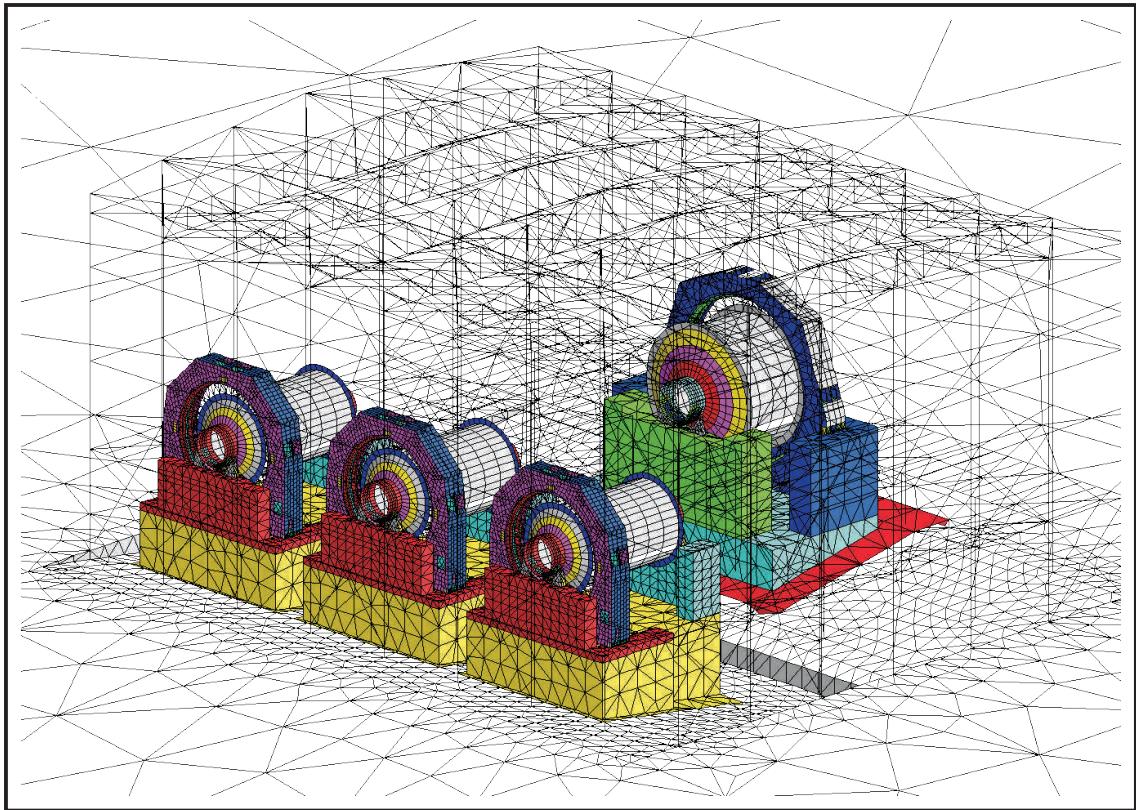


eand

engineering analysis & design Pty Ltd



Specialising in Mineral Processing Equipment & Foundation Systems

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What We Do:

We act as the Owner's Team Technical Superintendent for high capital cost equipment used in mining and mineral processing. We provide the specialist knowledge required to select the right type of equipment and the experience needed to make sure that what you paid for is what you get.

Our key role is managing technical risk. As equipment become larger and more capital and production are concentrated within fewer machines, the consequences of failure of these machines increase. The Owner has an obligation to their shareholders to ensure that the concentration of capital and production is accompanied by a reduction in *risk of failure*. EAnD achieves this reduction in risk through a complete and vertically integrated risk-management service that monitors and controls risk from the feasibility phase of the project right through to installation of the equipment.

EAnD is unique in its breadth and depth of experience. We have acted as Owner's technical representative for most large mineral processing plants built worldwide since 1996. A list of recent projects is included later in this statement. Our knowledge is based on many years spent measuring, analysing and repairing mills, mill drives, mill foundations, crushers, and other equipment. We also perform our own original research in mining equipment and publish regularly in the literature.

