end of the spectrum; the critical welds for powers stations, for example. Locally trained welders are typically assigned to non-critical welding tasks, while many of the more difficult and more critical welds are having to be done using imported skills," he tells *African Fusion*.

"As a whole country, our fabricators, government and training institutions need to put a lot more effort into up skilling local people to this higher level, so we can complete all fabrication tasks using skilled South Africans and even export these skills. The SAIW has long suggested that we follow the IIW International Welder programme in this regard. This course and qualification has proved successful the world over, and we believe it is the common factor for successfully developing higher level skills," Blake suggests.

The IIW Welder course involves a much wider variety of differently configured training and test pieces, so it is a better match for the situations welders have to deal with in the field. "Most welder training in South Africa is based on standard test pieces set up in simple configurations with little analysis of the overall quality of the weld. Therefore our welders tend to struggle when a weld needs to be analysed for code compliance, for example by radiographic analysis, to ensure adequate quality. This is even more difficult to attain when the weld is difficult to access or has to be performed in complicated positions.

"Welding fabricators tell us that when testing local welders, they seldom get a pass rate higher than 10%, while imported welders will almost all pass the same test. Clearly, this suggests that the quality of welder training in South Africa needs to be addressed," he asserts.

Blake's vision is for the widespread adoption and rollout of the IIW International Welder programme to all welder training schools, following which, schools need to be accredited as Authorised Training Bodies (ATB's) in the IIW scheme. "This is an imperative for any training school that is developing skills for the power generation, petrochemical and railway industries or for any other

The Kusile power station under construction during July 2015. The erection of Unit 1 (left) is nearing completion and local component and structural steel fabrication is now complete, leaving South African fabricators facing difficult times.

A Pemamek water wall panel being set up for fabrication at Steinmüller's Pretoria West facility. Pema automatic welding systems were installed by several South Africa-based fabricators for producing membrane wall panels for the Medupi and Kusile boilers. (photographed in 2013).

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safety critical welding applications," Blake advises.

In addition, he would like to see more welders trained in the use of modern welding technologies. "Welders need to be trained to embrace technology and welding automaton. Productivity in South Africa is, unfortunately, relatively poor and advanced technologies can have a significantly positive impact on quality and productivity. In addition, the younger generation has grown up in this digital age, with smartphones, tablets and computers. The use of technology is not new to them and it may, in fact, make welding a more attractive career choice," he adds.

Fabrication for a vibrant economy

South Africa has a large workforce, which is necessary when implementing large projects such as Medupi and Kusile. For these two projects, however, most local fabricators have now delivered on their allocated contract work and many are relatively idle right now. "This is having a serious impact on employment and the entire steel industry is struggling at present," notes Blake.

"I am a firm believer that we should immediately invest in more coal-fired power capacity. The key reason is that many of our power plants are using old technology, which is much less efficient, and they are also nearing (or beyond) their end of life. Replacing these power plants with newer, more efficient coal technologies would be a positive step towards reducing the carbon footprint of the country, because of the significantly better efficiency that new super-critical power stations produce," argues Blake, "Emissions will also be improved because much more effective emission control technologies can be installed," he adds.

"Our fabrication industry developed considerable amounts of experience through the Medupi and Kusile project work, so I am sure it will be able to build Coal 3 and Coal 4 power stations far more effectively now. All of the design changes and manufacturing challenges are resolved, so repeat projects would progress far faster and more cost effectively than either Medupi or Kusile," he predicts.

"We know that the period between 2008 and 2014 was a very vibrant one for South Africa's fabrication industry. The two power station projects, along with the World Cup stadium construction projects, had an enormously positive effect on the economy as a whole, shielding us from the worst effects of the global economic downturn," Blake reminds *African Fusion*.

"Projects such as these have a huge multiplying effect on downstream and upstream industries, creating jobs in mining and steel making; engineering, manufacturing, fabrication and construction; and all the way through to logistics, financing and management. And we are now in a better position than we were to localise the construction of additional coal-fired plants," he says.

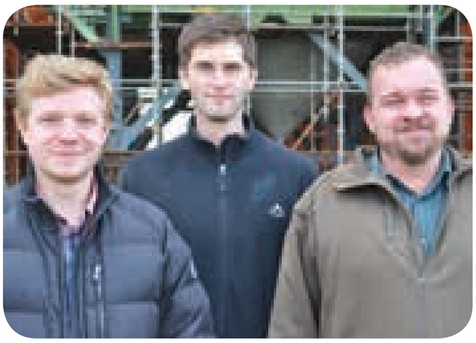
Could a nuclear new-build programme have the same affect? "Nuclear needs to be part of our future but we really need more time, training and up skilling before we attempt to build a nuclear power infrastructure for ourselves," Blake responds. "In the short term, the only sensible nuclear plant procurement strategy is to appoint a foreign contractor to build own and operate. We will, almost certainly, have to import many of the skills and high-end components. Very little benefit in term of jobs and economic growth is likely to accrue to South Africa.

Citing some positive developments for the local fabrication industry, Blake says that several rail projects are underway "progressing slower than the economy needs" but accelerating. "And the renewable generation projects are starting to have a positive impact.

"South Africans have always been able to change adversity into opportunity. I am confident that, by adopting modern best-practices with respect to fabrication and welder training, we will pull though these difficult times and emerge as a top-tier fabrication destination," Blake concludes.

SA fabrication specialist looks

Hydra-Arc, initially established in 1987 to source and supply welding and maintenance skills for Sasol shutdowns, has now established Sky-Hill Heavy Engineering, a facility for the fabrication of pressure vessels, heat exchangers, piping spools, structural steel and mechanical installations. *African Fusion* visits the facilities and talks to Riaan Kruger, quality manager; Ewan Huisamen, engineering manager; and Jacek Matyja, technical services manager about the group's capabilities and its new position as a high quality and globally competitive fabricator.



Photographed outside of Sky-Hill's Bay 4 are Jacek Matyja, technical services manager; Ewan Huisamen, engineering manager; and Riaan Kruger, quality manager.

Originally founded by Jose Maciel in 1987 to source and supply artisans to the petrochemical industry in the Secunda area to satisfy the project and shutdown needs of local plants, Hydra-Arc has its roots in identifying and training skilled people from all over the country. "We began by creating a database of locally skilled and qualified people for use during maintenance shutdowns," says Huisamen. This work continues today, via Jomele Labour Hire and Placements, which recruits artisans for placement within the Group and on client sites for the duration of project or maintenance contracts.

In 2002, realising the importance of skills for the future of the South African fabrication industry, Maciel established the Jose Maciel Welding Academy. This has evolved into the Mshiniwami Training Academy, with the capacity to train up to 1 000 artisans every year. "This highly successful business, which feeds the needs of the Hydra-Arc Group as well as the country's fabrication industry, is a vital component for economic growth," Huisamen adds.

Mshiniwami, which is situated on the opposite side of the road to Hydra-Arc's Sky-Hill facility, offers practical skills development in boilermaking, pipefitting, welding and grinding, with the more competent trainees having the opportunity to complete their trade tests and to become fully fledged qualified artisans.

Maintenance and shutdown expertise

Today, Hydra-Arc is a group of company's that embrace its expanded suite of services. As well as Jomele and Mshiniwami on the personnel side, the Group began to use its skills and other assets to offer direct maintenance services in the early 2000s. These services, which include the MEIP (mechanical, piping, electrical & instrumentation (subcontracted)) side of plant construction, are now offered under the Hydra-Arc name and extend from overall plant maintenance shutdown management and turnaround services to the execution of specific vessel repair, piping replacement, mechanical overhauls, high-pressure cleaning (subcontracted) and routine plant, equipment servicing and new fabrication of pressure equipment.

Regular maintenance and refurbishment expertise includes: maintenance of gasifiers – jacket replacements, pressure vessel repair and the replacement of raw gas outlet nozzles; day to day and maintenance shutdown work on the oxygen plant, which consist of aluminium welding and stainless steel heat exchangers, pressure vessels and cooling boxes; continuous boiler maintenance – structural, boiler tubing and

Above and right: The manipulators for refurbishing ashlock vessels consist of rotators with a capacity of 50 t. An internal boom system is synchronised to deposit a spiral weld of equal thickness and heat input across the varying diameter of the conical vessel.

to the global market

burner repairs; structural and mechanical maintenance on the NATSIF processing plant; and service maintenance on the water purifying plant.

Citing an ongoing success story, Kruger points out the Ashlock refurbishment facility dominating the front end of Bay 1 at Sky-Hill. "We have been refurbishing these for nearly six years, and have become very good at it," he explains. These conical vessels are subject to high temperature erosive wear and are continuously being removed from service and refurbished. Bay 1 of Hydra-Arc's Sky-Hill facility has been fitted with purpose-designed systems to machine the internal surface back to sound metal and to re-clad the inner surface to its original thickness. The submerged-arc process is used with twin-wire Lincoln 1000 ac/dc power sources. The manipulators are most impressive, though, consisting of rotators with a capacity of 50 t, each with an internal boom system that is synchronised to deposit a spiral weld of equal thickness and heat input across the varying diameter of the conical vessel.

Bay 1 of this the facility, with two 45 t and two 80 t overhead cranes at an under hook height of 9.1 m, is 430 m long and has 12 600 m^2 under roof. It is primarily used for maintenance and refurbishment projects of existing equipment including: pressure vessels; heat exchangers; piping; and storage tanks. At the end of the bay are a 9×9×15 m heat treatment furnace and a sand blasting and painting booth.

Bay 2 of Hydra-Arc's Sky-Hill fabrication facility is also used for refurbishment/maintenance work, but it also accommodates new fabrication projects, mostly on a smaller scale or those that require more exotic materials. Also having a bay length is 430 m, Bay 2 has three 20 t cranes under a hook height of 8.0 m. "Current work in Bay 2 includes the ongoing construction of water tanks for provincial governments around South Africa," Kruger reveals. "These are made in 3CR12 ferritic stainless steel and we have developed a modular construction that enables them to be easily transported to site, rapidly assembles and welded. We can also supply the tanks in four different volumes, 200 kℓ, 400 kℓ, 600 kℓ and 800 kℓ, simply by adding modular shells between the base and the cap," he says, adding that, "with a design life of 100 years, these tanks will outlast all traditional water tanks including concrete tanks."

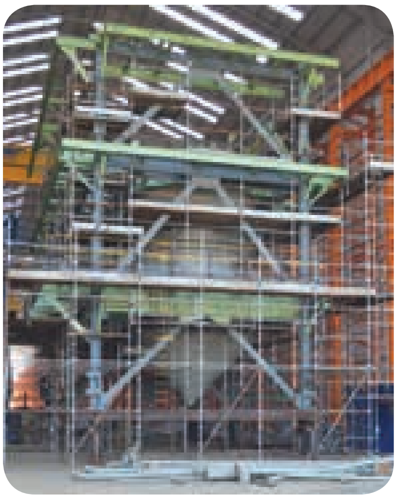
Sky-Hill Heavy Engineering

More than half of the Hydra-Arc Group's Sky-Hill facility is dedicate to new fabrication work, which is at the heart of the company's future strategy. The facility has been set up on a farm between Evander and Secunda, just off the N17, to take full advantage of export opportunities for new plant equipment.

Most notable on the facilities' manufacturing reference list are five propylene storage vessels called bullets that were manufactured in 2013. These vessels, with a mass of over 446 t each, are 59.09 m long with an internal diameter of 6.0 m and a wall thickness of between 45 and 50 mm – and after manufacture, they were heat treated as a single piece in a one-of-a-kind heat treatment furnace 66 m long. "This was the largest vessel fabrication project ever undertaken by a South African company," believes Matyja.

Current work also includes the fabrication of modern plant modules for the petrochemical industries. "In the workshop at the moment are the OBL (outside battery limits) modules for Sasol's Coal Tar Filtration East (CTFE) project," explains Huisamen. "This project involves a novel approach to plant design and construction. The whole plant is broken into interconnectable modules, which maximises the amount of factory-based fabrication and minimises onsite construction time. The idea is that each module is fabricated to include all of its equipment, vessels, piping, instrumentation and supporting structures. Then, once the site foundations have been prepared, the modules are simply delivered to site and coupled up to form a functional plant," he explains. "But these are not skid-based systems. One of the soon to be completed CTFE modules has a mass of over 400 t and includes two pressure vessels and all of the interconnecting piping, flanges and support structures. And the current CTFE plant being built consists of 24 individual modules, which will all be fabricated in this facility. This is the first time a plant has ever been constructed in this way in South Africa," he adds.

The bullets and modules were built



One of the 24 CTFE modules has a mass of over 400 t and includes two pressure vessels and all of the interconnecting piping, flanges and support structures.

One of five propylene storage vessels manufactured at Sky-Hill. Called bullets, these vessels have a mass of over 446 t, are 59.09 m long with an internal diameter of 6.0 m and a wall thickness of between 45 and 50 mm.

in Bay 3 of the Sky-Hill facility. With the same length and area as the adjacent bays, Bay 3 is exclusively reserved for new fabrication projects of small to very large scale components in any material type: pressure vessels (drums, columns, thin/heavy wall vessels); heat exchangers (fixed/floating tubesheets, U-tube HEX's, channel/bonnet types); larger bore piping prefabrication; and supported flat-bottom-type storage tanks.

Maximum lifting capacity totalling 540 t under a 9.3 m hook height is provided for by three 160 t overhead cranes with 20 t auxiliaries – and the bay has an additional two 45 t cranes. Heavy submerged arc welding is enabled by five 1 000 A submerged arc welding machines; six column and boom systems; along with five driven and 28 support rotators giving a capacity to rotate five 200 t weldments.

The company's massive 9×9×66 m heat treatment furnace sits at the end of Bay 3. Soon to be partitioned, this fully automated, gas-scrubber type furnace enables efficient onsite heat treatment of completed projects of almost any size.

With a view to further expansion and to capitalise on its successes in fabricating very large components, Bay 4 is currently under construction, with completion planned for before the end of 2015. "This Bay has been designed for mega-scale projects, such as heavy-walled, large diameter pressure vessels and the large modularised plant fabrications," says Matyja.

With a length: 550 m and a 25 m width, the hook height has been raised to 19 m and the total lifting capacity to 1 500 t. A fully equipped, state of the art, machine shop will also form part of the bay, along with an extended PWHT furnace (12×12×80 m).

In addition to the four bays at Sky-Hill, the facility has a plasma and oxyfuel plate preparation shop and a dedicated pipe shop, which includes four semi-automatic pipe-welding machines.

The Sky-Hill site consists of, in total, 100 000 m² of fabrication space, of which 75 000 m² is under roof. Support utilities include: Drinking and pressure test water purified to below 50 ppm of particulate; a 1 000 kVA grid-connected electricity supply, supplemented by a total of 3 000 kVA via back-up and standby generators; and 30 t of LPG/butane bulk storage for the heat treatment furnaces. Bulk oxygen, argon and acetylene for welding and pre-heating are also available throughout the facility.

Water tanks for provincial governments around South Africa are made in 3CR12 ferritic stainless steel and using a modular construction that enables them to be easily transported to site, rapidly assembles and welded.

The Hydra-Arc group also operates its own internal tooling, equipment hire and asset management service called WeldMech, which supplies all the equipment needs for projects being undertaken by any of the Group's companies.

