Introduction to Rolling Concepts - Rolloff mechanics, tabulation of relevant properties of roll and strip, definition of terminology and variables, effect of roll and strip roughness on friction, forward slip definition, yield stress dependence on temperature and strain rate.

An Introduction to the Metallurgy of Sheet Products - Reviews the structure of metals and examines the development of the properties of steel and aluminium sheet during each stage of production, from smelting and casting to rolling and heat treatment. Tensile testing and the classification of sheet products are discussed.

Rolling Theory - Development and interpretation of models for the prediction of roll force, torque and slip in rolling. The use of the friction hill model for explaining rollgap phenomena. The derivation of simplified models for solving a wide range of rolling problems and algorithms for solving model equations.

Rollgap Modelling for Hot Rolling - Development in yield stress, friction, slip and strip temperature models for hot rolling. The influence of temperature, recrystallisation, precipitation and phase transformations on yield stress.


Thin Strip, Foil and Temp Rolling Models - Examination of the limitation of circular arc models and development of more accurate models for rolling strips. The effect of rolling speed and roll force on the roll strip interface is considered along with the consequences for the strip, foil and temp rolling. Closed gap rolling is also discussed.

Lubrication and Cooling - Discussion of the principal features for an integrated roll bite lubrication and cooling system.

Mill Thermal Analysis - Identification of heat flows in rolling, derivation of strip temperature models in the rollgap and between stands.

Roll Thermal Camber Analysis - Solution of temperature fields within rolls and application to the prediction of roll camber and roll surface expansion. Dynamic response of thermal camber to rolling conditions and individual cooling sprays and the application of hot edge sprays in rolling.

Introduction to Strip Profile, Shape and Flatness Concepts - Introduction to definitions and causes of mill roll and strip profile and roll profile. Parametric representation of measured flatness and thickness profile.

A Model for Flatness and Profile Analysis - Physical modelling of profile and flatness development in hot and cold rolling and a discussion of the various mechanisms for profile change and tension stress feedback.

Mill Vibration Phenomena - A review of the different forms of mill vibration phenomena, known as ‘chatter’ and ‘rumble’, the conditions which contribute to their occurrence, and possible means of minimising or avoiding the problems.

Mill Automation

Hot Tandem Mill Control - Design of actuator and mill control strategies to improve the performance of hot tandem cold mills. Optimization of process control and actuator disturbances leading to the design of thickness, tension and temperature control for tandem hot finish mills.

Actuator, Instrumentation and Mill Performance - The operation and performance of a rolling mill is influenced by many factors, key being the design, speed, accuracy and robustness of the instrumentation and actuators. An introduction to the major instrumentation and actuators associated with the production of the correct final strip thickness is presented. The merits of each type of instrument and actuator are discussed, with typical response times and design limitations.

Shape Control Systems - Design of integrated shape control systems for cold mills and a discussion of the areas where practical problems may arise.

Profile Control Strategies - Mathematical formulations of a variety of profile and flatness control algorithms. Application of insights from shape simulation studies to the design of profile control systems. Discussion of practical constraints and achievable performance.

Mill Thickness Control - Logical procedures for designing mill control systems and for decoupling interactions between tension and thickness control in single stand and tandem cold mills.

Tandem Cold Mill Setup Strategies - Techniques for scheduling tensions and thickness reductions on tandem cold mills in an on-line environment. Calculation of control actuator reference for the scheduling of tandem cold mills to minimise off thickness material and through thickness delays.

Case Study in Reversing Cold Mill Automation - Discussion of issues involved in automating single stand rolling mills, highlighting the areas of similarity and difference and the advantages of this approach.

Hot Finishing Mill Setup Strategies - The selection of starting strategies to meet the conflicting constraints of power, profile and flatness, and finishing temperature, are reviewed. Tension and temperature policies are also described.

Adoption of Rolling Mill Models - Motivation for adapting rolling models and derivation of simple algorithms for thin strip, as well as an introduction to control calculation models. Practical aspects of model adaptation schemes for reversing and tandem mills.

Scheduling of Hot Reversing Mills - Operating constraints are discussed and algorithms described for mill scheduling and calculation of pass speeds to achieve specified exit conditions.

