OPERATIONAL EXCELLENCE

MINERALS TECHNOLOGIES' JOURNEY

MINERALS
TECHNOLOGIES

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A MESSAGE FROM OUR CEO:

MTI's Operational Excellence (OE) journey, rooted in the active engagement of our dedicated employees, began more than a decade ago when we put in place a comprehensive and highly structured business system of lean principles closely integrated with safe and reliable work practices.

Douglas T. Dietrich | _Chief Executive Officer_

Over that time, OE has become the foundation of MTI, and more than 3,700 employees globally are at the heart of it. Put simply, OE is MTI. We have significantly advanced OE across all levels of our company, fostering a culture of continuous improvement where each employee recognizes the importance of applying these people-focused principles and tools to solve challenges, constantly refine our processes and deliver value to our customers.

Continuous improvement is pervasive in everything we do and the deep integration of OE as our operating model has been paramount to MTI's lasting success. Our employees are at the center of our Operational Excellence culture, which is a strategic differentiator for our company, and has solidified our high-performance culture by making MTI a more resilient, agile and disciplined organization.

We encourage a high-level of involvement from our employees as exemplified by a robust suggestion system and prevalent kaizen activities — both of which have been pivotal in reducing waste and risk from our processes. These activities compound each other and benefit MTI's performance over the long-term and through changing conditions. Specifically, OE and lean practices have accelerated our sales growth, driven earnings higher, improved efficiencies, enhanced our cost competitiveness through productivity improvements and mitigated external pressures on our business.

Continuous improvement activities are also instrumental in positioning MTI to better serve our customers. Our new product development pipeline has been significantly strengthened through our close alignment with customers and the application of lean tools to increase the number of products commercialized and improve the speed with which we bring these products to market.

Our safety metrics are tightly linked to our OE efforts. Since initiating OE, our recordable and lost workday injury rates have been reduced by 58% and 85%, respectively, moving MTI closer to our goal of a zero-injury workplace. Our strong safety performance is a result of the hard work and dedication of all MTI employees who hold themselves and each other accountable for practicing safe behaviors. Through active engagement, extensive training and management's commitment to safety, employees directly participate in identifying safety issues and implementing solutions to improve their work areas.

As a company, we firmly believe that MTI has a responsibility to ensure the needs of our business are met today while building a healthy and sustainable future for our employees, customers, shareholders and communities. OE supports these efforts by continuously identifying opportunities to better protect the environment, improve our operating footprint at our mines and facilities and evolve our processes to further reduce the impact our activities have on the local communities.

Most importantly, OE serves as a cornerstone for the development of our employees, promoting a work environment that is marked by high levels of personal achievement, satisfaction and collaboration. All employees are involved in supporting our goals and helping our organization overcome challenges we may face. OE is a clear competitive advantage in growing and retaining a highly-skilled workforce and is a driving force in our push to become even more agile, more diverse and inclusive, more customer centric and more attractive to new talent.

The advancement of OE has led to demonstrable results across our organization. With this highly structured business system as the foundation of MTI, we have created a sustainable business model that is delivering significant value to our stakeholders in an environmentally and socially responsible manner.

So when do the benefits of these process improvements come to an end? When is all the waste eliminated? The answer to those questions is that the OE journey never ends. There are always new and improved ways to further capture value and remove waste from our processes.

I encourage you to read and understand MTI's deployment of OE and to implement it with the passion and commitment I know we share.

Sincerely,

Douglas T. Dietrich

Chief Executive Officer

ORGANIZATIONAL PROFILE

Minerals Technologies Inc. (MTI) is a leading global resource- and technology-based company that develops, produces and markets a broad range of specialty mineral, mineral-based and synthetic mineral products and supporting systems and services. We are, in essence, two types of businesses - minerals-based and service-based.

The Performance Materials and Specialty Minerals segments, which comprise the minerals-based businesses, produce and sell products and technologies based upon the minerals bentonite, calcium carbonate, talc and leonardite. These minerals are used principally in the metalcasting,

paper and packaging, automotive, building materials, paints and coatings, consumer products, ceramic, polymer, food and pharmaceutical industries.

The Refractories and Energy Services segments, which comprise the service-based businesses, produce and market patented technologies, products and services. The Refractories segment develops monolithic refractory materials and specialty products, services and application equipment used primarily by the steel, non-ferrous metal industries, and other industrial refractory applications. Energy Services provides a range of offshore produced water filtration and well testing services to the worldwide oil and gas industry.

