James Byrne and VA Technology: A Legacy with More Than 400 Shell Manufacturing Systems Installed Worldwide

An Interview with James Byrne by Carlos Olabe, Executive Director, EICF

Last 6 of March 2020, just before the pandemic lockdown, James Byrne was making an important decision in his professional life, stepping down as Chairman/Director of VA Technology Ltd and entering a new challenging phase of his life.

Being conscious of the relevant and significant impact of Jim Byrne's legacy to the investment casting industry, the EICF requested Jim to hold a conversation to review this legacy.

Q What do you think when you look back and realize the enormous impact to this industry with the solutions provided by you and your company?

A It's been a great journey, and I feel privileged to have worked with so many excellent people within the industry. Together, we have achieved many things and perhaps the greatest has been our contribution towards bringing the process from an art-form to a controllable, technology-based industry.

In the case of the shellroom, the expectation of shell quality perfection has been transformed from unique to normal, bringing stability to the process.

Q When did you first become aware of the possibilities of automation and in particular, robotics in the manufacturing industry?

A I started my professional career with Chrysler UK, designing large scale truck manufacturing facilities for Dodge, and then joined Black & Decker Irl in a senior role to set up an Advanced Manufacturing Factory with leading edge technology and automated processes in every aspect of production.

So the challenge has always been about building efficient manufacturing solutions. This role was also my working introduction to aluminium die casting, with robotic automation of the process and I was hooked!

I returned to UK, and joined Unimation Eur Ltd. as Operations and Engineering Director, heading up engineering development and manufacture of the Unimate Puma Electric Robots.

This machine was the definitive industrial robot of the '80s, operating VAL and carried me into the expanding and dynamic world of automation.

Q How did you become involved with the investment casting industry? What where your first initial ideas when looking to the possibilities of automation and robotics?

A The company was acquired by Westinghouse Inc. and operations were moved to USA in the late '80s. I decided to remain in Europe and became Managing Director of Prab Robots International Ltd, which acquired the ownership rights to the Unimate heavy duty robots.

Within a couple of years I took ownership of the company and shortly thereafter, Versatile Automation Technology Ltd was formed... shortened to VA Tech Ltd.

The business scope was spread across welding, forging and die casting, with investment casting applications at the embryonic stage.

From the very beginning, I enjoyed the investment casting industry the most. It was full of dedicated people, knowledgeable in their own fields, and the attraction of working with all things metallurgical and allied to the aerospace industry was too much for me to put down! We also had the robotic automation technology and skills that the industry desired.

Q What were the initial challenges that investment casting presented in your aim of implementing automation to reduce process variability?

A In the beginning, and for some time, the investment casting process was considered an art-form, especially within the shellroom. Huge credit was endowed upon the skill of the operator in manually manipulating the wax patterns to ensure slurry coverage of the shells. Skill levels differed greatly between individuals, and it was this very fact of skill dependency and therefore process variability that drove the opportunity for process automation. Simultaneously, the move away from ethyl silicate to water-based binders for environmental reasons added further pressure to solve the requirement for process repetition. Variability Avoidance became the key attribute required of the shell manufacturing process, and robotic technology had the solution.

Initially, the backup process automation was industry accepted, then the final dry process, and finally the prime coating process was accepted. Each stage required the development of enabling technologies both in the consumable materials, and

in the process enabling equipment, and all enveloped with the power of computerised process control.

Q ***Was the shellroom your first area of actuation? What sort of challenges did you find there? I can anticipate there were not only technical challenges, but also cultural ones?***

A Yes, the shellroom was the first priority area for robotic automation.

From the outset, the challenge was to recognise the sense of art form prevalent in the process, and without alienating the artists, encourage and convince them to stand back and embrace the change.

Using the robot to provide the muscle to do the heavy lifting was fairly easy to do, particularly on the backup coats. To overcome the perception of magic being applied with the prime coat was a tougher task. And when this was achieved, and a sense of predictability applied to the coating process, intercoat durations were determined, schedule make-up and dosing of slurries established, stucco usage by shell types, shell weight data, etc. All could be accurately determined and the process could be normalised.

From the start, it made sense to apply a PC supervisory control to the robot, and with it the opportunity to interface and control all of the equipment that the robot was required to work with such as slurry tanks, sanders, conveyor, drying systems etc. The shell management screen became the cockpit and the artist became the pilot.

