Abstracts for the 6th Australasian Aluminium Extrusion Conference Technical Program

11-12 September, 2018

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*Not in speaking order*
Australian Aluminium in a Global Context
Miles Prosser
Australian Aluminium Council, PO Box 63, Dickson ACT 2602, Australia

Abstract. Global supply chains in the upstream aluminium industry are in a state of flux. Recent trends have seen: significant growth in alumina refining and aluminium smelting in China, albeit with recent limitations; and a rise in the number and volume of independent bauxite mines and alumina refineries. The traditional corporate model of vertical integration is no longer dominant. Competitive forces are also leading to increased up-take of third-party certification schemes and a general trend towards protectionist policies at a national level. Australia’s role in the international industry is also changing – partly in response to the global changes, and partly from domestic forces including rising costs of electricity and gas. The major factors that will influence short- and medium-term prospects for each of the three upstream sectors are: Aluminium smelting: - electricity policy, speed and cost of transition; Alumina refining: - diversity and price in the domestic gas market, competition from China; Bauxite mining: - Chinese demand, competition from new sources.

Pimple Defects on Powder-Coated Aluminium Extrusions
Xinquan Zhang1, Christopher East2 and Natalia Danilova2

1Rio Tinto, 1 Research Avenue, Bundoora, Vic 3083, Australia
2Queensland University of Technology, 2 George Street, Brisbane, QLD 4000, Australia

Abstract. More than 85% of aluminium extrusions for architectural applications are powder-coated in the Australasia region. Pimple defects, defined as protruding dots randomly located on painted surfaces, are one of the most common causes of scrap for powder-coated products. Case studies presented in this paper demonstrate that, while in some cases pimple defects result from gas porosity or inclusions in the powder coating material, in most cases pimple defects are related to aluminium particles, often termed as grits or slivers, on the extrusion surface. Further studies show that grits are significantly different to conventional pick-ups which typically appear as comet-tail shaped flecks. Instead, grits exhibit a layered structure and only form a loose connection to the extrusion surface. Based on the case studies and a comprehensive literature review, a mechanism on grit formation is suggested. The proposed mechanism involves three stages, that is, coating of an aluminium film on die bearing surface, accumulation of the coating layer to form a particle, and detachment of the particle from the bearing surface. Main contributing factors and key countermeasures are discussed.
Boosting Overall Equipment Effectiveness (OEE)

Markus Dobler and Daniel Meier

Manufacturing Consulting Establishment, Gewerbeweg 1, 9486 Schaanwald, Principality of Liechtenstein

Abstract. The Overall Equipment Effectiveness (OEE) value is a common value to measure and compare between process units. In many places the monitoring of the machines, automated and semi-automated work places is not performed accurately and the reporting is carried out manually the next day. The development of the CHRONOS package has been performed with the intent to plan, monitor, inform in real time and report accurately by delivering important information not only to the management but also to the operator at the production unit.

On a roof rail bending machine the application of accurate real time information succeeded in increasing the OEE from 42% to 72% within four months. The procedure for how to approach and influence the key drivers of OEE - availability, performance and quality will be presented.

The Relation Between the Temperature We Measure at the Press Exit and What is Happening at the Die Bearing

Chris Jowett¹, Nick Parson¹ and Yahya Mahmoodkhani²

¹Rio Tinto, Kingston, Canada
²University of Waterloo, Canada

Abstract. Exit temperature measurement in 6XXX alloy extrusion is routinely used to ensure the solution of Mg and Si required to achieve satisfactory mechanical properties. It is also measured as a guide to control the quality of the profile. The other important temperature, not routinely measured, is the die bearing surface temperature. This determines the surface quality of the product and also tells us a lot about the possible life of the die. It is well established that the latter temperature bears little relation to that measured at the press platen. Using a combination of experimental extrusion trials and FE modelling, this paper describes work directed at understanding the complex relation between the surface temperature at the die bearing and the bulk temperature measured at the press exit by pyrometry or contact probe. Clearly this latter temperature can give a false impression of what is happening in the die and therefore not a good indicator of maximum possible extrusion speed with acceptable surface finish. We are never going to measure die bearing temperatures in production, however we see no reason why we should not be able to calculate the bearing temperature based on pyrometer values, profile geometry and extrusion conditions. By doing this it might be possible to achieve isothermal extrusion based on this truly limiting temperature.
Al-Mg-Si Billets with High Extrudability – State of the Art and Beyond