MTI AT A GLANCE

35
COUNTRIES

158
WORLDWIDE LOCATIONS

12
R&D CENTERS

3,720
EMPLOYEES

A $1.8 BILLION GLOBAL MINERALS-BASED COMPANY

THE WORLD LEADER IN BENTONITE

THE WORLD LEADER IN PRECIPITATED CALCIUM CARBONATE (PCC)

A LEADER IN MINERALS-BASED APPLICATION TECHNOLOGY AND INNOVATION

STRONG SAFETY AND OPERATIONAL EXCELLENCE FOUNDATION

INTRODUCTION

At Minerals Technologies we believe in something infinitely positive and uplifting – Operational Excellence. Since 2007, it's been both an operating philosophy and a daily work practice for our entire organization. The original objective of our Operational Excellence journey continues, which is to deliver superior value to our customers through safe, highly efficient and reliable production and service delivery processes. This objective is achieved through the never-ending pursuit of continuous improvement in all facets of our organization and the elimination of waste, which are prerequisites to being a leader in the global marketplace. **The linchpin of our Operational Excellence culture is our dedicated employees.**

We know from our performance that Operational Excellence contributes to superior business performance and fostering an engaging work environment. **Operational Excellence has helped drive MTI's cultural transformation. Under CEO Doug Dietrich, the deployment of Operational Excellence and all associated activities have become the foundation of MTI.**

This quest for even higher levels of performance and execution has been underway through the implementation of sustainable improvement processes, such as 5S, Total Productive Maintenance (TPM), Daily Management Control, Standard Work, Kanban and Problem Solving, and processes in eliminating waste.

STRUCTURE

The Operational Excellence Lead Team, which reports directly to our Chief Executive Officer, provides the policies, practices, objectives, procedures and standards to be deployed throughout MTI. The team, consisting of key leaders in the company, continues to guide our overall effort.

The Operational Excellence Lead Team is supported by a Facilitation Team, also comprised of key leaders. This group meets regularly to assist with the ongoing deployment of Operational Excellence.

PREPARING THE WORKFORCE

Operational Excellence is a **people-centric** system and philosophy of doing business. In our business, as in all organizations, problems are solved by people, not machines or spreadsheets. To prepare our workforce to become highly proficient problem-solvers, and to help the company eliminate as much waste and risk as possible from our operations, we have been offering education related to the principles of Lean Manufacturing (Lean) since 2008, which is closely aligned with Operational Excellence. This includes training in leading and participating in kaizen events, 5S, Standard Work development, Hoshin Kanri, Total Productive Maintenance, Daily Management Control, Failure Mode Effects Analysis (FMEA) and Kanban.

Senior leaders at MTI are given **at least 15 personal development activities on a yearly basis** to further build their personal capabilities in leading Operational Excellence. These activities require leaders to attend learning sessions, read books, set personal improvement objectives, practice leader standard work, conduct audits and undertake other key Lean initiatives. Completion progress is reviewed by the MTI Leadership Council.

In addition, MTI **hosts monthly employee-driven webinars** on specific OE activities that are occurring across the company or on topics that require a more in-depth discussion. These webinar themes are determined by managers from all areas of the organization and serve as both training modules and opportunities to highlight key successes that could then be applied to other facilities at MTI. In conjunction with onboarding, new employees participate in a variety of online modules spanning a period of four months. These modules are intended to provide an introduction to key Operational Excellence concepts that will be later reinforced by the employee's supervisor.

MTI also strongly supports the Association for Manufacturing Excellence (AME). Since 2008 we have enrolled a large contingent of employees, from all global regions and all organizational levels, to attend the global conference that features organizations with cutting-edge levels of OE deployment. MTI is one of the larger companies participating based on employee attendance. Participation at AME provides additional OE learning, as well as offering a form of reward and recognition for our employees. Employees also deliver presentations specific to our journey and learnings as a company, most recently sharing about our world-class suggestion system.