Q ***And as you were overcoming those challenges what were the new challenges coming over?***

A With the operator removed from the process, the weight limitation of what could be lifted was removed. IC-Robots were developed with payload capacities ranging from 100kg all the way up to 1500 kg and even gantry based robots of 2500kg capacity. Robots were equipped with single, double or triple axis gripper systems and the capabilities to process vast quantities of shells concurrently, or single ultra large massive shells.

Simultaneously, the move away from ethyl silicate to water-based binders for environmental reasons added further pressure to solve the requirement for process repetition. Specialised ceramic shell drying equipment had to be engineered to bring stability and accuracy to the process, and many new technical concepts were developed.

Q ***Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, among others… and in addition you still need to understand the technicalities of the industrial process where this is bound to be applied. How it is all these competence acquired?***

A Yes, you are right. The engineering expertise and skills set necessary is very broad. The investment casting process itself brings many unique challenges. The process rightly occupies the throne of Precision Casting and with that comes the pressure for exactness in every aspect of production. Nowhere more so than in the manufacture of the shell itself.

Competence is acquired through understanding the technical requirement of the end user, building a strong team motivated to deliver, and providing them with the best available leadership and team support.

All of which translates to: lots of work, lots of study, a great team, and staying close to the end user.

In the beginning, it's about pointing the ship in the right direction, then keep running between the engine room, the rudder, and the bridge while making continuous adjustments until you get to the destination.

Q ***In addition to your capabilities as an innovator and experienced engineer, you are an entrepreneur. How does this visionary entrepreneur persona develop?***

A If you are constructed that your enjoyment is inseparable from your work, that's the first hurdle crossed. Then it's about taking care to protect your happiness, and that typically means working harder, longer, and with all the passion you can bring together in everything you do in business, particularly at the beginning.

Along the way, it's about building the vision together with the team and customers alike.

Q ***Can you please explain about this vision of yours, relative to the world market as a single entity and your mission statement in respect?***

A On a business level, I had always viewed the world market to be a single entity, albeit divided into geographical sectors and industrial segments. Irrespective of company size, it was important to have a 'no limits' philosophy within the company, and to recognise a lost opportunity in any part of the world as a lost opportunity local to us and particularly so if we were not competing there.

The mission definition has always been a simple one and has remained the same throughout: to be the best in the world at what we choose to do.

Q ***VA Tech developed not only in the UK but soon it was present locally within the markets to serve Germany, USA and China. Can you tell us about all this development and the associated challenges?***

A Yes, soon after setting up the UK operation, VA Tech Germany was established, shortly thereafter VA Tech USA, and sometime later VA Tech China. From the start, we recognised the need to be physically located within each of the key market sectors we would serve, and that the company team would all be VA Tech employees… a single VA Tech Team.

It was fortunate that within the UK, there was a sizeable, strong investment casting industry in the three industrial segments, of aviation, medical, and auto/industrial, and we therefore had the available opportunity to understand the precise needs of the industry and to work with casting experts in the important segments for turbine blades,

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medical prosthesis, turbo chargers and commercial castings. We also had the opportunity to work with some of the key suppliers to the industry, which helped to deepen our understanding of the process.

Q *I guess that the domain of such different technologies, plus the geographical different locations and the technicalities of the different process applications requires the availability of a competent and diverse integrated team. How is this achieved?*

A Yes, this is tough, and it takes considerable time to understand the diverse priorities and preferred solutions for different market sectors and locations, but in reality, engineering is a universally shared language and having our own team located in the principal market areas helps to bridge the gaps.

Equally important, is that every system is designed, manufactured, installed, and serviced by the company, so the opportunity for close communication and understanding is strengthened within the whole team and with the end users.

Q *Companies with culture and companies with soul, they do make the difference. Can you speak to us about the culture and soul that inspire VA Tech?*

A *Innovation* and *Can Do* are at the heart of the company culture, and with these, we can design our future.

Creativity is the fountain of great ideas, and putting the ideas into practice is what defines Innovation. This has been at the root of finding the best solution to meet the customers' needs.

Can Do describes the attitude necessary to place in front of all contact and communications with colleagues and customers alike. It is the key attribute for all employees and is the foundation for training, learning, and the development of the employee.