Vertically Integrated Risk Management Services:

Making sure that the equipment you purchase is appropriate and satisfies the task it was chosen for requires a vertically integrated approach. Vertical integration means that the technical management must monitor the whole process of acquiring the equipment. EAnD is the only independent company world-wide that has the necessary knowledge to provide such an integrated service. EAnD provides the following services:

PRE-AWARD

- Benchmarking of mill types, mill drives, gearing, ring motors;
- Economic Evaluation of Options - Geared vs gearless drives; trunnion vs shell-supported mills, etc;
- Development of Specifications, Tender Management and Evaluation;
- Pre-qualification of Vendors and their Sub-Suppliers - Who can build mills, where and by when?

POST-AWARD

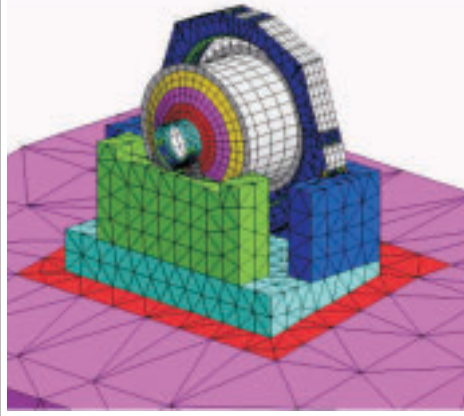
- Independent Structural Integrity Design Audits for Mills and Gearless Drives based on measured data from successful and failed installations;
- Complete Equipment System Analysis - The world's best analysis of mill systems (both geared and gearless), crusher and HPGR systems. This includes the mill, crusher or HPGR, the drive, the foundation and the supporting soil/rock. Our analyses are calibrated using our own measured data from many installations including Cadia, Collahuasi, Freeport, Telfer, Antamina, and Olympic Dam;
- Manufacturing Quality Systems - Development and review of vendor and sub-supplier quality documentation to ensure compliance with the Owner specifications and relevant code;
- Quality Surveillance - Targeted inspections by qualified professionals to ensure potential problems are detected and addressed quickly. Prompt detection and resolution of problems avoids the classic scenario in which problems are left unresolved and eventually schedule becomes a driver to sacrifice quality;
- Vendor Coordination Reviews - These ensure that the equipment purchased from separate vendors work together properly as a system;
- Installation Quality Documentation and Surveillance - Quality systems for installation are developed to ensure key components of the equipment are installed properly, e.g., bolting, joint tightness and tolerances, sole plates, grout, foundation fill.

The differentiating point between EAnD and other companies involved in mill installations is our Calibrated System Analysis. Our approach is to analyse the system as a whole, not as separate components. This includes the foundation and the soil/rock below. The outputs from the analysis are calibrated estimates of vibration, stress and deflection levels in the equipment and the foundations. This provides a predictive tool for designing mill and crusher systems rather than the standard coarse and often inappropriate static stiffness and modal frequency calculations that have failed to predict problems in the past. More detail is presented on Pages 3 and 4.