Jostein Røyset¹, Ulf Tundal¹, Oddvin Reiso¹, Cristina Espezel² and Scott Rogers³

¹Hydro Aluminium Research and Technology Development, Sunndalsøra, Norway
²Hydro Aluminium Extrusion Ingot Customer Support, Oslo, Norway
³Hydro Aluminium Asia, Singapore

Abstract. Within the alloy groups EN-AW6060 and EN-AW6063 a range of alloys termed High Speed Alloys have been developed. The underlying metallurgical principles of this development are explained. Further, new technological developments and new experimental discoveries have led to a new, upcoming billet quality, HP 6xxx. Three different billet qualities, Standard 6060, High Speed 6060 and HP 6060 were compared in a full-scale industrial trial, and the results indicate that the improvement in extrudability of HP 6060 over High Speed 6060 is of the same order as the improvement of High Speed 6060 over Standard 6060.

Modeling the Effect of Manganese on the Mechanical Properties, Grain Structure and Extrudability of High Strength 6082 Alloys

Trond Furu¹, Rune Osthus², Nadia Telioui³, Regine Aagard⁴, Magnus Bru⁴, Ole Runar Myhr⁵ and Richard Dickson⁶

¹Norsk Hydro ASA, Corporate Technology Office, Oslo, Norway
²SINTEF Raufoss Manufacturing, Raufoss, Norway
³Hydro Aluminium, Customer Technical Support, Havik, Norway
⁴NTNU Dept. of Materials Science and Engineering, Trondheim, Norway
⁵Hydro Aluminium, Research and Technology Development, Sunndalsøra, Norway
⁶Hydro Aluminium Metals USA, Customer Training and Development, Zeeland, Michigan USA

Abstract. A Through Process Model (TPM) has been developed, linking physical based microstructure models for precipitation of Mn-dispersoids and MgSi-phases, with models for generation of deformation and recrystallisation structures. These models are linked with Finite Element (FE) simulation of the extrusion process, to produce a true through process model which can predict final properties, microstructure and grain size, based only on the input of the processing parameters from casting, homogenisation, extrusion, and aging. These predictions are compared to an extensive experimental program which was designed using AA6082 alloy with six levels of Mn (0-1.2wt%) and two specific homogenisation cycles, prior to extrusion, aging and subsequent testing. This paper compares the results from this experimental program with the predictions from the TPM. The impact on the mechanical properties, grain structure and final microstructure of Mn-dispersoids and Mn in solid solution are identified and separated. Comparison of the results of the experiments and modelling has confirmed the ability of the TPM to predict changes in extrusion forces, grain structures and mechanical properties, without need for tuning or calibration. This TPM presents an opportunity for developing new optimised alloys for high performance applications.
**Effects of Manual Polishing on Die Bearings**

Richard Dickson\(^1\), Eskild Hoff\(^1\), Adam Cramlet\(^2\), Dennis Ebnet\(^2\), Jon Veenstra\(^3\) and Scott Rogers\(^4\)

\(^1\)Hydro Aluminium Metals USA, Zeeland, Michigan USA  
\(^2\)Alexandria Industries, Alexandria, USA  
\(^3\)WEFA, Cedar Inc, Cedar Springs, USA  
\(^4\)Hydro Aluminium Metal Markets Asia, Newcastle, Australia

**Abstract.** DIMEX, a device for the precision measurement of die bearing geometry, was introduced at ET’08, where it was used in a detailed study of the manufacturing capabilities of the die makers. That paper showed that using modern WEDM machines and CNC machining centres, the manufacturing repeatability and geometric precision of the die bearing can be impressive.

Whilst the tools used in die making have changed dramatically over the last 30 years, the tools available to the die corrector have changed little. Most die bearings are cleaned and corrected using simple hand files or abrasive paper. The impact of these manual polishing and cleaning procedures on the bearing geometry has never been scientifically quantified. By the use of a DIMEX, this paper quantifies the impact of some of these various polishing/cleaning techniques on the die bearing geometry.

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**Baseless Packaging System for Aluminium Extrusions**

Damir Merdovic, and Ryszard Michael

Capral Limited, Level 4, 60 Phillip Street, Parramatta, NSW 2150, Australia

**Abstract.** At the moment the majority of aluminium extrusion packaging utilises standard dimensions timber base, and/or side and top cleats. Integrity of the pack is dependent on the quality/tightness of strapping, which goes over the cleats. There are a few deficiencies of this approach and some damage occurs during transport of storage.