Q *How is* Can Do *recognised within the company?*

A Throughout the life of the company, the annual *Can Do Awards* have represented the high point of the year, and provides the company's own annual Oscar Awards equivalent, albeit without the dressing up. It is attended by all employees at all locations and the company closes for an afternoon BBQ party in summer. The awards are presented in front of the whole workforce. Award categories include all things important to the company culture and well being, including education, customer service, teamwork, quality, etc. High among all the categories is *Innovation* and *Can Do*, and the importance of recognition and providing an award to all employees is paramount.

Having won the *Can Do: Innovation Award* one year myself, the award certificate still hangs most proudly on the office wall at my home.

Q *Professional recognition is something that in many occasions is missing, but in your case you have had the opportunity to be recognized in several occasions. Can you tell us about those?*

A Winning the *Queens Award for Enterprise* in 2009 felt good and it was a great day out to visit Buckingham Palace. This award recognised the team's high level of achievement in international exports of systems and equipment to the investment casting industry worldwide.

Another moment of strong company pride was in receiving the inaugural: ICI's *Innovator of the Year Award* in 2015. This was indeed a great honour, shared and celebrated by all employees in every role within the company.

On a personal level, and in further acknowledgement and reflection of the team's achievements, I have been delighted and privileged to become an inductee to the ICI's *Hall of Honor* in 2016.

Q *In this conversation we have been looking back, but in more specific technical aspects what would you consider the most important engineering developments achieved by your professional career?*

A Within the investment casting industry, the most important task has been to develop strong engineering solutions for the shellroom, to enable reliable, and efficient productivity from receipt of the wax pattern through to delivery of the completed shells, ready for dewax.

This has meant providing equipment and systems to minimise labour dependency and reduce operational cost at every stage of the process.

Although the basic process across the industry is nominally the same, the Key Process Variable tolerances across the three principal sectors of aerospace, medical, and auto industry are critically different, and providing the total system solution to meet these differing requirements has defined the important engineering challenge and achievement.

Innovation has been the fuel along the way, and this has led to a wide array of IC specific product offerings and technologies.

First among the technologies developed was the mathematic modelling of the system. From the base system maths, the complete system is assessed to determine the overall system profile. Hanger capacities, robot configuration, in-cell slurry and stucco processing equipment and capacities, inter-process drying and final drying configurations are all established at the outset.

The complete shellroom system may represent a physically large set of equipment and therefore, industry sectors, available workspace area, and customer specific requirements can impact and determine the most suitable system configuration to be applied.

The company has uniquely developed Standard Cycle, Mixed Cycle and Rapid Access Cycle, manufacturing logic solutions to deliver these specialised efficient systems.

An important element of the company resource has been the widespread use of 3D CAD at every step of the design process and the significant

investment in this technology has been well justified.

Q You easily identify any VA Technology installation when visiting any investment casting foundry, as the design style and well structured lay outs are talking by themselves, but in addition there is a word displayed on the robots "Shellmaker". I understand that was the name of the first software that you personally developed. Can you tell us on the software developments and evolution along those years and the improved functionalities achieved?

A Many 'firsts' were achieved at the outset. From the start, the complete shell manufacturing systems delivered were computer controlled from a central PC, and the first version of Shellmaker was launched.

Initially it was called CD1 and then at the first customer training session, the end user attendees referred to the system as the Shellmaker that was it!

CD1 was first on display at the ICI in 1990 and then superceeded after a couple of systems with CD2, operating in DOS and written in C and this went on to be developed and utilised in more than 100 systems worldwide.

This system became a de-facto standard within the industry and provided for full shellroom process control of single or multiple systems, networked together, and accessible across the internet.

In 2005, CD2 was replaced with the more advanced and user friendly IC-QL which was Windows-based and provided all the tools and powerful capability that Windows offered. All elements of the previous system were enhanced and the system capability was greatly expanded. Process data management, total foundry integration and IT standardisation were strengthened.

Ten years later, a new level of process capability was achieved with the release of IC-Crystal. This new system represented a great leap forward in every aspect of the System Process management capability and performance. The platform and structure for advanced remote data access for production and process management, and most importantly Advanced Servicing capability and support was greatly enhanced. With IC-Connect, developed by the same team, the whole shellroom system process environment was opened to authorised handheld device access.