Welding and quality

Underpinning the group's success is Hydra-Arc's commitment to excellence with respect to quality, safety and business practices. "We are a Level 2 B-BBEE contributor with a NOSA 5-Star safety rating and ISO 9001 and ISO 3834-2 quality certifications," says Kruger.

On the international front, the company has also won several awards: The Arch of Europe Award – Frankfurt, ESQR Best Quality Leadership award – Brussels, International Quality Crown Award – London, ESQR Quality Leadership Award – Las Vegas, ESQR Quality achievement award – London, and the ISLQ Diamond Award – Paris

According to Kruger: "we have been ISO 3834 part 2 certified for the past six years and in our annual audit cycles, we have had no findings for the past three years. As a fabricator, welding processes are critical to the end quality of our products and ISO 3834 provides an ideal vehicle for building quality into a component from the first step to the last. This raises quality standards and gives clients confidence that all our work is inline with the highest international standards. It also enables us to compete globally on an equal footing," he says, adding "most of our work also

A new group of trainees at the Mshiniwami Training Academy, which has the capacity to train up to 1 000 artisans every year.

has to comply with client specifications, such as Sasol, which insist on the most stringent quality requirements in the industry."

"For us, ISO 3834 offers business sustainability going forward," continues Matyja. "But we are also currently busy applying for ASME certifications marks (ASME VIII Div 1 and Div 2) as well as the CE marking, which falls under the European PED H1 directive. Once we are certified as compliant with these, we can use the CE stamp or the U-stamp on any of our pressure equipment. These two global certifications will allow us to export into Europe and the US and for our equipment to be used on any European- or US-built plant anywhere in the world.

"The Hydra-Arc Group is a proudly South African business that has proved that, by developing local skills and paying attention to quality and on-time delivery, it is possible to be successful and competitive in this challenging industry. By taking on the global market, we fully intent to lead South Africa into a better future, one with better job prospects for South Africans and a stronger local economy," Matyja concludes.

SAIW celebrates the success of its students

SAIW's second Johannesburg graduation dinner for 2015 was celebrated at Emperors Palace in Kempton Park on July 24, 2015, at which 108 Inspector Level 1 and 36 Inspector Level 2 graduation certificates were awarded, along with one IIW Welding Specialist qualification.

Gert Joubert of ArcelorMittal delivers a motivational address at the SAIW's second Johannesburg graduation dinner for 2015.

Londeka Princess Mavuso receives her Level 2 Welding and Fabrication Inspector Level 2 certificate from SAIW President Morris Maroga.

With many welding and inspection stalwarts in attendance, including Eskom's chief welding engineer and SAIW president, Morris Maroga; along with board members Ben Beetge of Sentinel Inspection; Dawie Olivier, the SAQCC CP representative; Frikkie Buys of Sasol Synfuels; Gert Joubert of ArcelorMittal; Robin Williamson, an ex SAIW president and consultant; Tom Rice, a consultant to Böhler Udderholm Africa; Johan Pieterse of Afrox, Joseph Zinyana of New Age Welding Solutions; and Pieter Venter, chairperson of the SAIW Technology and Training boards and a welding engineer at ArcelorMittal. "Also a special word of thanks to the SAIW staff members. Without your continued effort tonight would not be possible," said SAIW executive director Sean Blake during the welcome.

Comedy was chosen for the evening's entertainment: "We have a surprise for you tonight," said Blake. "We have brought, all the way from Durban, the tallest Indian female comedienne in South Africa," referring to the 1.77 m beauty, Karmen Naidoo, who is also a qualified mechanical engineer.

Delivering the motivational address, Gert Joubert said that graduates entering the world of the welding inspection need to understand welding specifications, guidelines and rules and they have an important responsibility to ensure adherence to the Occupational Health and Safety Act (OHS Act).

"The concept of weldability is complex and involved," he advises. "It depends on material properties, procedures to be followed, metallurgical behaviour during welding and heat treatment, the choice of welding processes and the competency, skills, workmanship and knowledge applied throughout the process of fabrication and inspection.

"An inspector's job is to assure the quality of welding. To do so we inspect weldments during and after fabrication, using visual and NDT techniques, and we deploy quality systems such as the ISO 3834 – Welding Fabricators Certification Scheme in our welding environments," he adds.

"In performing these responsibilities, though, I urge you to develop respect and understanding of welders and the tasks they perform. A good inspector understands the welding conditions, knows what is required of a welder and treats him or her as a true artisan. You need to understand the limitations of welding position and accessibility, have intimate knowledge of the weld design and quality requirements and it helps to know what is happening in the arc at the point of welding.

"Together with the welder, you are part of a quality team and together you can build knowledge and experience about the importance of proper joint design, the control of process parameters and the need to always follow welding procedures. While we inspect and test in accordance with applicable specifications such as AWS and ISO, there is no substitute for following approved procedures from start to finish of a welding project.

"Non-adherence to proper procedure can kill people, cause failure or damage, and significant downtime costs can be incurred. Your job is to save lives, ensure production is maintained, maintenance costs are reduced and a quality product is delivered.

"Now that you are qualified, be proud! Go out and build your career in this exiting engineering discipline. You are indeed a significant and much needed role player in this industry," Joubert concludes.

Alex van Jaarsveldt (left) and Robin Nankomar (right) photographed with their respective partners receiving IIW Welding Inspector and SAIW Level 2 Inspector certificates.

IIW Annual Assembly and Conference: Helsinki, 2015

The 68th IIW Annual Assembly and International Conference was held from June 28 to July 3, 2015 in Helsinki, Finland. Hosted by the Welding Society of Finland, this year's conference title, *'High strength materials – challenges and applications'*, was chosen to reflect that design solutions incorporating high strength steels, stainless steels, aluminium and other advanced materials provide considerable potential for raw materials and energy savings, improved performance and lower costs.

'Design decisions for fabricated structures are rarely made based solely on technical grounds. Safety requirements, cost restrictions, structural performance demands, and increasingly, environmental pressures all contribute to the decision-making process. The importance of raw materials and energy efficiency is constantly growing. This has motivated many industries to perform total lifecycle cost assessment and environmental footprint computations, both of which now integrally influence design and purchasing decisions', reads the conference information circular.

Photographed at the 2015 IIW Assembly and Conference in Helsinki are, from left: Herman Potgieter, Morris Maroga, Jim Guild, Pieter Pistorius, Sean Blake and Riaan Loots.

Representing South Africa in Helsinki were SAIW president Morris Maroga; executive director, Sean Blake; Herman Potgieter of SAIW Certification; Pieter Pistorius and Riaan Loots of the University of Pretoria; and recently retired executive director Jim Guild, who is the current chairman of the IIW's International Authorisation Board (IAB), a body created to operate International IIW qualification, certification and authorisation systems.

Sean Blake represents South Africa on the IAB and several of the technical committees. He returns to South Africa with renewed determination to encourage local fabricators to "raise their game" with respect to the use of modern communication technology for on-line monitoring of quality systems. "We are also falling being when it comes to skills," says Blake. "For South Africa to

Continued on page 13

Alan Reid: SAIW's new Technical Services manager

Reporting directly to executive director, Sean Blake, Alan Reid joined the Institute in July as the new manager of the SAIW's Technical Services department.

"I graduated with a degree in Physical Metallurgy from Wits University back in 1998 and, in 1999, I started work at DCD Heavy Engineering as a Welding Technician. I was there for over 16 years in several different positions: fabrication manager; production manager; QA manager; contracts manager; cluster SHEQ manager; and finally, sales and marketing manager," Reid tells *African Fusion*.

As well as a BSc (Eng) in Physical Metallurgy from Wits, Reid completed an MBa in 2011 through the North West University's Potchefstroom Business School. "And I am now about to embark on the IIW's International Welding Engineer (IWE) course under Professor Pieter Pistorius at the University of Pretoria," he says.

Describing his new role at the Institute he says that he oversees the suite of Technical Services offerings, which include: expert welding consultancy; welding coordinator support; procedure development; consumable assessments; failure investigations; quality system development; and implementation of research projects. "I am the 'go to guy' for industry related welding development or problems," he adds.

Underpinning the Technical Services offering is the SAIW's new laboratory. "My number one priority right now is to have the lab SANAS accredited to ISO 17025. The manual has already been submitted but a few revisions still have to be incorporated. Within the next few months, we aim to resubmit the amended manual, following which we will be audited by SANAS to obtain ISO 17025 certification for the mechanical and chemical testing laboratory, which has been specifically set up for welding related tests: welding procedure qualifications (PQRs) and welder qualifications.

"Following accreditation, the lab will then be able to reach its full commercial potential. And, unlike many other test labs in South Africa, we have considerable experience in welding. Our consulting department offers help to develop welding procedures, for example, and all of the associated mechanical tests, compositional analyses and micrographs needed for a procedure qualification will be able to be offered from our own accredited laboratory," he says.

"And while many larger users and fabricators operate their own labs, ours is independent and backed up by the best welding support available," he suggests.

Reid also reveals that the SAIW is looking for a second welding consultant to join the Technical Services team, following Renier Mostert's move to SAIW Certification to join Herman Potgieter. Technical Services' Thulani Mngomezulu is the only other SAIW welding consultant. "We are looking to appoint a second welding consultant/engineer to this role in the near future," Reid confirms.

"This new position is an excellent growth opportunity for me. I have now returned to the technical side, which is what attracted me to metallurgy and welding in the first place. When I left school, I was passionate about engineering, so I am looking forward to being back doing the things that I really enjoy," Reid concludes.

IIW Annual Assembly and Conference: Helsinki, 2015

Continued from page 11

become a preferred destination for fabrication, we need to adopt technology for better quality systems management and we must renew our efforts to implement internationally approved welder training programmes – such as the IIW International Welder programme – in training schools across the country," he says.

Morris Maroga, who represents South Africa in commission XIV: Education and Training and SC-Qual: Quality management in welding and applied processes says: "Education and training as well as welding quality management remain major challenges in completing the current infrastructure development projects in South Africa, and maintaining our power plants using local skills. South Africa still lags behind in the training of welding engineers (IWEs), technologists (IWTs) and International Welders (IWs). We need to create a sustainable welding skills base to achieve world-class welding performance.

"Only when South Africa is able to use local skills to successfully execute major fabrication and construction projects and to maintain those plants, can say we have achieved our goals," Maroga says. "But I am quite confident that our renewed focus will enable us to develop a new generation of reliable and skilled local people," he adds.

High quality papers were presented to appeal to industrial sectors including: shipbuilding, ground transportation, energy, pressure and process equipment and aerospace.

WorldSkills Welding 2015

Jacobus van Deventer, South Africa's welding candidate for the 2015 World Skills competition held in São Paulo, Brazil from 11-16 August, achieved 493 points in the welding competition, just seven points shy of the 500 needed for a Medallion of Excellence.

Although finishing in 25 place, he finished ahead and the German and Swedish welding entrants and only 50 points behind the Gold Medal winner, Zhengchao Zeng from China. The Silver Medal went to Jackielyson Alves of Brazil, while Thailand's Suparat Rattanapan took Bronze.

Van Deventer is a product of the Steinmüller Africa's Technical Training Academy (SATTA) in Pretoria West, which, along with its sister facility in Bethal, Mpumalanga, is accredited by the Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA).

South Africa's WorldSkills 2015 entrant for the welding competition, Jacobus van Deventer, on completion of his carbon steel pressure protect. Jaco achieved 493 points, just seven points shy of the 500 needed for a Medallion of Excellence.

Robotic automation:
SA's manufacturing challenges and opportunities

***African Fusion* talks to Yaskawa Southern Africa's Terry Rosenberg (left) about the manufacturing challenges in South Africa and how the growth of robotic automation can help to improve global competitiveness, economic growth and employment prospects.**

"Things are looking grim for South African manufacturers at the moment," Rosenberg begins. "Our unions want the salaries of unskilled labourers to double and they don't seem to care about the impact that has on business, jobs or competitiveness. As a consequence, in the car industry, for example, there are no new investments from any of the car makers or the global automotive component manufacturers, because global investors have very little confidence in our economy," he suggests.

NAAMSA, the National Association of Automobile Manufactures of South Africa, lists eight car makers as members: BMW, Ford, GMSA, Mercedes Benz, Nissan, Renault, Toyota and VW. "These companies all assemble cars in South Africa, but this is only part of a much bigger picture. The car makers are all supported by a host of Tier 1 and Tier 2 component sub-suppliers, which manufacture parts such as batteries, tyres, axles, suspensions, engines, seats, exhausts, converters and a host of others. This component sub-supplier industry is probably one of the most vital industries in South Africa in terms of automotive manufacturing," Rosenberg continues.

"Imagine being the global chairman of BMW. Every two or three years a new model is launched, which needs to be manufactured somewhere. As a global supplier, where do you build your new model? Germany? Mexico? Poland? China? India? South Africa?

"Would you put a R100-million investment into South Africa without the assurance that the labour force is stable? Could you bank on the quality and dependability of the sub-component supplier base? Could you be certain that cars made in South Africa could be delivered on-time, all the time anywhere in the world?" he asks.

Currently, according to Rosenberg, Poland, The Czech Republic, China, India, Mexico and Brazil are favoured countries for car makers, because they have a stable workforce, low cost manufacturing and can guarantee reliable delivery. "The big new investment are not coming to South Africa at the moment," he confirms.

This has a ripple effect all the way down into Tier 1 and Tier 2 suppliers. "Because the car makers are reluctant to invest, the parents of the component manufacturers are also reluctant. So the factory that makes exhausts or seats also suffer – and if the sub-suppliers are not making new investments, then I am not selling robots into these industries," he points out.

Rosenberg says that the converter industry in South Africa is far more than a local Tier 1 supplier, since 90% of its products are for export. South Africa currently supplies about 2.0% of the catalytic converters used globally. "So if we had business-friendly policies and a stable economy and labour market, global investments by the big players could easily double or triple the size of the South African converter industry, which would have huge implications for the economy, the balance of payments, jobs and poverty."

He believes that the global market would definitely buy from South Africa if the economic environment was stable and prices were competitive. "Can you imagine if we doubled our global market share to 4.0%? The converter industry needs stainless steel, which is made from iron-ore and ferro-chrome, which we mine. Converters use platinum, which we produce, Our steel- and stainless steel-makers and our platinum processing plants can supply materials for the commodity – and these industries are all struggling right now. Any growth

A Yaskawa robotic automation cell at a catalytic converter manufacturing facility in Port Elizabeth. "If we had business-friendly policies and a stable economy and labour market, global investments by the big players could easily double or triple the size of the South African converter industry," believes Rosenberg.

Three new gantry-based welding stations have been installed recently, two in Durban and one in Koedoespoort, to fabricate locomotive bogey. Like this one, each gantry has two robots with manipulators, SKS power sources and Servo Robot vision seam tracking systems.

Yaskawa continues to dominate the rail manufacturing industry in South Africa. Shown here is the final wagon welding station at Transnet Rail Engineering (TRE), Bloemfontein.

in an industry such as this creates a snowball effect that benefit the supply chain further down, from mining through processing and to logistics and shipping.

"And this is just one industry. The total export revenue from the automotive industry in South Africa is nearly as big as that from the gold mining industry. If the industry collapses, we are in serious trouble. But if it grows, then the additional employment potential is thousands and thousands of jobs," he assures.