Capral Ltd has developed a concept for packaging aluminium extrusion products utilising prefabricated plastic cleats. Depending on the length of packaged product, there would be a number of top and bottom cleat sets. As there is positive location of the side cleats, the damage due to loose cleats should be eliminated and even after strap removal the pack will hold its integrity, preventing material spilling. Because standard cleats can be utilised, a high reusability rate can be achieved.

The results are: a reduction in transport damage of the product, reduced packaging cost for the supplier, no waste disposal costs to the customer and a positive effect on the environment.
Development of 6XXX Series Special Alloy Aiming for Superior Extrudability

Dushyant Kumar Gupta, Ram Ramanan and Ram Sandipam Adhikary
Vedanta Limited, Jharsuguda, Odisha, India

Abstract. 6060 & 6063 are the two most widely used varieties of 6XXX series Aluminium alloys with numerous end applications. But we always look for better extrudability, enhanced productivity and superior finish. Objective is to optimise the extrusion process capability without sacrificing the heat treatment characteristics of the extrusion. This paper chalks out the impact on physical characteristics attained at an extrusion press with lowering Mg content in the extrusion ingot. Determining the sweet spot i.e. the right combination of chemistry supported by various test results on mechanical properties against altering chemical composition – is the major attribute of this paper. The experimental alloy not only demonstrated superior extrudability but also improved the productivity of the extrusion press with enhanced die life. Vedanta has supplied this special alloy to a specific customer and test result on the same is very encouraging. We are engaged with the customer and trials are continuing for further improvement on different finishing requirements.

Mechanical Finishes - Different Ways to Treat Aluminium Profiles

Raffaele D'Andrea
Emmebi S.r.l, Via della Tecnologia, 12 - Pavia di Udine (UD) Italy

Abstract. There are many ways to mechanically treat an aluminium surface to obtain optical effects or better surface quality, depending on the final scope of the profile.

The market recognises 3 types of finish: Mill finish, anodised or painted profiles. Quality and properties of the surfaces may change considerably between these three categories. The mill finish profiles can be mechanically treated without any further surface protection for high end applications (horse trailers, electrical components, furniture, automotive). If a more resistant surface is required, the profile can be anodised to allow the perception of the mechanical treatment performed or to mask defects as die lines (windows, automotive, picture frames) or painted by liquid or powder paint. In this case, the mechanical treatment is used to remove most of the surface imperfections. Polishing, brushing, sand blasting and sand paper finishes will be discussed in terms of characteristics and machines used to perform the operation.
Latest Technology in Packaging of Aluminium Profiles

Raffaele D'Andrea
Emmebi S.r.l, Via della Tecnologia, 12 - Pavia di Udine (UD) Italy

Abstract. In the latest 10 years, the use of destacking equipment to improve the packing efficiency and meet higher ergonomics standards is growing constantly. A destacker is a machine that extracts the layers of profiles from extrusion baskets, recovering the spacers and moving the layers towards the operators at a comfort height of approximately 900 mm. Destackers can be synchronised to destack profiles up to 30 meters. An innovative technology is to use this equipment to restack profiles if it is required to move profiles from the extrusion baskets to storage or customer baskets. An overview of packing aids to speed up packing operations and reduce injury risks in the packing area will be presented with focus on the packing stations. Furthermore, different types of automatic packing of bundles will be discussed, starting with sub bundles and ending with master bundles to reduce damages to surfaces and shapes and improve stability during shipment.

Aluminium Extruded Products for Transport Applications

Garry Martin
Aluminium Consultant –Aluminium Bahrain, Alba, Kingdom of Bahrain, Middle East

Abstract. The use of aluminium extruded profiles in the transport industry for shipbuilding, road transport inclusive of the automotive industry and rail has shown a major increase in volume and requirements during the last number of years.

The alloys generally used for extrusion of profiles in the above transport markets are from the AA6000 aluminium alloy series such as 6060, 6063, and 6106 alloys in the lower strength and 6005, 6005A, 6061 and 6082 alloys in the higher strength. The total extrusion process inclusive of the use of high quality billet, section design, extrusion dies and toolage, process conditions and control in the actual extrusion of the profiles as well as ageing and handling of the profiles needs to be carefully considered and planned to ensure the profiles being produced will meet the customers quality and design requirements for transport applications.