The IC-Crystal control capability places the shellroom at the forefront group of the Investment Casting Process Technologies… and who knows where the next 30 years will take the investment casting process, and for sure it will be exciting!

Q The involvement of VA Technology in providing solutions for the shellroom implied not only the aspects we have been discussing about the core equipment for shell making but all sort of auxiliary equipment that in their integration constitute a manufacturing system. Can you tell us about the equipment and the associated challenges both in functionality, process control and system integration?

A Ceramic pre-mix, in-cell slurry machines, supplementary equipment for pattern cleaning, slurry KPV monitoring, automatic dosing machines, in-line and in cell shell weighing and measuring systems and many more machines have been developed. Industry sector specific machines include high speed spinning machines, plate edge cleaning machines and slurry coat fluidity assist machines.

Ceramics slurries are applied to the shell through immersion, flow jet, or flow coat techniques, and in-cell slurry capacities have been installed ranging from 100kg all the way up to 20 tons.

Stucco application machines have been engineered for rotary, vertical oscillatory, or fluidizing application… enabling the application of stuccos for shell structural and preferred porosity characteristics.

Developing the machine technologies to deliver the requirements engenders great teamwork at all skill levels and professions within the engineering team, and nothing gives greater satisfaction to a design engineer than to see the fruits of his team efforts translate from concept into the actual reality of a working machine or system. Getting it right has helped expand the industry from small and medium sized parts production, to encompass the manufacture of large castings, each weighing several tons.

The design and development of intelligent conveying systems to transfer shells with payload capacities from 100kg to 1500kg has also been

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important. The shellroom application requires specific design characteristics prohibiting external oil lubrication and a level of motion smoothness necessary to protect delicate shells. Additionally, positional accuracy performance to enable inter-process interfacing with robotic machines has been solved.

Robotic engineering technology and system unique signature configuration have been developed by the company and design embedded within the conveyor systems, to meet the special requirement of the shellroom. Hanger units are engineered for fixed, unpowered rotating, powered rotating, and specialised final dry stacked carrier application.

Since the advent of water based binder materials, the requirement for efficient intercoat and final drying of the in-process ceramic shell has been a critical component in the success of the large scale ceramic shell production.

Specialised air movement machines developed have included : High Velocity Vectored airflow units, High Volume Air Stream units, and Variar mixer units, all equipped for process optimisation and control integration.

Drying systems design have included; V type Vertical Producers, H&M type Horizontal Producers and the D type 'Doughnut' for specialist application.

Horizontal IC-conveyor based drying systems of single, double, and multi levels of many configurations and capacities have been engineered and delivered all around the world of Investment Casting with the majority operating continuously 24 hrs a day!

Q Discussing on System integration can you tell us about the role played by Software advance in supporting this?

A In today's systems engineering, Mechatronics is the key interdisciplinary branch of engineering that brings together the combined skills of electronic, electrical and mechanical engineering systems. It also includes a combination of robotics, computer, telecommunications, control, and extends to the process specifics of the IC industry. Software engineering plays a key role in the context of Robot System Software, Control System Software, and in Shell Management System software. Of these, the Shell Management System (IC-Crystal) software group forms the largest resource, and is tasked to implement the specific individual system design configuration within IC-Crystal, and to continuously develop the IC-Crystal product to stay at the forefront of Process control Innovation, KPV control, and MES integration.

Q Although the Investment Casting process participate of a similar basic stages, clearly the end product application and characteristics, define the specific technology required. How this has been affecting to the solutions provided by VA Technology? Can be inferred that each application required of a specific engineered solution?

A The process requirement for single crystal ceramic shells used in aerospace application is vastly different from that required in an open tolerance commercial casting, and while the tolerance limits may be different, the requirement for variability avoidance outside the limits remains the same.

Different shape parts, shell mass, shell materials, shell size, shell quantities, shell thermal characteristics and many more factors, define the shell drying requirements, and a range of technical solutions have been engineered and developed by the team to meet these needs:

Fundamental to the success of the Shell drying systems, has been the development and engineering of the Environment Air Conditioning systems (E –system). The shell drying process demands industry unique tight tolerances for temperature and Humidity. Conventional AC systems cannot deliver the environmental tolerances required and VA Tech has over many years developed, engineered, and produced unique 4-Element P-technology E-Systems solutions to achieve the goal.