"But no car maker or component manufacturer can succeed without robots. Globally all parts are made using robots and nobody will buy products that do not meet the consistency and quality standards expected by global users. To participate in the automotive market, the correct technologies have to be used to manufacture product, and the dominant technology is robotic automation," Rosenberg tells *African Fusion*.

"Industrial robots are designed to perform very specific and repetitive processes and are able to produce identical results thousands of times over. No factory in the world is going to accept parts from a supplier that are hand made, because no human being is anywhere near as consistent as a robot. And even if they were, where would you get the skilled welders to produce these flawless parts?" he asks.

"But what people miss is that, when you automate, significant numbers of additional jobs are created. You still need people to support logistics, stores, materials handling, financing accounting and a host of other jobs. People are needed to load and unload the robots, and then to clean, paint and package the products.

"Also, highly skilled people are needed to programme and manage robot production. The robot's role is to ensure consistent quality, but manufacturing still has to managed by people and robots need to be programmed by people who understand the processes being applied," Rosenberg argues, adding that one of South Africa's biggest problems is the diminishing numbers of skilled and qualified artisans.

"With the amount of welding automation going into the manufacturing industries, our skilled artisans also need to understand how to use and programme robots. For welding, for example, it is people who know how to weld that can make the best use of modern automation technologies such as robot welding cells," he explains.

Yaskawa is cooperating with the SAIW to develop welders that are also trained in robot technologies. "We at Yaskawa are able to teach people how to programme robots, but we can't teach them how to weld. A trained welder who knows about robots will be able to programme optimised welding procedures into robots for best possible quality and productivity results.

"We see a robot diploma module as a potential add-on to a welding course, and we know that any trained robot welding technician will be more multi-skilled and much more employable in the modern workplace," Rosenberg informs *African Fusion*.

"People with trade skills and process knowledge are able to apply automation more effectively and productively. Yaskawa wants to associate with people who are enthusiastic about robots and their technical trade, because we don't sell robots, we sell welding solutions," he adds.

When asked about current successes, Rosenberg reveals that Yaskawa continues to dominate the rail manufacturing industry in South Africa. "We have just installed three massive systems, two big gantries in Durban and another new system for Koedoespoort, the third gantry system to be installed there," he says. Each gantry has two robots with manipulators and all three will be used to fabricate locomotive bogeys using SKS power sources. In addition, Servo Robot vision seam tracking systems have been installed on all of the robots to compensate for variations in fit-up.

"We are also in conversation with the Gibela Rail Transport Consortium, which will be manufacturing 580-odd trains and 3 600 coaches at its Dunnottar facility near Nigel. A huge new train manufacturing factory is being built there and we expect that our considerable experience in robotic automation for the rail industry in South Africa makes us a serious contender to be Gibela's local robotic system partner," Rosenberg says.

"The potential in this country is unbelievable. We are sitting on a wealth of resources and, if we can stop bickering, improve our work ethic, improve education and training standards and adopt strong growth policies, we can easily become a successful exporter of manufactured goods," he concludes.

Dissimilar welding of high-strength steels

B Mvola, P Kah, J Martikainen and R Suoranta

Presented at the IIW International Conference in Helsinki, Finland, held from July 2-3, 2015, this paper describes the challenges of welding new high-strength steels to conventional steels and the development of suitable welding procedure specifications.

One of the major obstacles to the use of conventional steels in higher height infrastructure has been their weight. The demand for materials with a good ratio of high strength to light weight has arisen from new challenges inherent in changed working conditions and environments. In recent years, conventional steels have been successfully welded to high-strength steels (HSS). It is expected that demand for dissimilar welding of HSS will grow because of the characteristics of HSS and its diversity.

The objectives of this study are to develop a framework for dissimilar high-strength metal welding compatibilities and to provide the suitable welding procedure specifications necessary to achieve acceptable weld quality and flawless joints. In addition, the study takes into consideration the effect of high-strength steel manufacturing techniques on welding properties.

The methods comprise an experimental review of scientific papers based on dissimilar metal welding experiments of high-strength steels and an analysis of the properties of different HSS grades, and the paper suggests different combinations of steels, electrode selection, welding processes and suitable heat treatments.

The results show that dissimilar high-strength steels provide better mechanical joint properties with higher impact toughness resistance and better ductile-to-brittle transition characteristics. The corrosion resistance of the heat-affected zone and the weld depend on the alloy elements and the manufacturing of the base metal.

Due to their diversity, dissimilar high-strength steels offer advantages in demanding applications such as industrial applications for nuclear plants, equipment operating in challenging environments, higher amplitude lifting devices and sustainable energy production.

Introduction

Welding joints with different metals are common, particularly when responding to the stress associated with the welded joint. It is often recommended that a welded joint with the same base metal should have a mismatch weld metal composition. This mismatch characteristic of the weld is to ensure that the welded joint withstands in-service constraints and provides good weld quality.

Besides the desire to achieve acceptable weld quality, dissimilar welded joints may be selected to meet a functional need. Particular functional needs can concern a specific quality of the weld, such as different thermal conditions near the joint, strength, type of wear, corrosion, or reduced total weight while maintaining essential physical properties. The need for dissimilar weld metals is significant because their application is becoming increasingly essential in design.

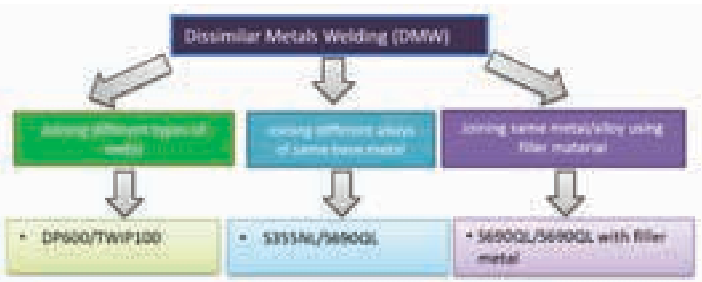


Figure 1: Dissimilar welding categories.

The definition of high-strength steel varies depending on the source. Steels with ultimate tensile strength (UTS) below 450 MPa are called conventional high-strength steels. Steels with a UTS rating between 450 and 800 MPa are defined as advanced high-strength steels (AHSS). Ultra high-strength steels (UHSS) are those with UTSs beyond 980 MPa. Other sources designate all steels with UTS above 550 MPa as UHSS.

Several studies have been carried out on the welding of dissimilar HSSs. Most of these focus on resistance spot welding (RSW) [1 and 2], others on laser welding (LW) [3] and a rather small number on gas metal arc welding (GMAW) [4]. However, there are only few studies that comprehensively address dissimilar-metals welding (DMW) of HSS with consideration to the major challenge of the continuous reduction of the weldability lobe as the strength increases.

This study aims to investigate the fusion welding of HSSs to identify the difficulties involved, raise awareness of possible problems that may be encountered during welding, and provide guidance on various combinations of HSS. The study investigates combinations from 300 MPa up to the maximum available.

The study briefly reviews the welding of HSSs, then analyses the different categories of DMW and finally develops a cross-examination of different combinations, their associated incompatibility in different manufacturing processes and the effect of thermal treatments. Figure 1 shows the different categories of DMW in fusion welding investigated in this study.

Better knowledge translated into significant progress in dissimilar welding in HSS welding procedures, and the advantages thus obtained are as vast as the wide range of applications of these metals, for example, in the energy industry (power plants, wind power), transportation (cars, vehicles, rail vehicles), lifting devices (mobile cranes, truck mounted cranes), infrastructure (housing, bridges), features that require precision and demand consistency, offshore platforms, and highly loaded applications such as roof supports in mines.

Challenges in welding dissimilar high- strength steels

High strength steels are designed to improve weldability of steels in general, however, it has been observed that some challenges still surround these steels. For example, it has been noted that difficulties and sensitivities in welding effects increase with increasing carbon content and alloying elements (e.g. Al, Si, Mn) [6]. The method of manufacturing of HSS steels, which combines thermal and mechanical control, poses additional challenges to the welding process. [5]

To maintain HSS weldment qualities, very strict control of welding parameters is necessary. Transformations of these metals at the end of the welding operation, which significantly affect the microstructure and mechanical properties and fatigue life, are difficult or practically impossible to reverse despite post-weld heat treatments [7 and 8]. Because of the different methods that are used to manufacture the various high-strength steels available, welding conditions that are applicable to one steel may not be applicable to another [7, 9 and10]. This is an important factor to consider in the case of welding dissimilar metals. Figure 2 shows how two different high-strength steels from different weldability zones may exhibit different challenges in welding, causing them to require their own specific welding procedures.

The carbon content is a factor to be considered along with other austenite stabilisers, as has already been noted above. Risks are particularly associated with a significant increase in the diffusion quantity of brittle component elements during very rapid cooling, especially around the fusion zone (FZ) and heat-affected zones (HAZ) [1]. These risks are the fundamental reason for the establishment of appropriate welding procedures for these metals in general and particularly for the dissimilar welding of high strength steels.

Welding procedures in the case of high-strength steels include several key factors. Among them, there is the use of carbon equivalent (CE) equations to evaluate weldability. Grafille's diagram in Figure 2 is an illustration for determining the degree of difficulty of welding a high-strength steel. In addition to carbon equivalent, an analysis of the thermal conditions of the welding process must be added, as they define the welding cooling time and conditions. The admissible temperature limit takes into account the preheating and possible inter-pass temperatures. It is possible to define an acceptable welding lobe for each HSS on the basis of the temperature of the preheat or inter-passes and the heat input required.

Software thus makes it possible to plot the allowable welding limit frame of the HSS. Figure 3 presents the two welding frames of S355K2+N and high S1100QL grades given by welding software based on the CE method [12]. In the case of a dissimilar weld between these two metals, it is necessary to take care to keep the temperature within S1100QL limits, since its welding temperature condition is smaller and inside the allowable heat frame of S355K2+N. This example is evidence that high-strength steels have more restrictions on welding conditions than mild steel and require a method to ensure these conditions are respected.

Tables 1, 2 and 3 give an idea of the variety of high-strength

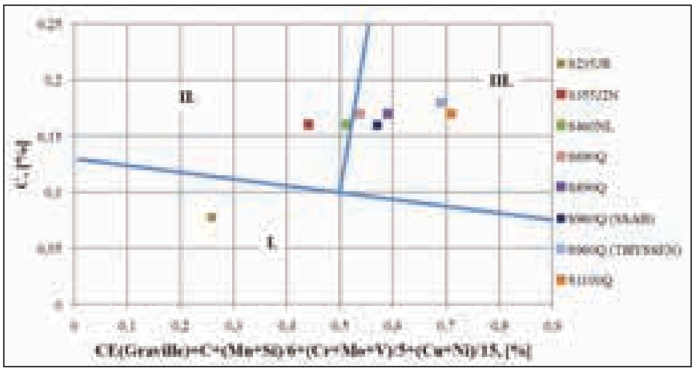


Figure 2: Weldability of structural steels by the Graville diagram [11].

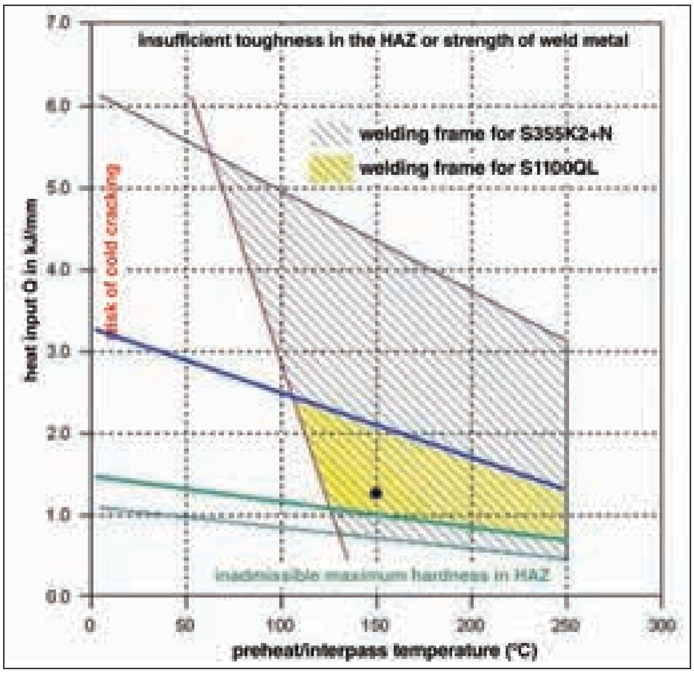


Figure 3: Welding frames of S335K2+N and S1100QL grades [12].

steels. Each table shows the ultimate tensile strength (UTS) limits, the method used to increase the strength and examples of existing grades. It can be observed that the methods utilised in manufacturing become increasingly complex as the strength increases. In addition it can be seen that strengths are becoming higher – up to 1 300 MPa.

Welding consumables

Apart from the welding category that does not use an electrode for welding, it should be noted that the filler metal plays a leading role in fusion welding. Filler metal is used for

(UTS<600 MPa)	
Characteristic features	**Example**
BH (bake hardening): increase strength during paint treatment by controlled carbon (C) ageing.	BH 280/400 (YS: 300-360 MPa, UTS: 420-480 MPa)
IF-HS (high-strength interstitial free): increase strength via manganese (Mn) and phosphorus (P) additions.	IF 300/420 (YS: 320 MPa, UTS [min]: 420 MPa)
P (re-phosphorised): phosphorus-alloyed high-strength steels.	H220PD (YS [min]: 220 MPa, UTS [min]: 420)
IS (Isotropic): increase in strength using isotropic flow behaviour, micro-alloyed with Ti or Nb.	HC260I (YS: 220/260, UTS [min]: 300/380)
CMn (Carbon-manganese): strengthened with an increase of C, Mn and Si additions for solid solution strengthening.	CMn 440 (YS [min]: 295 MPa, UTS [min]: 510)
HSLA (high-strength low-alloy): strengthened by micro-alloying with Nb or Ti.	HSLA 550/650 (YS: 585 MPa, UTS [min]: 650 MPa)

Table 1: High-strength steel (HSS) characteristics and examples.

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(600 MPa<UTS<1060 MPa)	
Characteristic features	**Example**
DP (Dual phase): microstructure composition of ferrite with 5 to 30 % by volume of martensite islands.	DP 980 (YS: 644 MPa, UTS: 1009 MPa)
TRIP (transformation induced plasticity):	TRIP 800 (YS: 478 MPa, UTS: 825 MPa)
PM (partially martensitic): partially or fully martensitic steels.	M220 YS [min]: 295 MPa, UTS [min]: 510)
CP (complex phase): Mixture of strengthened ferrite, bainite and martensite.	CP 1050//1470 (YS: 1060 MPa, UTS: 1470 MPa)

Table 2: Advanced high-strength steel (AHSS) characteristics and examples.

(UTS>1060 MPa)	
Characteristic features	**Example**
HMS-TRIP (high manganese-TRIP): comprises an alloying concept with strain-induced strengthening.	MS1250/1500 (YS: 1265 MPa, UTS: 1500 MPa)
HMS-TWIP (high Mn-twining induced plasticity): Mechanical twining occurs when straining.	TWIP 1000 (YS: 496 MPa, UTS: 1102 MPa)

Table 3; Ultra high-strength steel (UHSS) characteristics and examples.

the case of different base metals, metals of the same group but differing in strength characteristics or alloying elements, and finally the same class of base metal but welded using a different filler metal.