Strip Width Control - Conceptual design of width control systems typically employed at the roughing and finishing stands of steel hot strip mills. Edging reduction constraints, typical practices and designs, with numerous examples and samples. Effects by dynamic edger position control is addressed.

Course Program

This five and a half day course will commence on the Sunday afternoon with registration approximately 3.30pm, followed by an introduction to the operation and rolling the mill simulation software. It is important that delegates attend this session.

The course program will run from approximately 8.30am to 5.30pm, Monday to Friday. The course will conclude on Friday at approximately 4pm.

Tutorials and practical application studies, including hands-on exposure to a suite of advanced mill simulation and design programs, will support the theoretical concepts and model derivations discussed in the lectures. Facilities for private study and informal discussion sessions will be available and delegates are invited to present their own problems and discuss them with the course tutors.

The official course language is English.

Who Will Benefit?

This course is aimed at mill technologists and engineers involved in the design, operation, maintenance and improvement of modern, automated flat product rolling mills. The course is also suitable for companies to “kick start” their newer recruits into the field of rolling.

Course Documentation

Delegates receive an extensive set of detailed course notes for each lecture, together with other reference documentation, tutorial workbook and a training CD. Delegates have online access to demonstration versions of several simulation programs after the course and the opportunity to purchase this software at a discount.

Stuart Critchley - Stuart has over 30 years technical and operating experience in rolling and finishing. Working out of Hatch’s Canadian headquarters, his project experience includes initiating, participating and leading teams to complete major capital projects for new mill installations and on control systems upgrades. His interests span a range of topics, from full grinding to thickness control, however tandem mill vibration reduction and maintaining the thickness of existing mills to improve safety, throughput and quality has allowed him to visit and benchmark mills in various regions.

Ray Davies - Employed by BHP Steel for eighteen years, and having completed a Metallurgy degree and Graduate Studies in Control, Ray has gained experience across the steel rolling industry. Projects with BHP included the automation of a hot rolling mill, two tandem cold mills and coil painting line. Since joining IAS in 1988 Ray has been involved in a range of consultancy, training, rolling simulation and automation projects, including tandem cold mills, single stand reversing cold mills and hot strip finishing mills. As Consulting Manager he has had extensive involvement in hot mill and cold mill performance audits. His area of interest is in mill control systems.

Glen Wallace - Glen is the Global Director - Hatch IAS. His activities with the company started in 1991 with the design and implementation of control systems, shape and coating control systems. This work progressed into research and development activities contributing to patents in thickness control, mill vibration suppression and coating control. He has consulted to companies around the world on thin strip casting, rolling, annealing and galvanizing. In 1999 Glen established the North American operation of IAS and in 2003 he returned to Australia to lead IAS globally.

Stewart Paardekooper - Stewart completed a BE (Hons) degree in Electrical Engineering (1982) and a graduate diploma in Computer Science (1985). His previous experience included developing plant information systems, before joining IAS in 1988. Initially involved in aluminium casting and coil loading automation and systems, since 1990 he has worked in most aspects of sheet metal rolling (steel and aluminium), primarily in the development of setup models. Projects involve automation, setup models and shape control systems on cold tandem, temper, reversing, non-reversing and hot finishing mills. His broader scope of experience includes offline simulation and modelling, consulting, mill audits and training.

Tino Domanti - Tino commenced work with IAS in 1987 as a software engineer. In 1993 he completed his PhD in the modelling of residual stress in flat metal rolling. He currently heads the Research and Development group within Hatch IAS. Tino has developed models for this strip, temper, foil and asymmetrical rolling and has been involved in a number of consulting projects covering aspects from mill shape and profile performance to control system design.

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"It seems to me that the Hatch IAS team is a group of the most intelligent and experienced professionals in their field. They are a dedicated team that propagates the work hard/play hard mentality, which made the course more than just for learning, but also fun.

Alex Acciacca – ArcelorMittal USA

“The IRTC provided me with an understanding of rolling fundamentals. Such understanding allows us to move away from ‘trial and error’ approaches and can greatly increase the effectiveness of our process.”

Carol Anthonissen – Hulamin South Africa

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