IN 2018, OUR EMPLOYEES PARTICIPATED IN OE TRAINING AND RELATED-DEVELOPMENT ACTIVITIES TOTALING MORE THAN 75,000 CUMULATIVE HOURS.
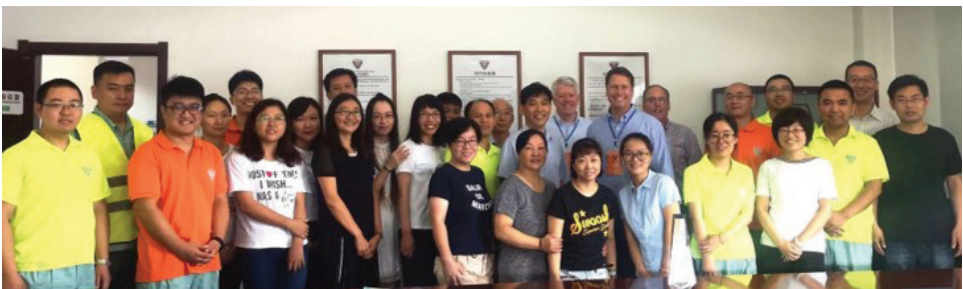
KAIZEN – THE NEVER-ENDING CYCLE OF CONTINUOUS IMPROVEMENT

Kaizen is a Japanese word defined as "improvement for the better," or "good change." At MTI, we practice kaizen as a form of ongoing, never-ending improvement of product and service processes.

Kaizen events at MTI are highly focused and structured improvement projects that target a particular process, work area, set of equipment or value chain. The events may last anywhere from one-half day up to five days, and they follow a consistent method of understanding the current process, identifying issues, problems or any of the eight forms of waste, brainstorming improvements, and building a new and improved process for the future. The events range from being highly formalized to more spontaneous and informal in response to a sudden production or customer issue.

Our kaizen events are led by employees who have attended training and been coached on leading kaizen events.

The number of kaizen events at MTI has steadily increased since 2008, and totaled over 7,000 in 2018.
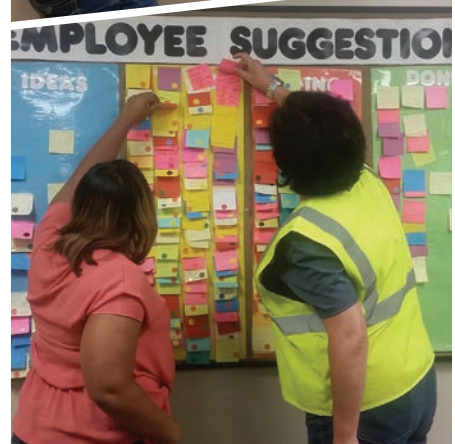
KAIZEN EVENTS
(# of Events)

'14	'15	'16	'17	'18
1,908	3,104	3,938	6,161	7,170
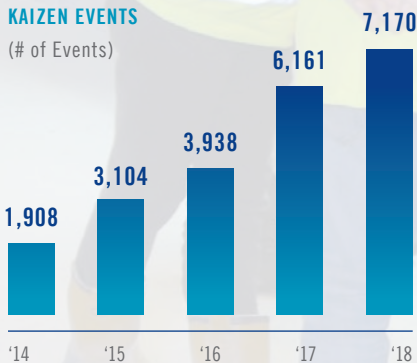
MTI'S ROBUST SUGGESTION SYSTEM

Our suggestion system is designed to promote "daily kaizen." Believing that those 'closest to the work' know the most about it, we empower our employees to continuously look for ways to remove any form of waste and risk in their work. We support viable suggestions no matter how minor they appear on the surface, as the power of a suggestion system is having a large volume of small suggestions that the competition cannot easily copy. A suggestion system operating in this fashion provides a very real form of competitive advantage. MTI's current system continues to evolve while maintaining the core principles established since inception. Built into the current system are flexibility and continuous improvement driven by our employees. We deploy two types of systems:

- Local suggestion systems are designed to gather and execute suggestions that pertain to work processes within a facility, department or business unit.

- The global suggestion system is optimized to process ideas that affect the overall MTI business, safety or ideas that cannot be acted upon at the local level.

To encourage participation, each facility, department or workgroup chooses how to deploy its own suggestion system, building from a common set of guidelines and principles. Having each workgroup design its own system ensures that it meets their needs, making it easier and more convenient to use.

The global system is an online system accessed through MTI's intranet, to which ideas are submitted via an electronic form. Assignments and status are tracked electronically on the site, and notifications are communicated via email.