For the most common case in welding, the dissimilar welds with the same base metals but different filler metal, there is a relationship between the mismatch of the electrode and the weld joint strength. In the specific case of consumable electrode welding, the performance of the weld depends on the size and the level of mismatch [13]. The following categories usually emerge from this mismatch; overmatched, matched or under-matched welds, which are, respectively, a weld metal (WM) whose ultimate strength is greater, equal to or below the base metal (BM).

The choice of the mismatch depends on the application of the weld strength in service. Thus, overmatched welding is generally applied to components subjected to tension, to ensure an efficient transfer of strength [14]. Generally, failure takes place either in the weld metal or in the heat-affected zone. Undermatching is generally used for joints with high-strength steels to minimise the risk of defects related to hydrogen, such as cold cracking. The application of under-matching can help to reduce or prevent the need for costly pre-heating operations. The reduction gain in temperature depends on the deposited metal and, in particular, the strength and impact toughness required for the welded joint [15].

Figure 4 shows the effect of different filler metals on the tensile strength and yield strength of a welded X96 grade metal. The difference becomes increasingly significant from the fusion line (FL), heat-affected zone (HAZ) and weld metal (WM).

Because of the significance of the choice of electrode for weld quality, it is important to re-asses the prescriptions of European standards and gaps must be filled to meet the requirements of higher high-strength steels and, most importantly, for the welding of dissimilar high-strength steels. The benchmark for the design code is EC 3-1-8 [17], which defines the characteristics for matching electrodes of all welds. It is recommended that matching electrodes be applied for the steel grades with yield strengths less than 460 MPa, which is a requirement that poses no significant difficulty. However, reassessment of the requirement for matching electrodes is needed for higher strength steels because there are no electrodes to date with sufficiently high strength. So the filler metal will likely cause some problems from the viewpoint of

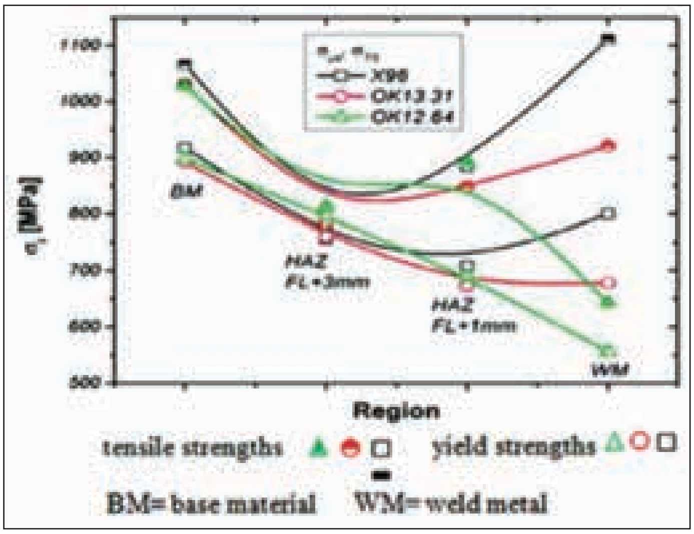

Figure 4: Strength of filler metals in terms of the joint region [16].

manufacturing, which is not the case with available electrodes with lower strength.

Research in the area of mismatch is currently a topic of considerable interest. For example, while it was established years ago that overmatching is a necessary condition to obtain acceptable weld toughness in structural steels, it is very difficult to combine both acceptable toughness and overmatching strength for AHSS. Consequently, it is essential to assess the need to apply overmatching for this type of steel and to determine the possible level of undermatching that could best be applied [18].

There are some considerations for the design of the weld that provide guidance and form a basis for this reflection. For the case of a T-joint, because of demands related to this type of welding, there is no specific need for matching electrodes. However, there is a requirement for mismatching in some codes. An example of such a rule can be found in the Swedish code [19]. Björk et al [20] studied the behaviour of T-joints of high-strength steels, and included in their analysis the effect of the geometry of the joints and their ability to resist deformation. It appeared from this study that the distortion of these joints is crucial to their quality. To this end, the use of under-matching filler metals can improve the performance of this type of joint. Furthermore, given the essential contribution of heat input for welding UHSS, one should take this factor

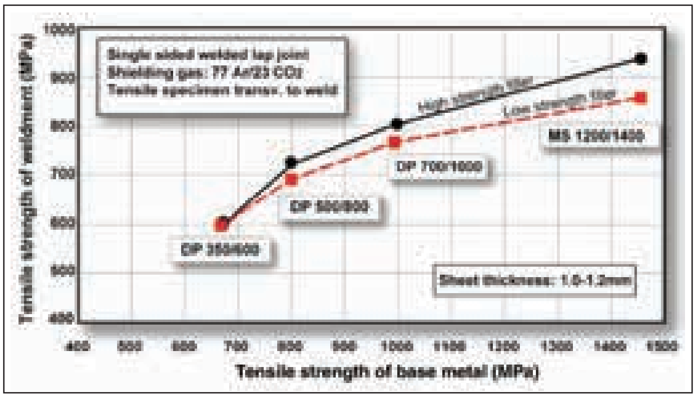

Figure 5: Influence of filler metal strength in arc welding of DP and MS [24].

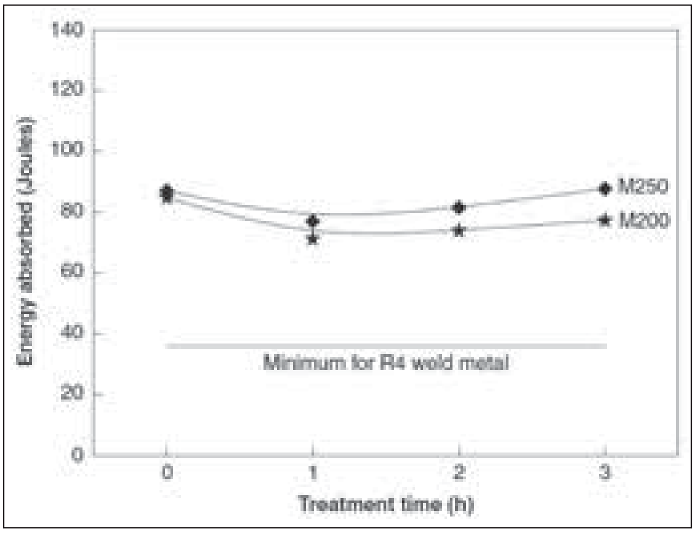

Figure 6: Effect of PWHT time on the mechanical strength/structural robustness of the weld metal [26].

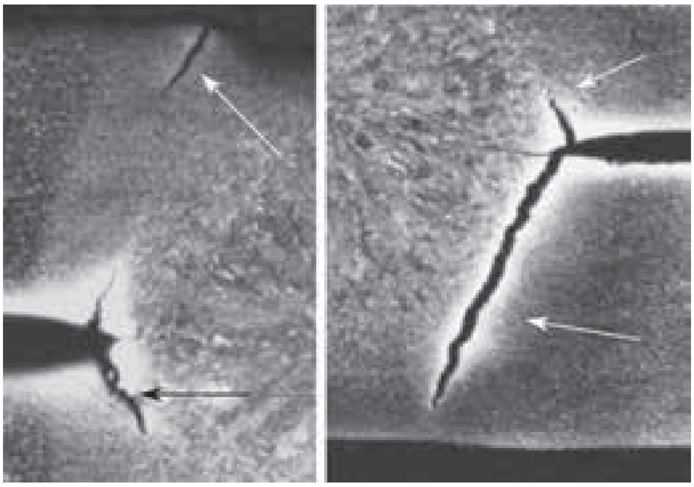

Figure 7: Appearance of cold cracking in the heat-affected zone of spot-welded DP780 (0.15% C) [30].

into account as an additional failure criterion in the design code. This additional precaution is necessary because of the softening of the heat-affected zone.

Regarding butt joints, lack of strength is generally associated with undermatching electrodes. For example, if the joint is completely subjected to transverse load, a matching electrode is the best fit. For other butt joints, undermatching electrodes are suitable. Note that the European Code 1-12 design rules, in part I, encompass yield strength grades up to 700 MPa and recommend the use of an undermatching consumable electrode [21].

Figure 5 depicts the tensile strength of the weldment as a function of the tensile strength of the base metal, depending on the strength of the filler material. It can be seen that as the tensile strength of the base metal increases, the weldment strength increases as well but there is a difference depending on the type of filler used. Higher-strength filler metals provide a stronger weldment compared to filler metals with lower strength. Therefore, attention should be paid to the base metals and consumable electrode strength and a compromise should be made for compatibility of both. This should take into account forces related to the in-service use, their directions and orientations.

Pre- or post-heat treatment and interpass temperatures

The number of publications related to the welding of steels of very high strength is abundant, but a large part is only concentrated on the chemical composition of these steels, the microstructure and mechanical properties. A very limited number is dedicated to the thermal treatment related to the actual welding. Among the studies available, the vast majority just address the effect of some alloying elements and focus only on high-strength low-alloyed steels.

Heat treatments, despite their cost, are crucial operations for welding high-strength steels. The heat treatment operations depend primarily on the composition of the base metal of the steel and the filler metal and consist of pre-heat treatment, and post-heat treatment (PWHT). Pre-heat treatment is used to limit heating the metal for too long at critical temperatures or to reduce cracking risks. For example, preheating is used to prevent cracks due to hydrogen. It increases the cooling period, and a longer cooling period allows the diffusion of hydrogen from the weld, which avoids the creation of hydrogen cracks. In addition, using higher inter-pass temperatures increases time spent in the critical temperature range. Post-heat treatment allows relaxation of the internal tensions and leads to desired microstructures. These operations are guided by the EN-1011-2 standard [25]. Figure 6 shows the effect of PWHT on the energy absorbed by the weld.

Certain studies have emphasised the importance of post weld heat treatment as this treatment improves the quality of a weld. Jorge et al [27] studied the effects of post weld heat treatment by analysing the effects on mechanical properties. The steel tested had a tensile strength greater than 860 MPa. The operation was applied with filler metal electrodes with 4.0 mm diameters, joint design was a butt-weld joint with several passes. The base metal was 19 mm thick, preheated at 200 and 250 ° C and post-weld heat treatment was performed at 600 ° C for 2:00 h. The results achieved the higher mechanical properties required.

The close relationship between the microstructure obtained after post-weld heat treatment and the mechanical properties noted in Jorge et al [27] confirms earlier studies. For instance, Svensson [26] reports, following analysis of a weld of yield strength higher than 690 MPa, that the weld metal was composed of acicular ferrite, martensite and bainite. This is corroborated by Karlsson et al [29], who presented that a high-strength steel containing between 2% and 3% Ni in the weld consists of acicular ferrite, martensite and bainite. In addition, the variation of the percentage of each of these elements had a direct influence on the mechanical properties of the weld.

Dissimilar welding of HSSs can produce brittle welds if they are not post-weld heat-treated (Figure 7). For that reason there is growing interest in reducing the carbon content in DP steel to below 0.1 percent by weight and this reduction in carbon content has become an important issue in steel manufacture [30]. Despite the possibility of improving the quality of welds through post-weld heat treatment, it must, nevertheless, be noted that because of the sensitivity of these steels, post-weld heat control requirements are very strict. For dissimilar welds, there should be room for compatible heat treatments.

Case studies and applications

As mentioned earlier, case studies on welding high-strength dissimilar metals are not numerous. This is due to the fast increase in the metals available, their diversity, the complexity of their manufacturing process, as well as the slow updating of welding procedures. There is however enough material to build a benchmark of this research. For each of the categories listed in this study, experimental example cases using different welding processes such as arc welding, laser welding and hybrid arc-laser welding are analysed.

Welding different base metals with and without filler metal

Dissimilar welding of high-strength steels can take place in two categories; without the use of a consumable electrode and with the use of the consumable electrode. The cases that serve as examples for our study in this subsection include both types. In this case study, evaluation of the carbon equivalent of the weld between the two base metals is used.

Santillan Esquivel et al [3] studied different combinations of welding steels of very high strength (DP600, DP780, TRIP780: DP600/TRIP780, DP780/TRIP780) using the laser diode welding process. A comparative study of combinations of similar and dissimilar metals was performed. The analysis after welding was to examine the mechanical properties of the weld microstructure and the different component parts of the weld.

A curve analysis of the fusion zone was plotted (Figure 8), under the calculated carbon equivalent, and the outcome of hardness tests. Figure 8 shows the three main regions. Region I with the highest carbon equivalent shows a complete martensite structure with close to the theoretically calculated martensite hardness. Region II is characterised by a mixture of martensite and bainite, which is close to the average theoretical level of hardness. Region III, as with the region II, deviates from the hardness obtained using the Yrioka formula. This area is a mixture of ferrite and martensite and has a considerably lower carbon equivalent. It is clear from this analysis that the carbon equivalent can actually be used to predict the microstructure of the fusion zone.

The influence of alloying elements of the above-mentioned metal combinations is confirmed by other experiments carried out with different welding processes. Hernandez et al [1] during their study of the resistance spot welding (RSW) of metals of different high strength (DP600/HSLA DP780/TRIP780) observed an increase in hardness at the fusion zone of the dissimilar combinations.

This increase in hardness seemed to grow as the percentage of alloying elements increased. In the specific case of the combination DP600/HSLA, a predominant presence of martensite was noticed. Figure 9 shows the carbon equivalent of each pair with DP600 and their standard deviations. It is observed that the hardness increases with increasing level of alloying elements in the carbon equivalent (CE). It appears in

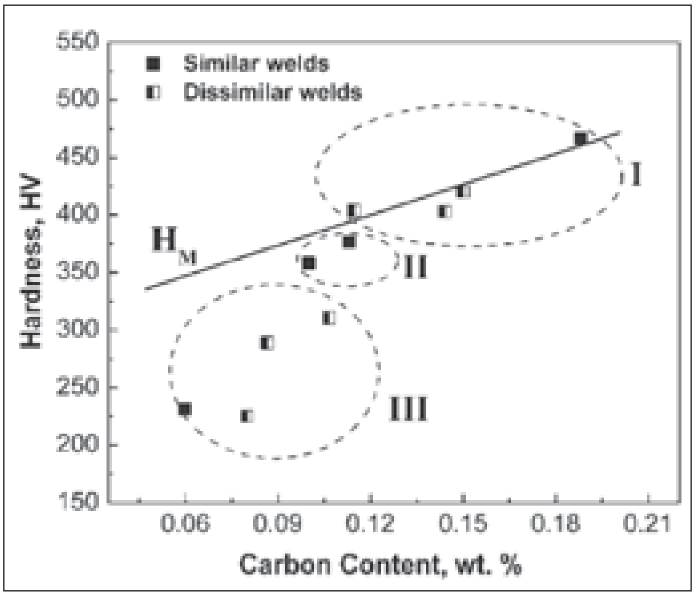

Figure 8: Variation of FZ hardness as a function of the carbon content in AHSS laser welds: Calculated martensite hardness Hm using the Yrioka formula is also included as a straight line to assist in predicting FZ microstructure [3].