The extruder needs to be aware of the final product requirements for extruded sections being supplied to ensure a successful outcome is achieved and a duty of care in supply is met for profiles going to transport end use. This paper will outline these requirements and the total extrusion process, in the steps mentioned above, for achieving a successful business outcome.
Optical and Microstructural Origins of Thermomechanical Streaking Defects in AA6060 Extrusions

Steven Babaniaris, Aiden Beer and Matthew R. Barnett
Institute for Frontier Materials, Deakin University, 75 Piddons Rd, Waurn Ponds, VIC 3216, Australia

Abstract. Thermomechanical streaking is a common optical surface defect that affects architectural 6xxx series aluminium extrusions and can be cause for rejection of the product. AA6060 profiles were extruded at a range of ram speeds at Deakin’s 300 ton extrusion facility, using a specialised die with internal geometry deliberately designed to produce thermomechanical variation throughout the profile. The extrudates subsequently underwent an industrial anodisation pre-treatment process that revealed the presence of streaks in the designated regions. The optical appearance, microstructure and surface topography of streaked and surrounding regions of the extrudate surface were analysed using colorimetry, EBSD and optical profilometry. Differences in perceived lightness, roughness and grain size were observed between streaked and surrounding regions. Changes in perceived lightness of the surface directly correlated with the surface roughness, where rougher surfaces related to an increase in the perceived lightness. The surface roughness was determined to be primarily dependant on the size and distribution of grain etching steps as related to the surface grain size. A difference in grain size in the regions surrounding the streaks was determined to be the microstructural origin of the visual defect. Strategies for streaking avoidance are discussed.

The Design and Benefits of a Thermally Stable Container to Extrusion Productivity

Paul Robbins and Ken Chien
Castool Tooling Systems, Uxbridge, Canada

Abstract. This paper addresses the thermal and mechanical design of a container influences on the press productivity and how the extrusion pressure, cycle time, temperature and billet length would affect productivity and tooling life. To help better understand container performance to their productivity; modeling is presented for various container designs and heating concepts. Based on the data, the paper describes how heating elements and thermocouple configurations along with best design and operating practices can achieve thermal stabilisation and increased productivity.

By process of improved and controlled billet flow into the die, resulting from container thermal stability, extrusion surface defect issues and run out variations are reduced, as well as improved extrusion dimensional consistency. This drives optimisation and increased productivity.
The Function and Benefits of Dummy Block Design
Paul Robbins and Ken Chien
Castool Tooling Systems, Uxbridge, Canada

Abstract. This paper reviews the development of the dummy block from the early days of the loose pad to today’s high pressure fixed dummy block. Residual aluminium skin thickness on containers supported by finite element analysis of deflections of both dummy block and container under typical temperature and pressure distributions, are presented. The impact of pressure, extrusion cycle time, temperature and billet length in relation to the functioning of the container and block are discussed.

The paper concludes with a comments section that establishes the design and best operating practices to maximise block life and minimise the deleterious effects of trapped air and back end defect and coring.

Process Lubricant Optimisation for Aluminium Extrusion
James E. Dyla
AMCOL Corporation, 21435 Dequindre, Hazel Park, MI 48030 USA

Abstract. Process lubrication used in aluminium extrusion has significantly changed in recent years with the inception and evolution of hot log shears, fixed dummy blocks, butt knockers, and traveling puller saws. More recently, front loading presses and hot log saws are quickly gaining in popularity where lubrication is extremely important. Lubrication in many of these applications is often viewed as an afterthought and does not get the attention to detail that many of the other important subcomponents receive. Automatic lubrication technologies have continued to progress in order to improve reliability and reduce overspray of lubricants. This paper explores the evolution and development of the dispensing systems and lubrication technologies with an emphasis on best practices used throughout the industry.

The Evolution of Vertical Powder Coating
Andrea Trevisan
SAT S.p.A., Via Antonio Meucci 4, 37135 Verona, Italy

Abstract. Aluminium extrusion powder coating with vertical plants was introduced in Europe in the early 80’s. This particular technology originally allowed to significantly growing the market share of aluminium in a various range of applications, especially in the architecture field.