GLOBAL SUGGESTION SYSTEM
(# of Suggestions)

17,842   39,693   45,097   53,118   59,237

67%   62%   71%   70%   71%

'14   '15   '16   '17   '18

■ # of ideas   •••• % implementation

PRODUCTIVITY IMPROVEMENT
(Percent Reduction in Hours Worked per Ton Produced)

6%   9%   7%   6%   6%

'14   '15   '16   '17   '18
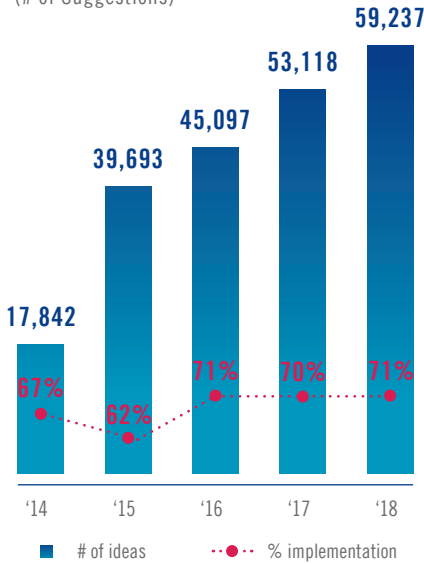
MTI places its suggestion system at the center of its approach to continuous improvement. Ideas come from everywhere and the suggestion system acts as a central repository to document all ideas from kaizen, Plan-Do- Check- Act, 5S and TPM events in one place. When all the ideas are available in a common place, the s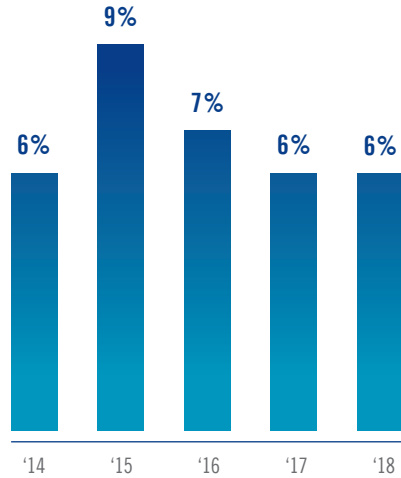ystem becomes visible—everyone can see the status of ideas and can decide what they can contribute to implement them. Also, as employees see the results, they get more interested and engaged in the process. **While we track the number of suggestions on an annual basis, we are just as focused on ensuring employees are providing quality, actionable suggestions across all areas of our company.**

Both kaizen events and the suggestion system are key indicators of employee engagement in Operational Excellence and Lean activities and have been instrumental in identifying and removing waste and risk from our processes and procedures.

EMPLOYEE RECOGNITION

Recognition of employee efforts in advancing Operational Excellence has helped to increase the level of engagement in our continuous improvement process. We recognize individual employees on a regular basis through Bravo Chips as well as collective facilities or organizations on an annual basis with the Operational Excellence Achievement Award.

BRAVO CHIPS GRANTED
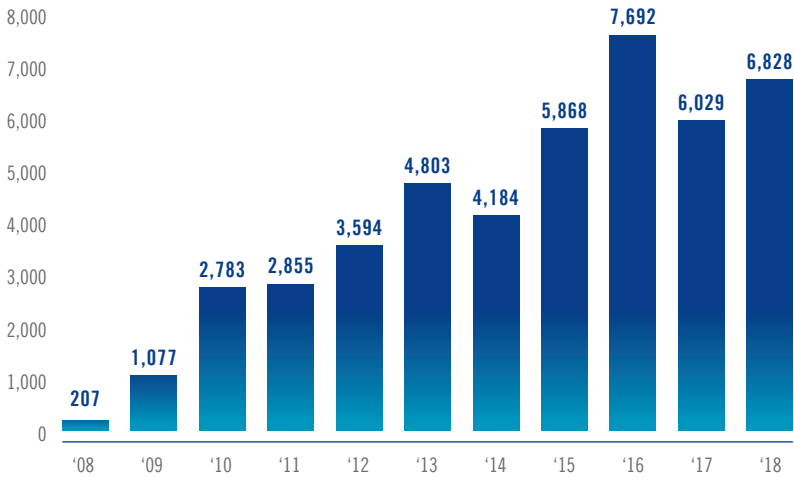
BRAVO CHIP

A key element of our recognition activities involves the use of a custom designed token chip called the Bravo Chip. The Bravo Chip is awarded to employees for accomplishments relating to process improvements, customer responsiveness or service, and cost reduction.

Each Bravo Chip represents an amount of cash based on the equivalent value of MTI shares. It is not a grant of stock - but a proxy of the value of a share of MTI stock. The Bravo Chip must be held for a period of one year before the final value is determined and payment occurs.

Since its inception as an important vehicle for recognizing employees, the number of Bravo Chips granted each year has steadily increased, as represented by the chart above.