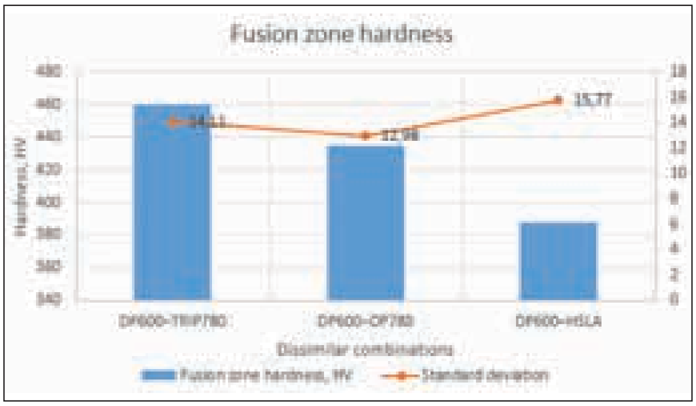

Figure 9: Average fusion zone hardness and standard deviation.

this analysis that, in the case of welding of high-strength steels without filler metal, hardness depends on the fusion level of both metals. The mechanical properties depend on the microstructure and fusion zone as well as the welding process used.

Arc welding process such as gas tungsten arc welding and gas metal arc welding are welding process that have been used for decades. These processes have achieved success for wider applications because of significant improvements in the control of welding parameters. In recent years, gas metal arc welding (GMAW) has shown promising results in welding HSS. This weld quality improvement was achieved by use of advanced control technology or hybrid welding processes.

The following cases considered in this section are those for welding different metals with a consumable electrode. Russo Spena et al [4] conducted a study to examine dissimilar high-strength steels (TWIP1000/DP600, TWIP1000/MN-B) welded using GMAW and a 307L consumable electrode. It was observed in the HAZ of the TWIP steel that the microstructure was of a coarse austenitic grain size compared to DP and Mn-B. The full martensite microstructure was noted in the HAZ of DP and Mn-B steels near the fusion zone (Figure 10).

The HAZ observed in the Mn-B side was higher than that noted on the side of the DP and TWIP steels. The difference between the maximum and minimum hardness in Mn-B is greater than in DP. This hardness difference is due to the lower carbon percentage of DP compared with Mn- B. The tensile test


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showed that, for the TWIP/DP combination, rupture occurred sometimes in the fusion zone or in the HAZ of the DP steel. In the case of the combination TWIP/Mn-B, rupture occurred either in the HAZ of TWIP or Mn-B.

It is recommended that incomplete penetration be avoided, because it is the origin of fracture failure initiation and brittle fracture failure because of the notch in the fusion zone.

Welding different alloys of the same base metal with and without filler metal

Welding the same type of base metals but with different strengths or different alloying elements (e.g. DP600/DP780 dissimilar welding) with or without filler metal is the second case of this study. This case is not far from the previous case in terms of the applicable welding processes, procedural rules to be observed and the risk of brittle element formation. It is also necessary here to consider the carbon equivalent (CE), analysis of critical temperatures $t_{8.5/5}$ and the Graville diagram to predict the quality of the weld. The risk of hardness and brittle components is, however, lower than in the case of the previous study, because the principle of manufacture of the base metal is the same. The difference between the base metals is basically in alloying constituents.

High-risk areas include; the fusion zone (FZ) and heat affected zone (HAZ). The former because it may result to alloying-element gradients and an increase in carbon or the formation of structural martensitic compounds, and the latter because differences of heat resistance capacity can lead to dramatic softening of the HAZ of the base metal with lower heat capacity resistance. The risk of diffusion of the alloying element is greater in welds completed without consumable electrodes.

In the case of electrode use, it is necessary to ensure a mismatch that does not cause fracture failure at the weld or HAZ. Some examples to better illustrate the case are presented below.

Hernandez et al [1] in their experiments studied dissimilar high-strength steels welded using the welding process without filler metal using resistance spot welding (RSW). Several combinations were analysed. Here we consider the case in that investigation that corresponds most closely to the specific case above, that of DP600/DP780). Figure 11 shows that, in dissimilar welding of DP600/DP780 without filler metal, the HAZ of DP780 has undergone a noticeable softening. This softening is due to the tempering of the martensite. One can also see an increase in the hardness in the fusion zone, in comparison to both base metals. This increase in hardness is the result of a growth of each alloying element quantity [31].

The second example analyses the case when welding with a filler metal. Rak et al [32] studied the welding of dissimilar high-strength low-alloyed steels (HSLA) using submerged arc welding (SAW). The weld joint design was a narrow gap, the base metals were S355NL (HT50, YS: 380 MPa) and S690QL1 (HT80, YS: 680 MPa) and thickness 50 mm. The cold cracking parameters (Pcm) for S355NL, S690QL1 and the weld metal, were respectively 0.101, 0.256 and 0.205.

Given the dissimilar nature of the welded joint, mismatching was calculated for each side in all weld parts such the base metal, weld cap, weld middle and weld root. The results of the calculation on the matching factor M indicated undermatching for S690QL1 and overmatching for S355NL1. Because of a very large difference in the mismatching, failure fracture occurred in the crack tip opening displacement (CTOD) test from the

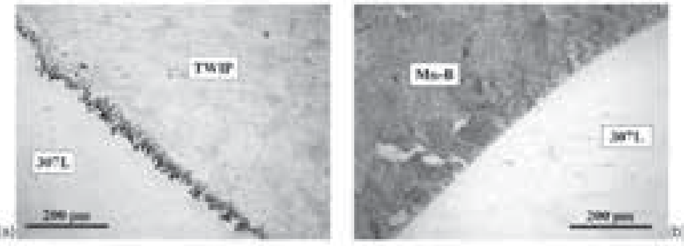

Figure 10: Metallographic examination of (a) TWIP/DP and (b) TWIP/MnB weld seams. Fusion zone (not etched) and HAZ [4].

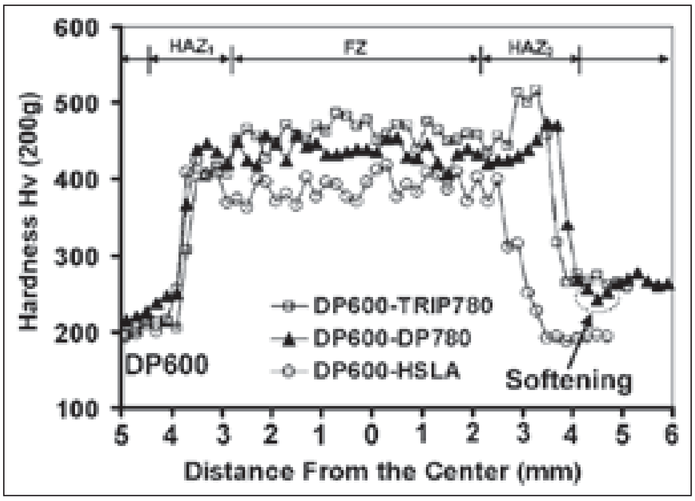

Figure 11: Cross-weld hardness profiles for dissimilar spot welds [1]

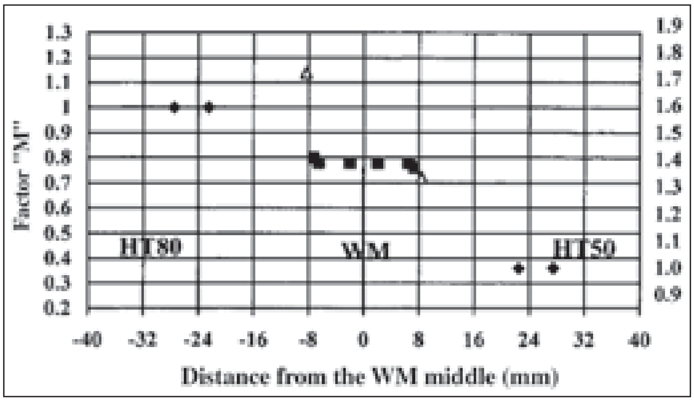

Figure 12: Global/local mismatch factor M in the dissimilar weld joint (S355NL/ S690QL1) cross-section [32].

coarse-grain heat-affected zone (CGHAZ) to the weld or the base metal. Figure 12 shows the mismatch of the two sides of the weld with the different base metals. The difference in the weld metal and the area close to both base metals is significant.

Welding the same base metal with a different filler metal

Welding dissimilar metal with the same base metal and a different filler metal is probably a more frequent case than the earlier two cases. This case is essentially based on mismatching between both the base metal and the filler metal. This mismatching in advanced ultra-higher strength steels constitutes one of the key research topics in welded joint design. [33 and 34]

Unlike with mild steels, steels with high-strength can accommodate undermatching well to reduce the risk of cold cracking and lamellar tearing. Analysis for the matching level should reflect not only strength but also ductility. As the strength increases, the choice of mismatching filler metal

should be more precise and delicate. The strength requirement in the case of advanced high-strength steels (AHSS) or ultra-high strength steels (UHSS) is that the filler metal strength should be one or two percent lower than that of the base metal.

However, this implies four to five percent higher elongation. To combine both undermatching for strength and overmatching for elongation, the design of the filler metal can rely on appropriate alloying element choices such as nickel (Ni) and molybdenum (Mo) in the composition of a filler metal [35]. The alloying elements of the filler metal promote a microstructure beneficial for weld properties. An example experiment shows how the change in alloying element proportions influence the formation of microstructures and its effect on the properties of the joint.

Seo et al [36] investigated the type of microstructure parameters that govern cold cracking risks. The results show that for the same level of exposure to hydrogen, filler metals having 1.5 % Ni are more resistant to cold cracking compared to filler metal containing 0 % Ni, regardless of any high -strength microstructure compound and carbon equivalent. Figure 13 shows the difference in percentage of acicular ferrite (AF) in a weld made with a filler metal with 1.5 % Ni in comparison to a weld made with a filler metal with 0 % Ni.

The second case examines the mismatching of base metal with the filler metal. Gáspár et al.[11] examined the matching and mismatching between the base metal and the filler metal. Base metal S960QL according to EN 10025-6, of thickness of 15 mm was welded with a filler metal (4 T69 Mn2NiMo MM) or (G 5 89 M Mn4Ni2, 5CrMo) solid wire electrodes using GMAW. The weld joint design was an X configuration with the use of multi-pass welding and optimal control parameters for $t_{8.5/5}$. Figure 5 shows the hardness profile of the two cases of experiments performed; one for a matching and the other an undermatching welded joint. One can observe that the hardness of the matching joint was 350-360 HV, which is 60-70 HV lower than the hardness of the undermatching welded joint. However, the maximum hardness was 450 HV in both cases with 400 HV at peak in both cases. The lack of homogeneity increases with the growth of the strength, which could result in in-service joint failure.

Comparative dissimilar combinations and welding processes

In the case studies section a particular emphasis has been placed on the microstructures and the mechanical properties of the welded joints made from dissimilar metals and very few comparisons are made as regards the welding processes. This section examines the relationship between results obtained and the welding process used.

Note that the use of filler metal (or not) also depends on the welding process used. Resistance spot welding (RSW) for example does not use filler metal, while GMAW, laser or hybrid laser/GMAW do. In the welding of dissimilar metals, the amount of energy and heat input have a significant effect on the fusion zone between the welded metals and the heat-affected zone. Laser beam welding (LBW) gives a smaller HAZ area but can lead to very hard and brittle regions in the middle of the weld metal. The combination of processes allows advantages to be taken from the best aspects of both material and process choices.

The example below illustrates the effect of welding processes on the welding of dissimilar metals of high-strength

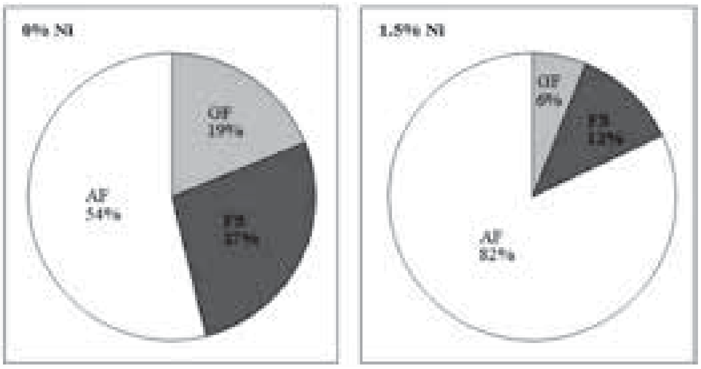

Figure 13: Quantitative analysis results of weld metal microstructures of different types of electrodes [36]. AF: acicular ferrite; GF: grain boundary ferrite; FS: ferrite with second phases.

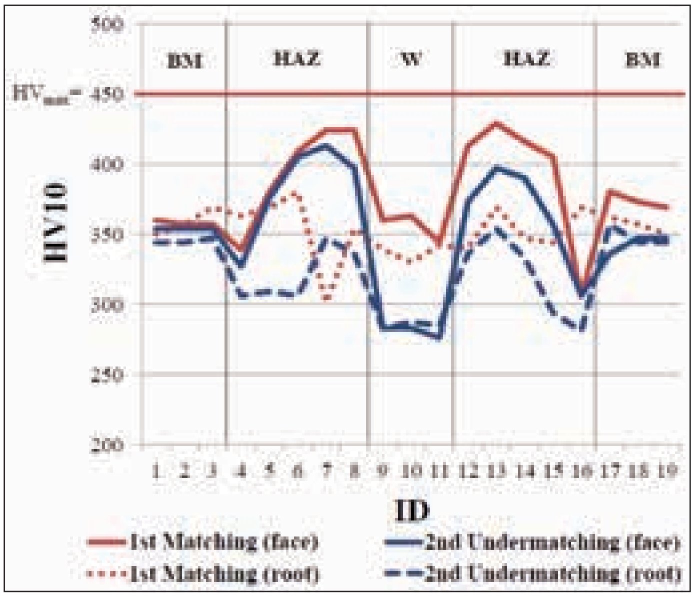

Figure 14: Hardness distribution of the matched and undermatched welded joint [11].

steels. Cortez et al [37] carried out an investigation of the weld integrity of TRIP800 steel using the GMAW process and CO_2 laser welding. A filler metal of high strength was used for the GMAW process whose designation is Mn3Ni1CrMo G according to EN ISO 16834-A. The results showed very high hardness for laser welding (LBW) due to a predominant presence of martensite in the fusion zone. The hardness was slightly above 500 HV for LBW with a peak of 600 HV, then the hardness of the GMAW welding reached up to 500 HV. A composition of bainite and ferrite was noted in both HAZs of GMAW and LBW. The fracture tests found failure in the base metal (BM) for GMAW, whereas the sample welded with LBW exhibited brittle fracture failure in the HAZ.

Table 4 compares, on the basis of the risk associated with each choice, the filler metal, the strength of the base metal and the differences of the filler metal for the main categories considered in this study. It is observed that the risk and constraints become greater when welding increasingly higher-strength steels.

Moreover, it can be noted that the risk of flaws and high-risk microstructures (e.g. cracks, martensite) and the prediction requirement to evaluate the susceptibility to brittle microstructure formation depend significantly on whether a filler metal is used. The need to predict the microstructure of different joint parts follows the same trend with the use of heat treatment.