Vertical coating lines spread all over the world very quickly and Australia was one of the first countries (after Italy and Belgium) to see this technical solution installed and operational. The paper analyzes the evolution and the latest development of verticality in aluminium powder coating, from traditional lines to the more compact and flexible solutions that recently brought numerous new installations in the Australian territory.
Securing Profit Through Reliable and High Productivity Machines

Davide Turla and Alessandro Guerrini
Turla srl, Via del Pavione 6/8, 25050 Paderno Franciacorta (BS), Italy

Abstract. How many factors are considered in the choice of a new extrusion system? Normally the most common factors mentioned and considered by users are; compliance with given specifications, perceived quality, behaviour of similar systems, and cost of the equipment. Customers often set clear requirements for reliability and productivity. These are normally considered very important parameters for the choice of an equipment.

However, the above factors are not the real end for which a system is purchased. A system is purchased to grant profitability to the company, to create value through the production of valuable and defect-free profiles. What are the parameters that secure profitability? These parameters can be analysed to guarantee profitability well before the annual balance sheets says whether a company has been successful or not.

Modern machines must be supplied with data collection systems that permit cross-checks of the different data coming from the machines. Only this cross check can indicate at the production stage if the profit will be reached or if not, what corrective actions need to be implemented immediately.

Low Maintenance Press Design

Davide Turla and Alessandro Guerrini
Turla srl, Via del Pavione 6/8, 25050 Paderno Franciacorta (BS), Italy

Abstract. Downtime of an extrusion press is often the most important parameter analysed by managers. This factor influences the capacity of the company to reach the production targets and, even more important, the capacity of the company to meet customer satisfaction based on timely delivery of the products. For this reason, design of modern presses is addressed to minimise corrective maintenance. This goal can be achieved by acting on three main aspects of press design; mechanics, hydraulics and electronics. Historically these aspects have been treated separately, but they are strictly interlinked and understanding how they can influence each other assists the optimisation of the whole system.

State of the art of software and electronic measurement systems help designers to control all the important parameters that can cause downtime of a press and prevent their occurrence. Advanced data acquisition systems permit data collection that can be used either during production or, even better, in the design phase, since the behaviour of a system is the result of all the steps taken during its design, components manufacturing, assembly and dry testing of a machine.
Opportunities for the Extrusion Industry with RMIT

Mark Easton, David Taylor, Maciej Mazur and Chow Yin Lai
School of Engineering, RMIT University, Melbourne VIC 3000, Australia

Abstract. RMIT has made a substantial commitment to support the local manufacturing industry and their global supply chains. The development of the Advanced Manufacturing Precinct with its focus on additive and subtractive manufacturing as well as automation is evidence of this. RMIT is also the lead of the ARC training centre in lightweight automotive structures in which there are projects on extrusion process and alloys in collaboration with Deakin University. A substantial opportunity to engage the local extrusion industry is through the ‘Learning Factory’, where local companies can work with final year and masters by coursework students on problems that they may have. A number of local extruders have already taken up this opportunity. The types of projects that may be of interest are: die design using additive manufacturing for tailored cooling, investigation of defects on extrudates, automation and Industry 4.0, value adding using technologies such as cutting, milling and cladding, and building costing models related to manufacturing operations.

Benefits of Neutralising Electrical Fields Surrounding the Powder Application Zone

Roberto Casati1 and Bill Wyllie2
1ATE Srl (Atimix), Via La Valle 76, I-22066 Mariano Comense (CO), Italy
2Australian Aluminium Finishing Pty Ltd, 23 Frank Street Wetherill Park NSW 2164, Australia

Abstract. A new process has been designed and developed to neutralise the electrical and magnetic fields surrounding the powder application zone. The benefit of the process is to improve finish quality, improve penetration into difficult recesses (Faraday cage effect) and reduce the rate of consumption of powder per square metre.

The application of powder coatings requires the powder to be electrically charged such that the powder is attracted to an earthed piece or product. To generate the electrical charge, powder is propelled past a charging device within the powder gun using compressed air.

Both these factors, and others, generate unwanted electrical/magnetic fields which inhibit the quality of the finish and transfer efficiency. Other methods have been developed to assist resolve the issue. For example, using non-magnetic material in booth construction, and to reduce the compressed air flow speed, using dense phase powder pumping systems.

This new neutralising process has been developed from the experience of ATE Atimix in containment/capture of electrical/magnetic field in other industries. There are three elements in the modification process. The powder application zone is wired and neutralised back to containment equipment. Secondly, the compressed air to the powder guns is passed through a neutralising/cleaning process, and thirdly, the fluidised powder bed is treated.