SAFETY

Safety is a primary foundation of Operational Excellence because a process is not efficient unless it's also safe. Accidents, injuries and inefficient ergonomics are all forms of waste, and their elimination has had a direct effect on operational performance and employee well-being.

In 2010, MTI began merging our focus on Safety with Lean principles to better leverage both efforts. This approach is illustrated by the combination of the MTI Residual Risk Reduction process to all kaizen, Standard Work, Non-Routine Task Reviews and TPM activities. This integration of Lean and Safety provides an excellent platform for performing tasks and managing our processes in the safest and least waste way.

MTI has experienced a 58% reduction in its Annual Recordable Injury Rate since 2007. Our Lost Workday Injury Rate (LWIR), which tracks the more severe injuries, has dropped by more than 85%. Our most recent LWIR represented the best performance in MTI's history and moves our company closer to the world class milestone of 0.10.

The improved safety performance is a direct result of several very powerful and ongoing safety engagement and Operational Excellence initiatives. It also follows a close examination of our severe injury causes and the introduction of new proactive safety measures, which allow our teams to focus on conditions or actions that exist around human performance or doing work the "right way."

The initiatives include:

1. Leadership Engagement – Leaders at all levels in the organization are actively engaged in setting safety performance expectations and holding themselves and the rest of their organization accountable.

2. Risk Identification and Mitigation – Through the use of the Residual Risk Reduction technique, hazards are proactively identified and mitigated. Near miss, unsafe act and unsafe condition reporting by all employees also is a mechanism to identify and address issues before they cause injuries.

3. Safety Training – All employees receive a level of continuous safety training commensurate with their level of exposure. Training is provided in both classroom and online-based formats and in the local language of the employee.

4. Worldwide Environmental, Health and Safety (EHS) Support – A global network of EHS professionals and EHS coordinators has been established to support organizational safety improvement. This group is guided by an EHS Lead Team that provides the strategic guidance to drive continual improvement.

5. 5S and Lean Tools – The worldwide implementation of 5S and Lean principles reduces waste and inefficiencies in our workplace in the form of injuries and incidents. Organization is improved and storage of tools, equipment, and raw materials is maximized. Visual and daily management principles enable more effective communication and engagement.

We remain proud of our longstanding position as a leader in safety, but continue to reflect upon this performance with a healthy level of dissatisfaction as we strive for a zero-injury workplace.

SAFETY: HISTORICAL INJURY RATES

(Injuries/100 Employees)

– – – World Class Recordable Injury Rate
–·–·· World Class Lost Workday Injury Rate
··●·· Annual Recordable Injury Rate
··○·· Lost Workday Injury Rate

Year	Annual Recordable Injury Rate	Lost Workday Injury Rate
'07	3.08	1.16
'08	2.63	0.94
'09	1.41	0.61
'10	2.06	0.75
'11	1.67	0.65
'12	1.34	0.38
'13	1.59	0.39
'14	0.97	0.40
'15	1.23	0.40
'16	1.25	0.26
'17	1.18	0.26
'18	1.28	0.16
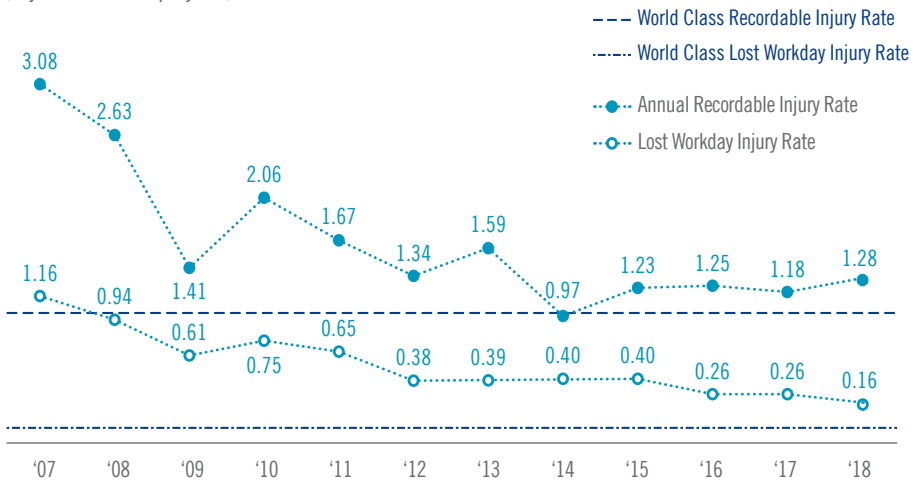
EIGHT FORMS OF WASTE

Operational Excellence aims to eliminate or reduce any of the eight major forms of waste found in either our operational or administrative work processes. These forms of waste add no value to our products or services from a customer perspective. Our continuous improvement activities, notably kaizen events and employee suggestions, are targeted to help identify and remove or minimize these forms of waste.