Joining different alloys of the same type of base metal with and without filler wire													
		High-Strength Steel (HSS)						Advanced High-Strength Steel (AHSS)				Ultra High-Strength Steel (UHSS)	
		BH	IF-HS	P	IS	CMn	HSLA	DP	TRIP	PM	CP	HMS-TRIP	HMS-TWIP
High-Strength Steel (HSS)	BH	*/x											
	IF-HS	+/++	*/x										
	P	+/++	+/++	*/x									
	IS	+/++	+/++	+/++	*/x								
	CMn	+/++	+/++	+/++	+/++	*/x							
	HSLA	+/++	+/++	+/++	+/++	+/++	*/x						
Advanced High-Strength Steel (AHSS)	DP	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	**/xx					
	TRIP	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	+/++/+++	**/xx				
	PM	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	+/++/+++	+/++/+++	**/xx			
	CP	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	+/++/+++	+/++/+++	+/++/+++	**/xx		
Ultra High-Strength Steel (UHSS)	HMS-TRIP	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	+/++/+++	+/++/+++	+/++/+++	+/++/+++	***/xxx	
	HMS-TWIP	++/+++	++/+++	++/+++	++/+++	++/+++	++/+++	+/++/+++	+/++/+++	+/++/+++	+/++/+++	***/+++	***/xxx

Different base metal with and without filler wire		Different alloys of the same type of base metal with and without filler wire		Same base metal with different filler metals	
+	Risk of element diffusion	*	Risk of carbon diffusion	x	Low risk element diffusion
++	Selection of suitable filler wire	**	Compatible filler wire	xx	Low risk for lower strength
+++	Suitable for base metal of comparable strength	***	Favour base metal of comparable strength	xxx	Mismatch concerned of weld

Table 4: Combination of DMW for high-strength steels.

Conclusion

The objective of this study was to analyse the conditions and the quality of welded joints of dissimilar high-strength steels. After analysis of experiments carried out with different methods of fusion welding processes, the following conclusions can be drawn:

The carbon equivalent (CE) can be used to evaluate the hardenability, brittleness and solidification cracking susceptibility of welds. In the Graville diagram, weldability prediction of advanced high-strength steels is located in Area III.

Welding of AHSS category steels should primarily be planned based on the manufacturing process, yield limit, thickness and expected load with controlled linear energy and preheating.

It is necessary to prescribe the $t_{8.5/5}$ expected cooling time interval during welding. In heat treatment control of the DP/TRIP welds, for example, the preheating procedure improved the splash of welding to some extent. The post-heating procedure improved the mechanical properties of spot welds owing to the temper of the spot weld microstructure. This improvement is also possible for other welding processes used in the experimental cases of this study.

Due improvements in welding technology and welding procedures for dissimilar base metals, the parent metal dilution width and the HAZ range have become smaller than in traditional welding processes. The welding process has an effect on the control of the heat input and consequently the microstructure of the weld as well as the fusion zone.

In GMAW (MIG) welding of AHSS, for example, it is important that the HAZ remains very small because of the carbon mobility in the atoms. The cooling process during the steel's manufacture is very precisely controlled; something that it is difficult to duplicate in welding after heating above the critical temperature.

Metals in dissimilar joints should be compatible with the welding process as well as the heat treatment.

Combinations with other types of steels with a non-equilibrium structure may lead to a weakened area. The reason is that the non-equilibrium structure of advanced high-strength steels becomes strengthened by strain hardening, transformation hardening and controlled temperature hot-forming, which is unfavourable to welding. Pre-heat, post-weld heat and welding generated heat energy input can cause disadvantageous changes in the microstructure.

Welding of high-strength low-alloy steels (HSLA) involves the usage of undermatching, matching and overmatching filler materials, the selection of which depends on the welding process, the application of the welded joint and the obtainability of the filler material.

The alloying elements also play a fundamental role in dissimilar welding; their composition has shown the ability to promote acicular ferrite microstructure that improves mechanical properties.

In terms of microstructural development, the use of low-alloyed filler material is beneficial to avoid excessive weld metal overmatching. The welding of advanced high-strength steels is impeded by several factors, partly because these steels are characterised by a chemical composition with a high carbon equivalent.

During their production, the steels also undergo a special heat treatment leading to the formation of a specific structure.

The application of dissimilar weld metals with different base metals with or without filler metal presents varying complexity. In the case of welding without a filler metal, it is essential to predict the effect of the alloying element, which may generate a hard microstructure component that can produce cracks.

The different ways of predicting suggested in this study must be applied. Moreover, a compromise between pre- and post-heat treatment must be carefully determined in order to prevent harm to the quality of the weld. In the case of filler metal use, it is necessary to predict the structure between both the fusion zone and the risks identified and associated with different metal compositions.

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Turnkey welding productivity

Kistler Cutting and Welding Techniques, a German family business that engineers and manufactures welding positioning and cutting systems, along with its South African distributor, Mazuret, exhibited its offering earlier this year at the Clean Energy Africa conference in Cape Town. *African Fusion* talks to Alexander Kistler, the company's CEO.

The Kistler Machine Company was founded back in 1966 by senior engineer Roland Kistler, the father of current CEO, Alexander: "My father, a mechanical engineer, came up with an idea for a pipe rotator for welding pipe spools with elbows and flanges. His idea was to clamp the pipe and rotate the entire pipe section so that the seam could be welded in the 12:00 o'clock position. This makes welding easier for the welder and significantly improves weld quality and fabrication productivity," begins Kistler. "For a refinery, for example, a lot of complicated pipework has to be fabricated with Y-junctions, elbows, bends and flanges, and my father's idea was to automate these welding tasks," he adds.

Roland Kistler, Alexander Kistler's father, designed a rotator with three wheels, two below and a third clamping onto the top of the weldment. This enables an eccentric weight to be rotated 360°, safely and under accurate speed control.

Conventional wheeled rotators rely on four points of contact underneath the component. "But if an offset or eccentric weight is being rotated, then the component will slip on these rollers as the weight begins to rise, making it impossible to complete a rotation safely at a controlled speed. My father designed a rotator with three wheels, two below and a third clamping onto the top of the weldment. This enables an eccentric weight to be rotated 360°, safely and under accurate speed control. This development enabled the welding of complex components to be automated, because the system can compensate for offset loads and the drive torques can be continuously adjusted to achieve constant travel speeds," he explains.

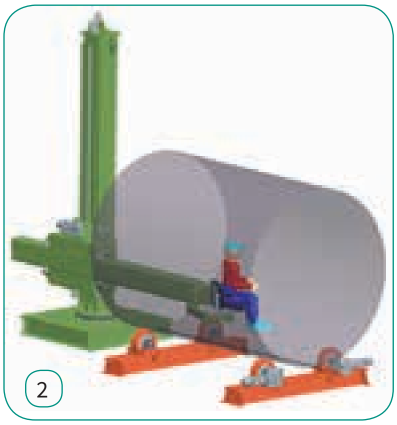
From this initial idea, the company quickly began to add other positioners and rotators to meet the specific welding needs of fabricators. Today, Kistler supplies standard equipment such as positioners, turning rolls and manipulators and designs and manufactures turnkey automation equipment according to customer's specific fabrication needs.

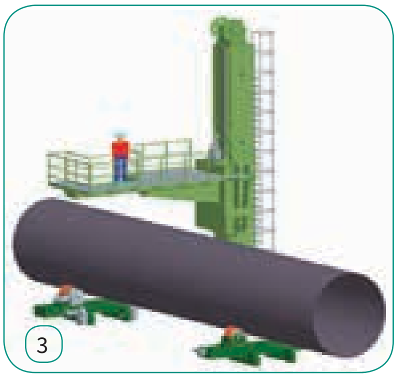
Alexander Kistler took over from his father after finishing his studies as a mechanical engineer in 1989. "Then in 2000, our main competitor, Bode went bankrupt and we purchased the intellectual property rights and the Bode name. This was a breakthrough for us, because it gave us access to a large portfolio of machines and a substantial global customer base," he says. "Today, we continue to manufacture Bode machines and we have retained the well-known Bode name. But the machines now come out of the Kistler factory in Bad Saulgau in the South of Germany, 60 km north of Lake Constance on the Swiss border," Kistler tells *African Fusion*.

For the fabrication of wind tower sections, Kistler supplies plate seam-welding systems, rotating equipment and the column and boom systems necessary for submerged arc welding of the cans and sections. Helvert's four-wire welding systems can be used to deposit up to 45 kg of weld metal per hour.

Alexander Kistler first came to South Africa after Andrew Masuret of Mazolutions contacted the company in 2008 with a refurbishment application for Secunda. "We engineered, manufactured and supplied a turnkey automation system for recladding conical ashlock vessels for the petrochemical industry in Secunda," he relates. "These were being done manually at that time, in unpleasant conditions. The vessels were preheated to 120 °C, with the welder having to work inside the cone. Using our rotating expertise, we developed a fully automated system that significantly reduces the health risks. Welding is now being done using Lincoln's twin-arc submerged-arc process. The rotator tilts the conical vessel to enable welding in the 12:00 o'clock position across the tapered internal surface, and some clever automation changes the rotation speed so that the linear travel speed remains constant for an even layer thickness and

solutions





1: External longitudinal welding using a traditional Kistler/Bode column and boom.

2: Internal longitudinal welding using the same column and boom.

3: Multiple external circumferential welding using a travelling platform column and boom system.

heat input," he explains. "This is a direct spin-off application for the pipe rotator that my father first invented," he adds.

Wind tower solutions

From 2000, the wind energy industry in Europe became strong and this "has since become one of our key industries". "The Bode portfolio of positioning equipment is probably the most comprehensive of any manufacturer in the world and the range of machines extends to over 2 000 models," Kistler continues.

For the fabrication of wind tower sections, Kistler supplies plate seam-welding systems, rotating equipment and the column and boom systems necessary for submerged-arc welding of the cans and sections. "In addition, in 2008, we acquired UP Helfert, a manufacturer of bespoke pipe-mill multi-head submerged-arc welding equipment, which is ideal for the wind tower industry because of the very high welding speed requirements. Helvert's four-wire welding heads can deposit up to 45 kg of weld metal per hour, which is twice that of the competition," he adds.

Citing SteelWind Nordenham and Ambau WindService as references, Kistler says that his company has considerable experience in systems for producing onshore and offshore wind towers. Opening a PowerPoint presentation on wind tower fabrication, he says that the process begins with the cutting and joining of plate. These plates are then rolled into 'can' sections ready for welding the longitudinal seams. "Traditionally, one column and boom is used to weld the external seam from the top and the same system is used to complete the internal seam at ground level," he says.

"But we separate the internal and external welding systems. We use a dedicated four-wire welding station with a walk-on platform for the external welding and a separate four-wire boom system for internal welding. Our rotators also allow the tapered tower sections to be tilted to level the seams for welding in the flat position," he says.

A purpose-built flange welding station adds flanges to end sections before more shells are added. "We can offer several different methods of adding shells to a wind tower section. First, we can manually tack weld a number of sections together to achieve the required section length. Then the whole section is moved to an internal circumferential seam welding system, which can again deposit up to four welding wires simultaneously. From there, a platform system is used to complete the external seams. And it is possible to complete two circumferential seams – internal or external – at the same time, so we can achieve an effective deposition rate of 80 kg per hour or more," Kistler points out.

Using growing lines is a second possibility, with shells being added one by one before completing the circumferential seams. "And the third way is to use hydraulic cylinders to position and clamp shells together. This allows the internal seams to be welded without the need for tacking. This is, by far, the quickest way to assemble a wind tower," he reveals.

Describing the requirements for offshore wind, he says that offshore turbines are generally supported by tripods, jackets or mono-piles. "Mono-piles have become much more popular in recent times because their fabrication is so much easier to automate. A typical monopile is a single welded construction 120 m long and weighing 900 t. Diameters range from 8.5 to 10 m and wall thicknesses can be up to 120 mm."

Kistler sees offshore wind becoming more interesting to developers in South Africa as the wind tower industry matures. "We expect to see offshore wind towers being erected off the coast of South Africa within the next decade," he predicts. "Wind speeds are more consistent offshore, so the efficiency of a offshore wind farm can be higher. The evolution from onshore to offshore occurred in Germany some 10 years back and we see a parallel evolution occurring in other countries of the world as confidence in the technology grows.

"We at Kistler are able to offer local manufacturers integrated and turnkey fabrication systems. We can design, supply, assemble, install and commission production facilities, and we also offer training and ongoing support. We don't simply sell machines, we sell productivity," he concludes.

Skills development: a long-term approach

To help overcome skills shortages in the welding industry, Afrox has adopted a long-term approach. *African Fusion* talks to Johan Pieterse at the company's Germiston demonstration and training centre, where nine teachers from Gauteng technical schools are being prepared to take welding into Grade 10 classrooms in South Africa from January 2016.

Photographed at the Afrox demonstration and training centre in July are, from left: Johann Pieterse, Afrox; Marchante Roets, student; Abraham Pedro, Missourilaan T.H.S; Thabelo Rabedzwana, Afrox; Dolf Willems, Primrose T.H.S; Jansen Kieth, Missourilaan T.H.S; Douglas Holmes, District Office; Gideon Brink, Primrose T.H.S; Cornelius Tema, Jabulani T.H.S; Gerald Maredi, Modiri T.H.S; Harm Veenstra, Technical Trainer for Afrox; and Johnny Loufant, Modiri T.H.S.

Houston Isaacs, Afrox's practical welding specialist, demonstrates the GMAW process to Cornelius Tema of Jabulani T.H.S and Johnny Louwfant of Modiri T.H.S.

"Current economic conditions in the fabrication and welding industries are not good, resulting in job losses as companies restructure to survive the down turn," Pieterse begins: "This exerts pressure on skills and skills requirements where potential employers have a much larger selection of potential employees and can therefore select the most skilled people in the labour market.

"Then we find, with new projects, we don't have enough skilled people to do the work, so we import skills while training. But the local skills only become available by the time these projects are over, and usually without the necessary experience," he adds.

"As market leaders in the welding industry, we at Afrox realise that to improve our economy we have to focus on creating jobs for local people and export our skills, rather than import them. In the welding industry, a person has to have skills to get a job," he reasons.

At the start of its skills development initiative, Afrox approached the Technical Vocational Education and Training (TVET) colleges, which suggested offering bursaries for welding students. "But when we approached schools, we discovered that not enough learners were interested in technical careers due to the lack of focus at school level," Pieterse relates.

The current initiative began when the Gauteng Department of Education (GDE) approached Afrox with the news that the Department of Basic Education (DBE) planned to create a new focus on technical training at school level by reintroducing specialisation under subjects such as Mechanical technology in its RECAP programme.

"Under the Mechanical Technology umbrella, the DBE is bringing back fitting and turning, automotive and welding as skills-based subjects at its technical high schools," Pieterse continues. "So from January 2016, Grade 10 learners at the selected schools will be able to choose welding as a specialist subject. This will be followed by a Grade 11 and Grade 12 course in 2017 and 2018, respectively."

"We assisted the Department of Education in revamping the available infra-structure at schools by designing new training facilities with the schools in question. Once the facilities were upgraded, Afrox supplied the schools with curriculum supporting equipment such as Afrox PortaPaks, Afrox Transarc inverters, the new PortaMig as well as PPE and consumables to get started. Afrox will also provide ongoing support at the selected schools," Pieterse assures.

To date, 14 schools have been equipped by Afrox in readiness for the 2016 launch of the RECAP programme.

"Now that the schools are equipped, we need to improve the knowledge and skills of the technical teachers. We developed five one-day training courses including: Safety; Oxyfuel welding and cutting; MMA welding; MIG/MAG/FCAW welding; and TIG welding. The training involves three hours of theory followed by an afternoon of practical training in our demonstration and training facility," Pieterse informs *African Fusion*. Following up, the course will be delivered to technical teachers nationally in their respective provinces.