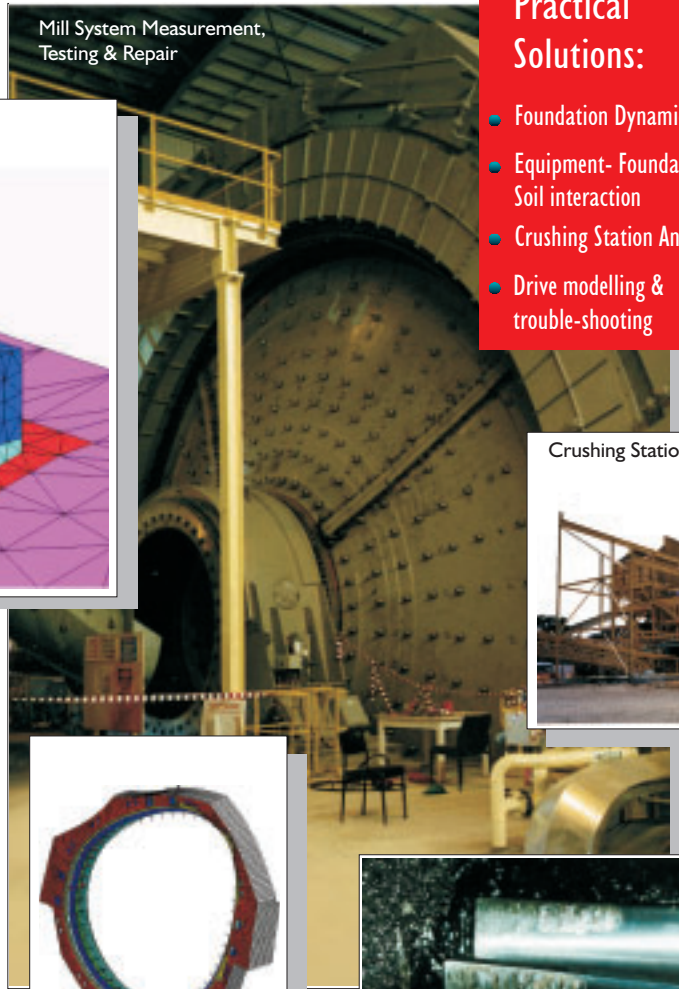
System Analyses

CRUSHING & GRINDING SYSTEMS

Foundation Dynamics & System Analysis



Mill System Measurement, Testing & Repair



Practical Solutions:

- Foundation Dynamics
- Equipment- Foundation - Soil interaction
- Crushing Station Analysis
- Drive modelling & trouble-shooting

Crushing Stations

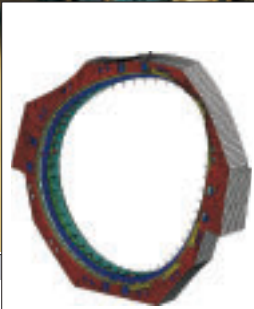


EAnD specializes in Systems Analysis & Design

Large mill systems have suffered damage due to inappropriate analysis methods. Linear analysis methods such as “stiffness analysis” and “modal analysis” have been used to design these systems but these techniques are not valid as ring motors behave nonlinearly. Furthermore, the “individual component approach” ignores the interfaces between the foundations and the machinery and this has led to damage in ring motors and foundations.

The individual component approach has also resulted in foundation failures and excessive vibration levels in gear driven mill systems.

EAnD's System Analysis combines the equipment, foundations and the founding soil or rock to assess the complete system rather than the individual components. Nonlinear behaviour, interface capacities, equipment dynamic loading, soil-foundation interaction, soil stratification are all included to determine the complete system response.



Stator Analysis



Gear Modelling, Torsional Vibration Measurement & Failure Analysis.

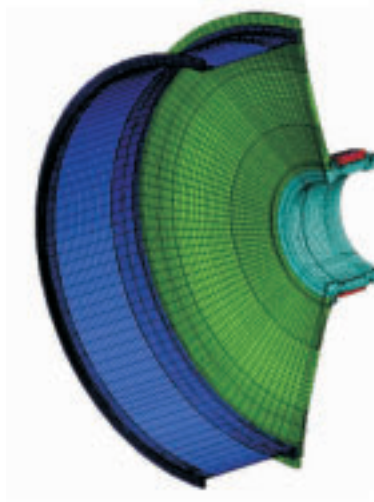
Services:

- Mills, crusher and HPGR system analyses
- Gearless & conventional drives - torsional dynamics modelling, testing and troubleshooting.
- Calibrated dynamic analysis of foundations.
- Vibration testing, strain gauging, performance monitoring of all mining & mineral processing equipment.
- Mechanical & structural design & modification