Modelling of the finish characteristics and powder consumption rates compare well for the results obtained through plant testing at Australian Aluminium Finishing in Sydney. Test results will be presented from this experience, as well as results from several European powder applicators.
Metallurgical Assessment of “Acid Etch” as an Anodising Pretreatment
Nick Parson¹, Jerome Fourmann² and Marc Lebleu¹

¹Rio Tinto, Arvida Development & Research Centre, Jonquière, Québec, Canada
²Rio Tinto, 6055 Rockside Woods Blvd., Suite 300 - Independence, Ohio 44131, USA

Abstract. A number of anodising lines in the United States and Australia have recently adopted alternate anodising pre-treatments using fluoride-based etch solutions. The claimed benefits include shorter cycle times and freedom from streaking. The traditional caustic-based etchants are known to be sensitive to the alloy chemistry and microstructure giving rise to the well-known color or shade match problem. The current work describes a test program conducted to measure the response of the “acid etch” process to various alloy compositions. The profiles tested included some with deliberately produced extrusion streaks. The impact of “acid etch” and combined caustic etch times was assessed along with the surface topography produced by these treatments. Comparisons were also made on the same profiles when treated with conventional caustic etching. Significant differences were found between “acid etch” and caustic etching in terms of the sensitivity of the final finish to alloy composition and also the ability to hide extrusion streaks.

The Ever-Growing Use of Electrical Power Versus Hydraulics in Extrusion Lines
Giovanni Sacristani
OMAV S.p.A., Via Stacca 2, 25050 Rodengo Saiano, Italy

Abstract. Using electric power versus hydraulics in the aluminium extrusion plant is considered. Today we can say that mainly three important aspects should be considered in the industry in general, including aluminium extrusion: energy saving for green technology; control of the process; and maintenance for opex. We are convinced that “e-drive” is the future and is already present in many applications in all fields of application. After this said, let’s see how the extrusion line can respond to the demands for electric power or hydraulics.

Several years of data collecting and after over twenty applications, four machineries provide answers to the aspects above. Log Saw because the risk of fire is excluded, no pollution and no disposal, no maintenance, repeatable control is not influenced by temperature, reducing the operational cost almost at 0, the same also for Final Cold Saw. The e-Puller & Saw has also other features like the best quality on profile because the direct drive on board avoids any vibration and because of cleaning without oil allowing 0% scrap and saving 50% energy, excluding chains or ropes. The Aging Oven where using electric power during soaking phase guarantees the best temperature control reaching ± 2°C temperature deviation.
Liquid Nitrogen Experience Using 6060, 6063 & 6005A Alloys
Hanif Hamzah
Press Metal Berhad, Lot 6464, Batu 5¾, Jalan Kapar, Sementa, 42100 Klang, Selangor, Malaysia

Abstract. Liquid nitrogen has been widely accepted as a method to increase productivity and to improve the surface finish of the extrudate before anodising or any final finish. However, the liquid nitrogen has also been tested for various extrusion alloy such as 6063 secondary billets versus the primary billet 6063. Both these billets were evaluated in terms of its performance and benefits drawn are discussed. The liquid nitrogen is also applied to 6060 and 6005A alloys to see its merit for productivity. Advantages and disadvantages gained using liquid nitrogen are discussed.

If Amazon was Interested in Aluminium Extrusion
Merih Marzari
WeStoreGroup, Italy

Abstract. In 1994 when Jeff Bezos decided to leave his lucrative wall street job to move to Seattle investing in the untapped internet market opening an online bookstore in his garage, probably most of his colleagues and parents though he was crazy. By investing in always more sophisticated intralogistics solutions in order to always put customers first, Amazon is growing and conquering markets every day.

If we could jump back in 1994 to take a look at our extrusion production plants, we would see a lot more operators in production managing a much lower number of customers and orders. In 1994 there were no smart phones nor tablets or no flat screen TVs. Google was born in 1998 and Facebook in 2004. What seemed impossible in 1994, today we take for granted. To remain competitive in a global economy, extruders must consider ways to use the flow of information and optimise the movement of profiles within the company walls.

This paper will describe an intralogistics project where by rethinking material flow and adding strategic intermediate buffers we are planning to achieve efficiencies that will make an extruder in Germany more competitive in an always more aggressive market.