Equally important is that the technology has been mastered and performance calculations validated, and the E-system can be engineered to a high degree of performance assurance at the Shell Manufacturing System engineering design stage.

Q Sensors have evolved enormously during the last years providing the possibility to capture real time data in a more affordable and accurate way. How has this affected to the evolution of the solutions provided by systems?

A The application of sensors has indeed changed significantly, and the pace of change as new and affordable sensors come on line

continues to increase. The nature of automation is dependent upon accurate determination of weight, dimension, position, temp, humidity, colour, presence, etc, and all of these, and many more are ever-present in the IC process. The machine are continuously developed to incorporate the latest sensor technologies available. Simultaneous with the increased availability of sensors is the knowledge base of the process and the future will see more application of real time process correction, to drive yield further up and costs further down.

Q ***The smart foundry is now a concept well spread and adopted by many foundries as its target for a full implementation of the possibilities that the digital transformation brings along. Having been a pioneer in this implementation what are the areas of the investment casting process that you would signal as full of potential improvement as per the implementation of the digital transformation with the technology possibilities of today and the years to come?***

A The list is long, and as engineers, we believe strongly that there is always opportunity for development and improvement at every stage of the process. The same can be said for all of the industry competing net shape foundry processes, which will doubtless also improve, so for the well being of the IC industry, we need to 'keep on running' in everything we do. Developing and adopting the most advanced technologies available and applicable, must always be our priority for survival and growth. It is also the prerequisite essential to encourage the new generations to seek to join this industry.

In the near term, the area of great priority is to reduce the amount of total consumption in the overall process. By this I mean reduction in the amount of all direct and indirect materials used, and in total energy consumed, per net unit weight of the finished part. It's all about using less while achieving more.

We already have the technologies around us to move forward on this.

Q ***I understand VA Technology has installed more than 400 Shell Manufacturing Systems with 35 different countries served isn´t it remarkable? I guess that this could also be read as a global technology contributor to the welfare development of society. Have you ever thought it in that way?***

A I have little doubt that Investment Casting has had significant impact on society.

It's at the heart of aviation, medical prosthetics, and auto engine technology.

The potential that the process provides to create amazing shapes in complex materials, from micro size to single castings of several tons is truly wonderful. With the addition of modern technology in the design, process simulation, and production of the part, the investment casting process can justifiably wear the crown of Smart casting.

To the extent that working with our customers we have contributed to this achievement, perhaps we can think of it in the way you describe, and I feel proud of what has been accomplished by the Team.

Q ***Looking to the technology evolution possibilities and the affordable access to knowledge and information, what would you like to say to the younger generation of engineers joining the industry today?***

A I am constantly amazed at the level of technology that our youth is surrounded by. The use of computer generated graphics that kids are watching provides no limits to the performance and capabilities of the lifelike objects they are watching …. whether it is a Train, Plane or Automobile !

When these kids become adults… if the equipment they are working with or using is not similarly powerful and characterful!… they will be disappointed.

So the young engineers joining us today are joining a great industry, full of technical opportunity and challenge, and they need to get running to prepare for the young engineers that will be following them!

Q ***An innovator like you surely is digging in new ideas and challenges. Is there any of those would you like to comment?***

A Yes, I still enjoy innovation. In my new role, I am engaged in some projects, away from Investment Casting, and innovation is the core theme.

It's an enjoyable and meaningful challenge, and who knows where for the next project will lead.

Meanwhile, the company continues to advance and is now in the safe hands of the senior management team and headed up by Sean Byrne, Susie Bergin, and Andy Hughes, who have collectively been part of the team for over 25 years!

Q ***Through your engineering contribution to the Aerospace industry you have a very good understanding of it, but I understand you are also a pilot, an end user of that technology. Can you tell us about how did you develop and practice this hobby?***

A Yes, I have been a pilot for more than 20 years. I trained as a pilot in General Aviation. I have a fascination of all things aeronautical, and privileged to still enjoy the sky from above.

As an engineer, it ticks all the boxes for me, and it's most unforgiving if you get it wrong! Best of all, every takeoff brings a wow!

The EICF would like to recognize in association with this conversation the engineering dimension and the contribution to the Investment Casting technology that the person of James Nicholas Byrne represents. It also should be noted the generosity in his continuous contributions to the EICF Conferences and Seminars through which the global IC technical community learn and identify new possibilities of the manufacturing technology.