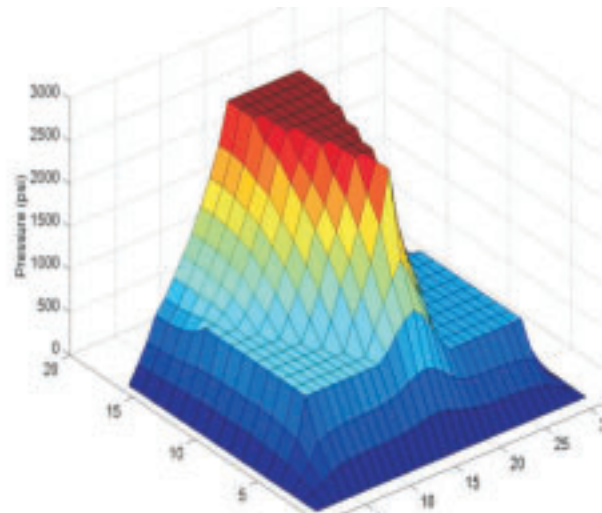
Some of Our Projects:

- RPM - Brazil (Kinross): 38 ft SAG and 24 ft Ball Mills
- Lumwana - Zambia (Equinox): 38 ft SAG and 26 ft Ball Mill
- Cadia - Australia (Newcrest): 40 ft SAG and 22 ft Ball Mills
- El Teniente - Chile (Codelco): 38 ft SAG and 24 ft Ball Mills
- Sossego - Brazil (CVRD): 38 ft SAG and 24 ft Ball Mills
- Telfer - Australia (Newcrest): 36 ft SAG and 24 ft Ball Mills
- Others include: Yanacocha & Cerro Verde in Peru; Boddington Cowal & St Ives in Australia and Rosia Montana in Rumania; Cadia, Collahuasi & Antamina GMD failure analysis and repairs

MACHINE DESIGN AUDITS



Mill Structural Audit



Hydrostatic Bearing Pressure Analysis

Design Audits:

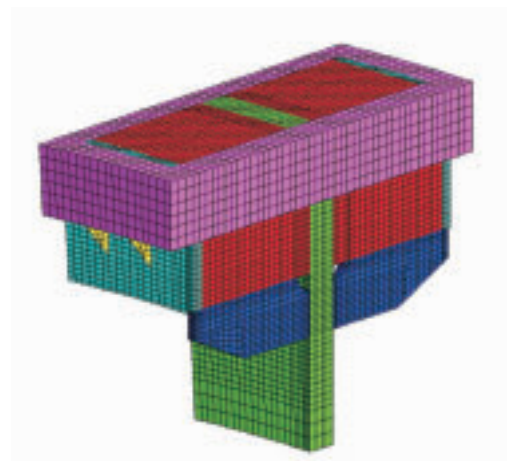
Detailed, design audits that are used to assess compliance against Owner specifications and other design criteria. EAnD's stress and vibration measurement database of mills, gearless drives and crushers ensures analyses are accurate and results are meaningful. To our knowledge, EAnD is the only company in the world that provides a calibrated, predictive analysis of the nonlinear vibration and deflection behaviour of both types of mill ring motors.



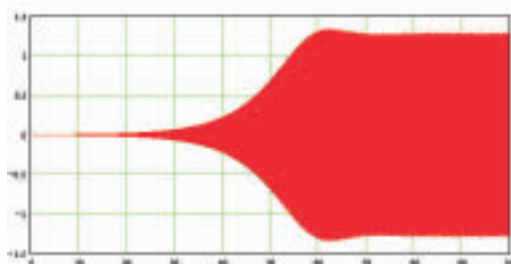
Gear Tooth Contact Analysis



SAG Mill Stator Structural Audit



Rotor Pole Analysis



NDE - QUALITY SYSTEM DEVELOPMENT NON-CONFORMANCE RESOLUTION

Typical SAG mill with segmented heads joined by flanges



Flange flaw detected by EAnD but considered to be "benign" by vendor



Casting required extensive work to remove flaws. Owner was also provided with a spare head for insurance.