"We are proud to confirm that today, we are delivering the last module in the range, the TIG module to teachers from the Gauteng schools, ending the course for the first group of teachers we plan to train. We will also be selecting schools in the different provinces and train teachers in selected areas who will then train their colleagues going forward.

"We intend to follow the learners who take up the welding course in 2016, with a view to offering them bursaries for welding apprenticeships, learnerships and opportunities to enter the Young Welder of the Year competition when they complete their schooling. Our ultimate goal is to see more young people taking up welding careers and to create employment for skilled local people in our industry," Pieterse concludes.

Gas distribution relationship focuses on growth

Cosmo Industrial has been an accredited industrial and specialty gas distributor for Air Products South Africa for the Tshwane and greater Pretoria area since 1996. In 2009, Cosmo moved to their new state-of-the-art facility, which incorporates a purpose-built gas distribution facility for Air Products' packaged gases. *African Fusion* pays Cosmo a visit.

Photographed at Cosmo's Training Academy are, from left: Air Products' Jorg Scholz with Cosmo Industrial's Jacques Uys, Petrus Pretorius and training manager, Leazle van Rooi.

"Cosmo Industrial and Air Products have had a longstanding supply relationship," says Air Products' Jorg Scholz, the company's distributor business manager for Packaged Gases. "Accredited distributors such as Cosmo Industrial offer a one-stop-shop concept for welding supply solutions to the market, which includes welding machines, consumables, safety equipment and industrial and specialty gases. Key to their success, are their high levels of business acumen, service and technical welding expertise, which makes Cosmo Industrial one of Air Products' most successful distributors. Gas sales have grown annually for the past 10 years and Cosmo is now one of the top 10 Air Products South Africa gas distributors," he adds.

As well as its two key partnerships with Lincoln Electric on the welding equipment and consumables side and with Air Products for the full range of industrial gases – shielding gases (MagMix and Coogar range), acetylene, oxygen, nitrogen and argon – Cosmo Industrial also stocks a full range of the following product categories: PPE; lifting and rigging equipment; hydraulic tools, fasteners; hand tools; power tools & accessories; LP Gas equipment and accessories; pneumatic tools; generators; abrasives, and general hardware.

"Welding constitutes about 45% of our business, with direct over-the-counter sales from our store contributing about 25% of that total. The remaining 75% is through direct interaction with local industrial clients," explains Jacques Uys, Cosmo Industrial's sales manager.

The company also offers a welding machine rental service, an equipment repair facility and is in the process of finalising its Cosmo Training Academy in Silverton, Pretoria.

Having sufficient gaseous product and cylinders to support our distributors' growth is of utmost importance: "It is very important for us to have the controls in place to monitor cylinder holdings at distributors and their client sites," says Scholz. This helps to ensure the sustainability of the distributor's future. "Air Products continuously invests in infrastructure to support its distributor network – in terms of plant, trucks, cylinders and value-added offerings. Our distributors differentiate themselves through exceptional service standards to industry, so we believe that we have to offer the same high levels of service to our distributors. We have a distributor network throughout South Africa and the relationships we build are very important. Distributors are our 'eyes and ears' on the ground. They feed back marketing intelligence to us, and as a team we can then develop strategies about how we can grow sales in the market," he continues.

"All our distributors can be assured that they will always be supported in retaining volumes and growing their markets. We offer innovative solutions to our distributors, supporting them with different modes of supply, advertising, organising open days and we run a national distributor conferences to bring all our distributors together. This provides an opportunity for distributors to meet, share information and grow together as a team," Scholz tells *African Fusion*.

Speaking from Cosmo Industrial's point of view, Uys says: "The partnership adds a lot of value to our customers and to their businesses. Cosmo and its partners bring brand equity to industrial workplaces. When a sales representative from Cosmo goes to a customer, the client knows immediately that he is talking to an Air Products, Lincoln and industry specialist. We offer quality brands, so the Cosmo name has weight with customers, which means a lot. It makes it easier for our sales teams to go out and grow our market share," he adds.

Air Products supplies industrial gas products directly to select clients and also via distributors to end-users. "Our distributors typically target the small-to-medium welding market and, through the partnership, we provide their sales staff with training on the unique selling points of each of our products. We also provide technical information and tools to help determine the appropriate gas for any specific applications, such as our gas selection application called Gas Selector, which is made available to all distributors," says Scholz.

"We at Air Products South Africa work closely with distributors to understand the market. Then we develop solutions and bring products to the table that will help fabricators improve their processes, quality and achieve more cost-effective results, so that their businesses can succeed and grow.

Utilising the 'hub and spoke principle', Air Products delivers bulk loads to distributors who in turn re-distribute the product in smaller quantities to the end-users in their allocated geographic

Air Products' CryoEase solution is an argon liquid offering utilising 600 litre to 2 000 litre maxitanks to service larger welding accounts.

The welding bays at the Cosmo Training Academy supply three welding gas mixes via the Air Products CryoEase system: pure argon for TIG and aluminium GTAW welding; argon, CO_2 and oxygen mixes for GMAW welding of steel; and pure CO_2 for short-arc FCAW welding of steel.

area. For a customer who requires higher volumes of welding gases, the CryoEase mode of supply is a unique offering that is utilised by select Air Products distributors.

Describing the CryoEase solution, Scholz says that this is an argon liquid offering utilising 600 litre to 2 000 litre maxitanks to service larger welding accounts via distributors. "Coupled to the tank is a two or three part mixing panel that connects to CO_2 and /or oxygen cylinder manifolds to provide the ideal welding mix. This combination allows us to produce any of the common welding gases required for welding," he explains. The welding gas is then piped directly to the welding stations on site, without the need for welders to exchange and transport cylinders.

The benefits of CryoEase include consistent quality, onsite telemetry for automated deliveries, bulk product on site and on tap for increased welding utilisation and improved site safety, because cylinder handling is eliminated at the welding stations. Efficiencies are also improved because less time is spent replacing empty cylinders and producing purchase orders for replacements.

Cosmo Industrial, with the support of Air Products, has installed a CryoEase-based gas reticulation system for its new Cosmo Training Academy. "In the bays for the training academy, we supply three welding gas mixes via the Air Products CryoEase system: pure argon for TIG and aluminium GTAW welding; argon, CO_2 and oxygen mixes for GMAW welding of steel; and pure CO_2 for short-arc FCAW welding of steel," Uys reveals.

The three mixes are calibrated and preset on their associated panels and analysed on a regular basis to ensure mixture accuracy. "We base the three-part mix on the standard Air Products MagMix 3 for thin mild steel, which consists of base argon with small percentages of CO_2 and oxygen," Scholz reveals. "For carbon steel welding, the argon acts as an inert gas preventing the weld pool from being contaminated by the atmospheric air; CO_2 governs the penetration and heat input; while small amounts of oxygen improve the wetting action/fluidity of the weld pool," he adds.

The Cosmo Training Academy is being set up to focus on safety, welding skills and continuous improvement of weld quality. "We aim to train new youngsters wishing to take up a welding career and to improve the skills of shop floor welders," says Cosmo's training manager, Leazle van Rooi. "We believe that, wherever a project needs welders, then local people should be trained and employed to do the work – not only in South Africa; we will also train people for projects north of our borders," she adds.

Cosmo is currently getting its accreditation in order from the National Artisan Moderation Body. "All the welding bays and classrooms are now built, but we are having to build a new grinding/hand power tools area to meet all the safety requirements. Power tool skills are another critical area of need in South Africa, as people need to be able to grind and repair welds properly to improve the finished quality of the work produced," Van Rooi adds.

While the Cosmo Training Academy hopes to be able to offer full Red Seal artisan training programmes, different pathways based on Section 26D of the Skills Development Act are envisaged. "We envision a modular course structure based on NQF-linked courses that will count towards full Red Seal qualifications," she tells *African Fusion*.

Underpinning the Academy's core purpose, however, is "a need to resolve quality problems coming from shop floors". "When we encounter specific welding problems, we often find that the welding procedure or technique are the cause. When we come across such cases, we will develop different training packages to meet these specific needs, to enable welders to change their process and improve their skills so that the quality coming off shop floors improves.

"We urgently need to find ways to improve quality, efficiency and productivity in our industries. Through the Cosmo Training Academy, we aim to help our fabrication shops to achieve continuous productivity improvements on their shop floors," she explains.

"Air Products has become involved in the Cosmo Training Academy as part of our CSI initiative." adds Scholz. "We also strive to support education and engagement with the youth of our country, to develop skills and create employment. For Air Products, the Academy offers opportunities to grow brand awareness among new welders entering the industry and it further cements our commitment to help Cosmo Industrial to grow," he says.

"We want to have a world-class facility, not just another training academy. Being trained at the Cosmo Academy must mean something. We want to develop welders who speak positively about Cosmo and about the welding profession," Uys concludes.

SA company builds 600 t bullet

Starweld Automation, a proudly South African welding equipment and automation OEM, has completed the design and manufacture of two 600 t rotators for fabricating five LPG storage bullets required for the new R1.3-billion Sunrise Terminal, currently under construction in Saldanha Bay. *African Fusion* talks to Starweld's Steve Hutchinson and Robert Case.

The Saldanha LPG Import Terminal, being developed by investment group Sunrise Energy, includes the construction of a multi-buoy mooring (MBM) system in Big Bay, Saldanha; a subsea and overland pipeline to the onshore terminal; rail and road distribution gantries, cylinder filling facilities and pipeline options for bulk users; and – for Phase 1 – 5 500 t of storage via five LPG storage tanks, which are going to built in South Africa by a local fabricator.

The terminal will be able to handle pressurised marine design vessels with DTW (dead weight tonnage) of between 3 000 and 20 000 t, including semi refrigerated and refrigerated vessels with overall lengths (LoA) of between 97 and 174 m and drafts of 6.0 to 10.4 m.

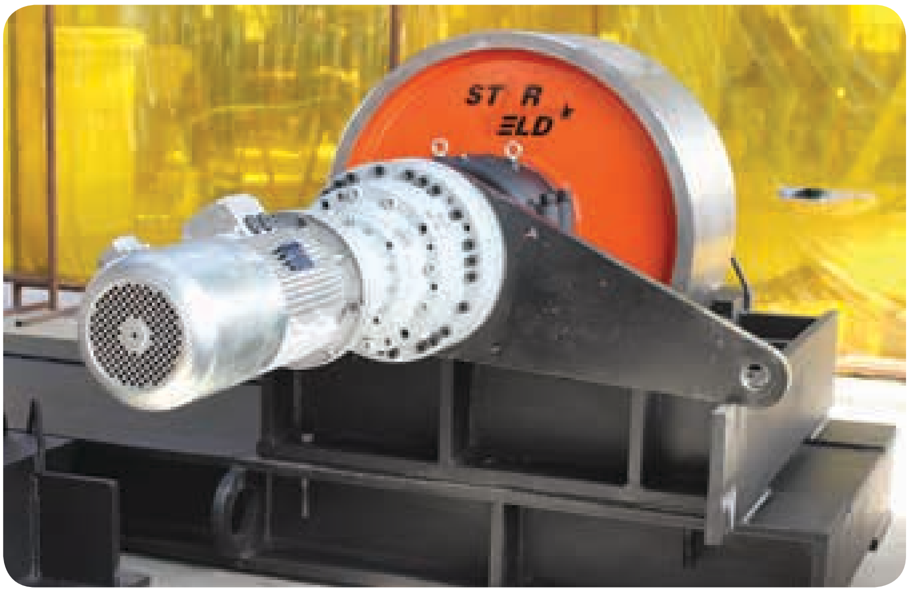
Long term, a modular expansion strategy has been adopted to allow for growth in LPG demand. On completion by the end of 2016, the initial handling capacity will be 17 500 t/month from the first five-vessel, 5 500 t bullet battery. For Phase 2, planned for completion by 2019, additional road loading gantries and a second bullet battery is planned, and if predicted demand is realised, Phase 3 will be implemented thereafter to take the terminal throughput capacity of 52 500 t/month.

At the terminal, imported commercial propane and butane in accordance with SANS 1774: 2007, will be blended and odorised before being transported via bulk road tankers, direct cylinder filling or via pipeline to downstream customers or storage facilities.

The bullet vessels for storing the imported LPG are at the heart of the terminal. Phase 1 vessels, comprising five mounded storage bullets, over 65 m long with a diameter of 7.0 m, will be installed during 2016 to meet currently predicted demand. In line with Sunrise Energy's objectives of maximising local content and optimising the use of local resources, fabrication of the bullets will be completed by a local fabricator at a facility adjacent to the Sunrise Energy site.

Starweld automation

Launched in 2010, Arc Quip is a locally based manufacturer of welding machines and related manipulation equipment and one of the few inverter-based welding machine manufacturer in South Africa. At the beginning of June



For the driven rolls, Bonfiglioli 7.5 kW induction motors connected to 311 planetary drives on a torque arm were chosen in a simple in-line design.

The 'wheels' are 1.0 m in diameter and have a 520 mm width, with a number of 40 and 50 mm stiffening ribs to ensure load carrying capacity, while the control system has variable speed drives (VSDs), switchgear and a remote control.

rotators

2012, Arc Quip began manufacturing and marketing Starweld welding inverters, a comprehensive range that covers MMA, MIG, TIG and submerged arc power sources and, according to Starweld's design engineer Robert Case, are "the first locally manufactured machines to be fully digitally controlled. Starweld machines are fitted with 32 bit microprocessors, typically the same as those found in current generation Smart Phones," he adds.

"This innovation, means that intelligent communication possibilities, within the machines, and between external devices, are now unlimited. Starweld uses CAN Bus technology, a two-way coded communication system first developed in the motorcar industry. This enables communication between the power source, interfaces, wire feeding systems and manipulation equipment to simplify the task of integrating welding machines into automation systems," he says, adding that this lead naturally to the company expanding its offering to include turnkey welding automation solutions.

Citing a typical example, he says that Starweld is about to introduce a Plasma TIG welding system. "This state-of-the-art technology is ideally suited to the stainless steel industry, where plates of up to 8.0 mm can be welded in a single pass, without the need for a bevelled weld preparation."

Starweld's 600 t rollers

The LPG bullets being manufactured for Sunrise's LPG Terminal have mounded (semi-spherical) ends with 3.5 m radii (internal), joined to eight cylindrical sections with a total length of 60 m. Including the ends, therefore, the length of each storage vessel is just over 67 m. The design pressure requirements are -0.7 bar to 16 bar in the temperature range from -40 ˚C to +40 ˚C.

The vessels are fabricated by rotating the weldment underneath submerged arc welding equipment, adding a cylindrical section at a time – one of 8.84 m, six of 7.5 m and one of 6.16 m, respectively. Hence the need for two sets of 600 t rotators, a contract awarded to Starweld earlier this year.

This rotator consists of two interconnected drive rollers; a control system with variable speed drives (VSDs), switchgear and a remote control; and a set of two separate idler rollers to support the growing end.

"Each individual roller for this system, and we have fabricated eight of these for the two systems we are manufacturing, has a material thickness of 50 mm for its 'tyre', which is first rolled, then submerged arc welded to close the seam and rolled again. The 'wheels' are 1.0 m in diameter and have a 520 mm width, with a number of 40 and 50 mm stiffening ribs to ensure load carrying capacity. Each wheel weighs approximately 1.2 t, the total weight of the driver set is 10 t and the two idlers on their bases weigh over 4.0 t each.