Further investigation by EAnD shows substantial flaws

Quality Surveillance:

Getting the specification and design right is only half the battle. Mineral processing equipment is built in factories all over the world and not all of these factories produce the same level of quality in their components. EAnD develops quality systems and performs targeted inspections using our team of qualified professionals. This ensures that problems are detected early and rectified rather than being found when the equipment is delivered to site when nothing can be done.

PRODUCT DEVELOPMENT & HEAVY ENGINEERING

Design



Vehicle Hoists

"Torbed" Gas Scrubbers for Aluminium Smelters



Furnace Vessels



Floating Waste-Water Aerators

Mechanical, Structural, Machine & Product Design:

EAnD provides a complete design service for anything mechanical from the smallest, most delicate transducers to large smelting vessels and mobile equipment. Functional requirement definition, ergonomic issues, manufacturing and material considerations, calculations and documentation for statutory authorities and compliance testing are just some of the services provided.

ANALYSIS & MEASUREMENT

Comprehensive Measurement Capability

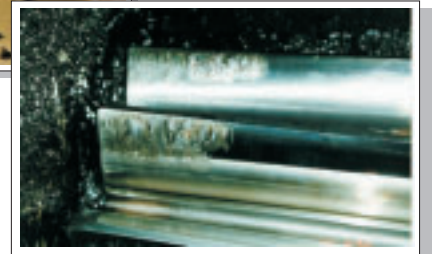
EAnD provide a comprehensive measurement service.

Capabilities include:

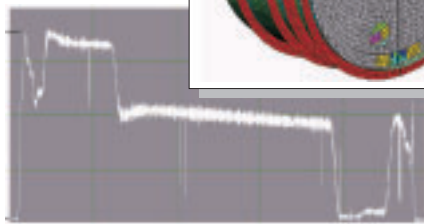
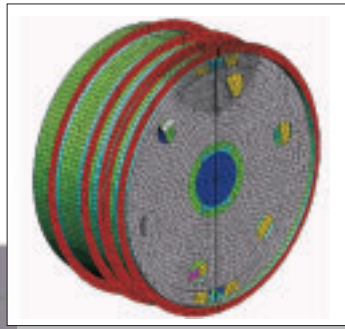
- Vibration - acceleration, modal analysis
- Strain - 16 channels dynamic and up to 128 channels static.
- Telemetry
- Torsion and torsional vibration
- Pressure - static and dynamic.
- Temperature
- Speed
- Acoustic
- Load



Impact hammer testing to determine natural frequency.



Torsional vibration and pinion load sharing on ball mills.



Production winder remnant life assessment - shown are the finite element model and measured torque trace.

Asset Management:

Remnant Life Analysis - Structural

Integrity - Performance Measurement

Proper planning of asset management and replacement is vital to business viability. Unexpected failures or downtime can lead to huge losses. The ever-growing pressures to extend the capabilities and operating life of plant and equipment necessitate formal remnant life assessments of critical assets. EAnD provide all the necessary skills to facilitate asset management including:

- Inspection;
- Analysis - fatigue, fracture mechanics, stress analysis;
- Measurement and testing to calibrate/validate conclusions;
- Risk assessment (see next page).

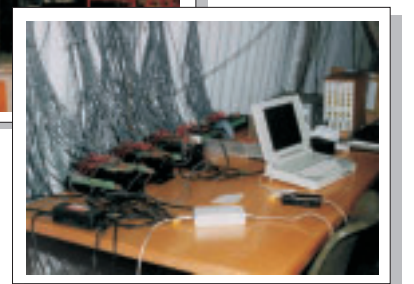


Finite element model



Design Analysis & Validation

To be competitive, the design of complex structures and mechanical equipment requires expert knowledge of modern methods of analysis and the ability to validate designs. EAnD provide both of these skills. The adjacent pictures show the evolution of a passenger locomotive design. We created a detailed finite element model of the locomotive to determine stress levels, fatigue life and vibration levels. Strains (stresses) were then measured at 120 locations on the locomotive prototype to validate the design.



Large scale strain measurement recording system

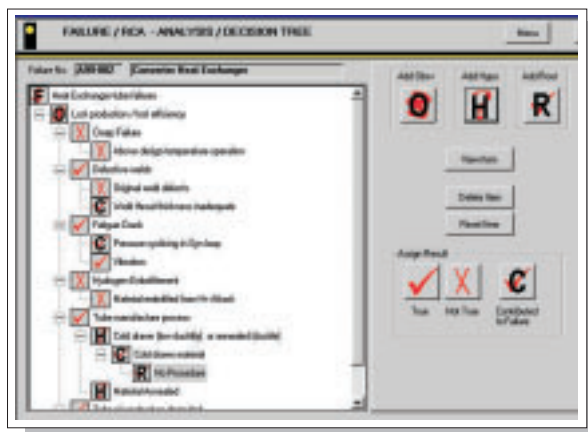
RELIABILITY ENGINEERING & RISK ASSESSMENT

Remedial Design - FMECA - RCM

Improving the reliability of machinery involves the gathering of detailed machine performance data by measurement, accurate modelling and a practical knowledge of the machines and their operating environment. If these steps are followed, remedial work, FMECA analyses and RCM planning is invariably successful. EAnD provides a full range of measurement equipment, an experienced analysis team and many years of experience in the remedial design, failure analysis and reliability planning of all aspects of process machinery and equipment.



Reciprocating compressors in a Urea plant - EAnD provided remedial foundation design, vibration monitoring, FMECA, based maintenance strategies and engineering critical assessments

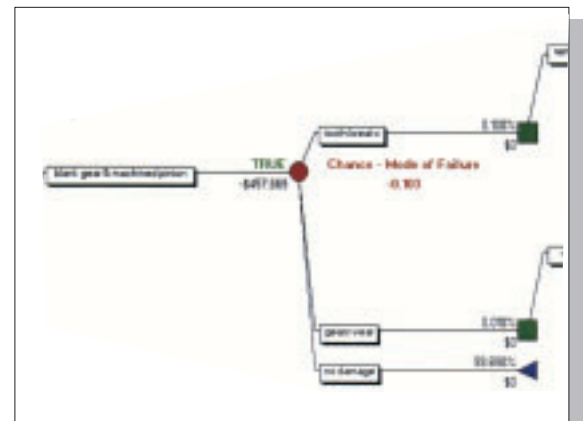


Root Cause Analysis

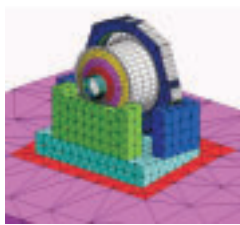
To prevent recurrent failures of equipment, the *Root Cause* of the failure must be determined. The key to *Root Cause Analysis* is the diligent adherence to the process of making observations, developing hypotheses to explain these observations and verifying the hypotheses. Good record keeping and clear logic are essential as are tracking of actions arising from the analysis. EAnD have developed specialised software that can be used to record & audit Root Cause Analyses. Incitec Ltd have purchased a licence for the software and to be used on all their sites across Australia. A typical analysis decision tree is shown adjacent. We also provide a complete root cause analysis service on a consulting basis.

Decision Analysis & Risk Assessment

Making the right decision or assessing risk can be complex. Technical issues must be balanced against cost and risk. A myriad of options may be available; each must be formally and rigorously assessed to determine the optimal strategy to reduce risk or maximise benefit. Statistical techniques such as Decision Analysis & Monte Carlo Simulation can be used to quantify risk and determine optimal decision strategies. EAnD provide consulting services in these specialised skills. Projects undertaken include developing the optimal decision strategy for spares inventory of mineral processing plants, assessing intervention strategies for the end-client during plant design and simulation of product warranty risk.



Partial branch of a decision tree for spares inventory



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