"The only company that could supply a suitable gearbox for driving the system was Bonfiglioli," Case tells *African Fusion*. A reduction ratio of 4 760 was required to enable the VSDs to accurately control linear welding speeds between 100 and 1 000 mm per min. Bonfiglioli 7.5 kW induction motors connected to 311 planetary drives on a torque arm were chosen in a simple in-line design. Custom designed and in-house manufactured tapered bushes were also machined to lock the shaft and rollers to the drive system.

The first 600 t rotator set was completed and ready for dispatch in mid August from Starweld's East Rand facility, with the second set due to be completed two weeks later. "This is a 100% South African design, purpose built to customer specifications in less than two months Case says.

"We do not compete in the low-cost equipment market. But through this project and through the increasing success of our robust and fully digital welding machines, we believe we can compete – on performance, quality and price – with premium-brand manipulator and welding equipment manufacturers from anywhere in the world," he concludes.

Arc Quip began manufacturing and marketing Starweld welding inverters in its Boksburg premises in 2012. These are "the first locally manufactured machines to be fully digitally controlled," says design engineer, Robert Case.

TPS/i Robotics – automated welding redefined

Fronius is launching new TPS/i Robotics power sources, which is specially designed to meet the demands of robot-assisted welding. Thanks to its interconnected and fully synchronised system components, it enables robotic welding to be performed faster and with a higher degree of reproducibility. A new level of quality can be achieved and maintained as a result of the ingenious yet easy-to-use functions of TPS/i Robotics systems.

Fronius engineers have drawn on the power source's consistently implemented digital system architecture and new communication technology features to cover and address all the major influencing factors crucial to the welding process with high definition and fast reaction speed. The result is an exceptionally stable arc and optimum welding results.

A crucial role is played by the modified dip transfer arc (LSC – low spatter control) and the modified pulsed arc (PMC – pulse multi control), which give significantly higher levels of control over the arc. The user is also supported by a penetration stabiliser that ensures that the penetration remains constant – even if stick out fluctuations occur – and, by adjusting the highly dynamic wirefeeder, the arc length stabiliser keeps the arc at an optimum length when the arc geometry – due to a change in the weld seam profile, for example – or the weld pool temperature changes.

As a result, TPS/i Robotics not only makes the welding process faster, it also enhances the weld seam quality. One of the visible improvements is the minimal amount of spatter produced.

Another benefit of the power source's digital control system is the continuous collection of information on the current status of the power source and on every weld seam, which is made available to the user. This detailed data can be used to monitor, analyse and document the welding process. Using the central server unit (WeldCube), the data gathered from several power sources, via their Ethernet interfaces, can be combined and managed from a company-wide perspective.

Fronius is also forging new paths in the area of communication between the welding system and the robot controller. Like all other process control components, the TPS/i system's new robot interfaces are incorporated into the system bus architecture and are therefore able to provide data relevant to the robot control in real time.

The new TPS/i Robotics power source is specially designed to meet the demands of robot welding.

A new Interface Designer allows the robot interface to be programmed quickly and conveniently offline using a graphical user interface. Users can configure and adapt the interface to their own individual requirements at any time. In addition, Fronius provides pre-prepared interfaces to the control systems of leading robot manufacturers.

www.fronius.com

At source extraction of welding fume

Welding fumes are a health hazard and welders who inhale too much fume run a higher risk of developing asthma, bronchitis, COPD, and cardiovascular disorders. The Dutch government has, as a result, instituted a new and more stringent limit for the amount of welding fumes in the workplace with the legal limit now down to 1.0 mg/m^3 over an eight-hour working day.

In practice this norm is exceeded in many companies even though they may have taken measures such as room ventilation, mobile extraction arms, or personal protective equipment such as dust masks or ventilated helmets. Integrated welding fume extraction in the welding torch is a more effective measure that is easier for the welder to apply in comparison to other measures.

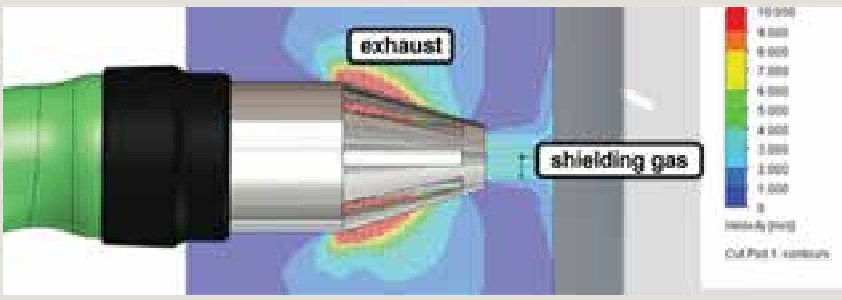
The Extractor lightweight GMAW welding torch from TransLas overcomes this problem by integrating fume extraction into the torch, allowing the fume to be extracted very close to point of generation. The torch can be connected to a central extraction system or to a standalone mobile extraction unit without any problems.

The Extractor torch has a conical gas nozzle with a gas orifice of 10 mm, which gives a better view and accessibility. Due to the design of the gas nozzle at the intake side, the shielding gas comes out faster than normal. The combination of faster gas flow and the extraction flow at the gas nozzle results in effective shielding and extraction, simultaneously.

A ball and socket joint between the torch handle and the hoses also offers improved flexibility and manoeuvrability.

The TransLas 7XE Extractor torch reduces the welder's exposure to welding fumes by 90-95% as measured by TNO in a 'worst case room'. This applies to underhand, overhand, pulled and pushed welding techniques and quick weaving.

The Translas Extractor torch is available in South Africa through Smarter Welding Africa. ***www.translas.com***



The Extractor lightweight GMAW welding torch from TransLas has a 10 mm inner gas nozzle for shielding gas and it simultaneously extracts fume through a slotted outer nozzle.

New Kemper welding helmets

With its optical classification Level 1/1/1/1 classification, the Kemper autodark® 760 welding helmet is setting new standards for professional welders.

The Kemper autodark 760 has the best possible optical filter classification – Level 1 in terms of the optical quality, light diffusion, homogeneity of the field of vision, and angle dependence.

"As a manufacturer of exhaust and filter systems, we care about effective occupational safety when it comes to all personal safety equipment," says Björn Kemper, managing director of Kemper GmbH. "We are one step ahead in comparison with the other solutions available on the market especially thanks to our top model autodark 760."

This high-quality welding helmet is suitable for permanent professional welders. With an extremely wide range of vision (96x68.5 mm) it provides a better view of the work piece. Additionally it is supported with the best possible optical filter classification – Level 1 in terms of the optical quality, light diffusion, homogeneity of the field of vision, and angle dependence.

Due to the optimised head support, autodark 760 offers a better wearing comfort and IR/UV protection is at Level 16, the highest. The sensitivity and lightening delay can be set using a control placed on the outside of the helmet and the helmet is equipped with a grinding mode. The protection helmet, as well as the new autodark 660 model, has been granted the DIN-plus certificate and Kemper offers four-year warranty for the autodark 760.

The comfortable helmet cover in all versions of the new Kemper autodark series is made of a combination of high-quality polyamide and Zytel. This makes the helmet cover very flexible and, at the same time, mechanically very stable and heat-resistant.

www.kemper.eu

Dependable cutting solutions

Koike is known for producing state-of-the-art cutting machines and advanced automated cutting systems. "We approach this challenge from two angles," says Sean Moriarty, sales director of Koike South Africa, "via problem-solving and support services. Based on a keen understanding of evolving customer needs, new technologies, improved processes and optimised technologies, we are able to focus on what is most important," he assures.

Koike is a global provider with customer support and technology centres in every major industrial region in the world. "We are one of the biggest cutting solutions provider worldwide and a member of the Japanese Koike Sanso Kogyo Corporation. Koike prides itself on solving process automation problems that others shy away from," Moriarty adds.

Koike is a global provider of advanced cutting machines and automated cutting systems.

Image courtesy of Koike Europe: www.koike-europe.com

The company is committed to thinking globally and acting locally, from initial contact to the realisation of even the most complex cutting tasks. "Knowledge, strength and commitment enable us to evaluate the challenges facing our clients from every relevant point of view.

"Service for us means cooperation from the beginning: initiating joint project management, assisting in setting up the project, consultation during installation and start-up processes, and we even include customer education and training sessions," Moriarty concludes.

Koike products and services are available in South Africa through Retecon (Pty) Ltd. ***www.retecon.co.za***

Manufacturing key to liner lifespan

Chromium Carbide (CrC) long-life wear plates can significantly improve operational efficiency and reduce maintenance costs in industrial applications – but only when manufactured and handled according to strict guidelines.

The manufacturing methodology of CrC can affect the quality, consistency, integrity and wear properties of long life liner plates, and it is therefore of the utmost importance that industrial operations make use of quality certified CrC products for the material handling process.

The manufacturing of CrC liner plates has vastly improved since the product was first introduced to the market 35 years ago, with top liner plate expert Rio-Carb playing a leading role in advancing technology and developing innovative variations in manufacturing methods.

Rio-Carb is the only CrC liner plate and equipment manufacturer whose welding standards are compliant with the internationally recognised American Welding Society (AWS) standards.

Rio-Carb MD, Martin Maine says that the biggest challenge with CrC is to get the weld beads smooth, as rough welds immediately create more cavities and disturbances to the material flow. "Customers need to be wary of companies that do not have certified welding processes as this may cause major future problems."

Rio-Carb moved into a new production factory with state-of-the-art equipment and technology. "To remain ahead of the game, we are also currently in the process of improving our overall quality management standards by becoming ISO 9001-2008 certified," adds Maine.

"As the balance between cost effectiveness and reliability becomes increasingly important, industries will be looking for new and improved methods to effectively transport abrasive materials, and the demand for excellent quality and genuine CrC products will increase," Maine concludes.

www.riocarb.com

LNG and LPG welding consumables

Transporting natural gas through pipelines can be non-profitable over long distances, so natural gas, which consists mostly of methane with smaller amounts of ethane and propane, is often transported by ship in the form of liquid natural gas (LNG). By super cooling natural gas to -163°C, its volume decreases 600 times. In this state, the 'gas' is known as liquid natural gas (LNG).

Liquefied petroleum gas (LPG) on the other hand, consists mostly of propane and butane stored as liquid at atmospheric temperatures but under pressures of between 200 and 250 bar.

LNG has to be stored in cryogenic conditions, which require the use of high quality materials and welding consumables. These materials and consumables are required in the construction of cryogenic gas plants such as: LNG trains and short pipelines; LNG carriers, tanker trucks and rail tank cars; regasification terminals, such as the Sunrise Energy's LPG terminal currently under construction in Saldanha Bay; and large cryogenic storage tanks.

Welding consumables play an important role in the construction of LNG and LPG projects. High quality products are major factors that contribute to the safety and cost efficiency of building plants and storage vessels. Materials and structures must meet the most stringent specifications.

A variety of materials are used for LPG and LNG plants, such as carbon steels, stainless steel, 3.5% to 9% Ni steels and aluminium. Nickel-based and austenitic welding consumables are used in cryogenic applications in order to comply with the high ductility and strength requirements at low temperatures.

voestalpine Böhler Welding offers a complete portfolio of specialised products for all the common welding processes: SMAW, SAW, GMAW and FCAW, with the required qualifications, certifications and documentation that meet the industry's quality requirements.

Some global reference, amongst many others, include: ethylene tanks for Antwerp in Belgium; an LNG-production plant at Bintulu, Malaysia; separators for low temperature service in France; an ethylene terminal facility in 9% nickel steel in India; and, built this year, a 52 000 m^3 ethane tank welded using flux-cored UTP AF 6222MoPW (E NiCrMo-3) consumables in Stenungsund, Sweden.

"We are a state-of-the art high-quality manufacturer of welding consumables with over 30 years of experience in the LPG and LNG fields. From us, you can expect consistently high-quality products and competent support. voestalpine Böhler Welding has supplied over 25 of the largest global LNG projects," says Tim Siveright of Böhler Udderholm Africa, voestalpine Böhler Welding's representative in South Africa. "And we are very excited about the future expansion prospects for the local LPG and LNG industry," he concludes.

www.bohler-uddeholm.co.za

voestalpine Böhler Welding offers a complete portfolio of specialised products for LNG and LPG welding projects for all common welding processes.

Simulation and offline programming of robot systems

Virtual simulation of robot-based systems and processes provides crucial advantages not only in planning, but also in the commissioning and operation of such systems. In particular, costly errors can be reliably excluded and resources used more efficiently.

The prerequisite is software solutions that cater for the technical parameters of robotics as well as the specific requirements of the system environment. One example is the MotoSim EG VRC (Enhanced Graphic – Virtual Robot Control) software developed by Yaskawa specifically for the simulation and offline programming of Motoman robot systems.

Planning and implementation of new robot-based manufacturing processes usually begins with the new process being subjected to lengthy weld testing. This calls for the repeated reprogramming of robots and other plant components such as positioners, torches and tracks. Once the desired result has been achieved, the system is retooled. Meanwhile, it is not available for actual production. Nor can unforeseen errors and disruptions be excluded during and after the start of operations.

There are very good reasons why simulation programs are winning increasing recognition. They enable the virtual configuration and inspection of manufacturing processes in a dynamic 3D environment. The desired standards of quality, resources, costs and deadlines are reliably guaranteed. Capacity utilisation and cycle times are optimised by simulation. Possible problems in the product design can be recognised at the outset and eliminated prior to the actual start of production.

The use of simulation and offline programming is of particular interest in medium-sized production plants with frequent product changes, such as sheet metal forming or coating applications. This applies to plant engineers as well as users: in addition to planning, plant engineers and system integrators can use them to completely pre-program cells.

Installation at the customer's premises is correspondingly simpler and faster. Users can significantly shorten their set-up times by simulation and offline programming. All processes can be developed parallel to production. Because the jig is checked in advance for accessibility, etc, only minor corrections – if any at all – are required later.

MotoSim enables fast assembly and analysis of system layouts. The integrated 3D Hoops Graphic Engine guarantees a high-quality graphic display.

MotoSim offline programming system

Yaskawa developed the MotoSim software package, an offline programming system with 3D simulation, specifically for planning Motoman robot systems. The controller function is integrated from the start. What is special about it is that MotoSim uses the same kinematic model as the robot control unit. The user interface of the teach pendant (TP) is thus mapped 1:1 to the software for robot programming on the PC. Even the programming language (Inform) is the same. This greatly simplifies the work of the operator. Downtime is minimised and productivity increased.

All Motoman control generations are supported by MotoSim EG, from type ERC to the latest FS100 and DX200 control units. Besides simple programmability, MotoSim facilitates planning with a comprehensive library of Motoman products. In other words: the library not only includes all robot models of various generations, it also offers accessories such as positioners and tracks.

Yaskawa's 3D data models can be downloaded from the company's homepage on the Internet. This service is already included in the software license, as are enhancements with new robot models.

The MotoSim EG is a simpler version for pure simulation. Per-track calculation using CAD enables fast estimation. On the other hand, the full version MotoSim EG VRC (Enhanced Graphic – Virtual Robot Control) is fully programmable offline and configured for multi-robot solutions. The full version supports robot generations NX100, DX100, DX200 and FS100.

www.yaskawa.za.com

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