The eight forms of waste are:

1. Transportation
Moving an item, product, material or information from one place to another, usually when not necessary or when there is an alternative.

2. Inventory
Carrying large inventories locks up financial resources and valuable space. It can also exist in transactions in the form of items or products waiting to be processed.

3. Motion
This is slightly different from the concept of transportation. Any time spent by a worker walking distances to complete their work, or looking for tools, equipment, supplies, or information is wasted motion.

4. Waiting
Waste of waiting occurs when people, jobs, items, information or material are waiting to be worked upon and is in queue. When employees wait for anything, they become a "wasted resource."

5. Over-Processing
Doing more than is necessary when the customer does not want the service or is not willing to pay for it.

6. Over-Production
Making or processing more than what is needed for producing items when there are no customer orders. Filling out reports or forms that no one is going to read is an enormous waste of time and resources.

7. Defects
Defects create rework. A key principle of Lean is to eliminate defects and errors at their source so resources are not wasted catching them later and then correcting.

8. Unused Skill
Refers to not leveraging employee talents to their full capability or using highly skilled resources for mundane tasks.

OUR CONTINUOUS IMPROVEMENT ACTIVITIES, NOTABLY KAIZEN EVENTS AND EMPLOYEE SUGGESTIONS, ARE TARGETED TO HELP IDENTIFY AND REMOVE OR MINIMIZE THESE FORMS OF WASTE.

5s DEPENDS ON YOU!

1 **SORT**
keep only what you need

2 **STRAIGHTEN**
organize and put everything in its place

3 **SHINE**
clean and inspect to make sure everything is in working ord

4 **STANDARDIZE**
use schedules and checklists to make it easy

5 **SUSTAIN**
train and maintain the standards

5S

SORT
SET IN ORDER
SHINE
STANDARDIZE
SUSTAIN

5S

5S is a method for organizing the workplace so that the various forms of waste in work processes can be more quickly and easily spotted and removed. It is the foundation for all activities in support of Operational Excellence, and is best described by the phrase, "A place for everything & everything in its place!"

5S helps to keep our workplace clean, provides a better, safer environment to work in, increases productivity, saves time, reduces costs, improves alignment and organization, makes work more hassle-free, and eliminates all types of waste. It largely accomplishes those results by eliminating the waste of motion when looking for tools, materials or information.

Sort - Seiri (整理) Going through all the tools, materials, etc., in the work area and keeping only essential items. Everything else is stored or discarded.

Set in Order - Seiton (整頓) Focuses on efficiency. The intent of this second step is to arrange workplace tools, materials and information in a manner that promotes work flow. For example, tools and equipment should be kept where they will be used (i.e., straighten the flow path), and the process should be set in an order that maximizes efficiency. For everything there should be a place and everything should be in its place (Demarcation and labeling of place.)

Shine - Seiso¯ (清掃) Shine refers to the need to keep the workplace clean as well as neat. The key point is that maintaining cleanliness should be part of the daily work - not an occasional activity initiated when things get too messy.

Standardize - Seiketsu (清潔) Work practices or operating in a consistent and standardized fashion. Everyone knows exactly what his or her responsibilities are to keep the above three S's.

Sustain - Shitsuke (躾) Refers to maintaining and reviewing standards with the discipline to ensure that the previous four S's are routinely followed.

STANDARD WORK

Standard Work is the foundational cornerstone of Operational Excellence, as there can be no improvement without first having an established standard. It ensures that operations are safely carried out with all tasks organized in the current "least waste way" sequence to ensure a stable, repeatable and unambiguous process to achieve reliable output of processes and superior quality. We strive to have standard work in place for 100% of our critical work processes.

Standard Work is not a rigid set of rules that never change; rather Standard Work reflects the currently identified "least waste way" to produce a product or service to meet customer demand. Employees continuously improve standard work and ensure that we are always evaluating new and enhanced approaches to work processes.

STANDARD WORK

STANDARD WORK

EMPLOYEE INPUT
AND SUGGESTIONS ARE
USED TO CONTINUOUSLY
IMPROVE STANDARD WORK
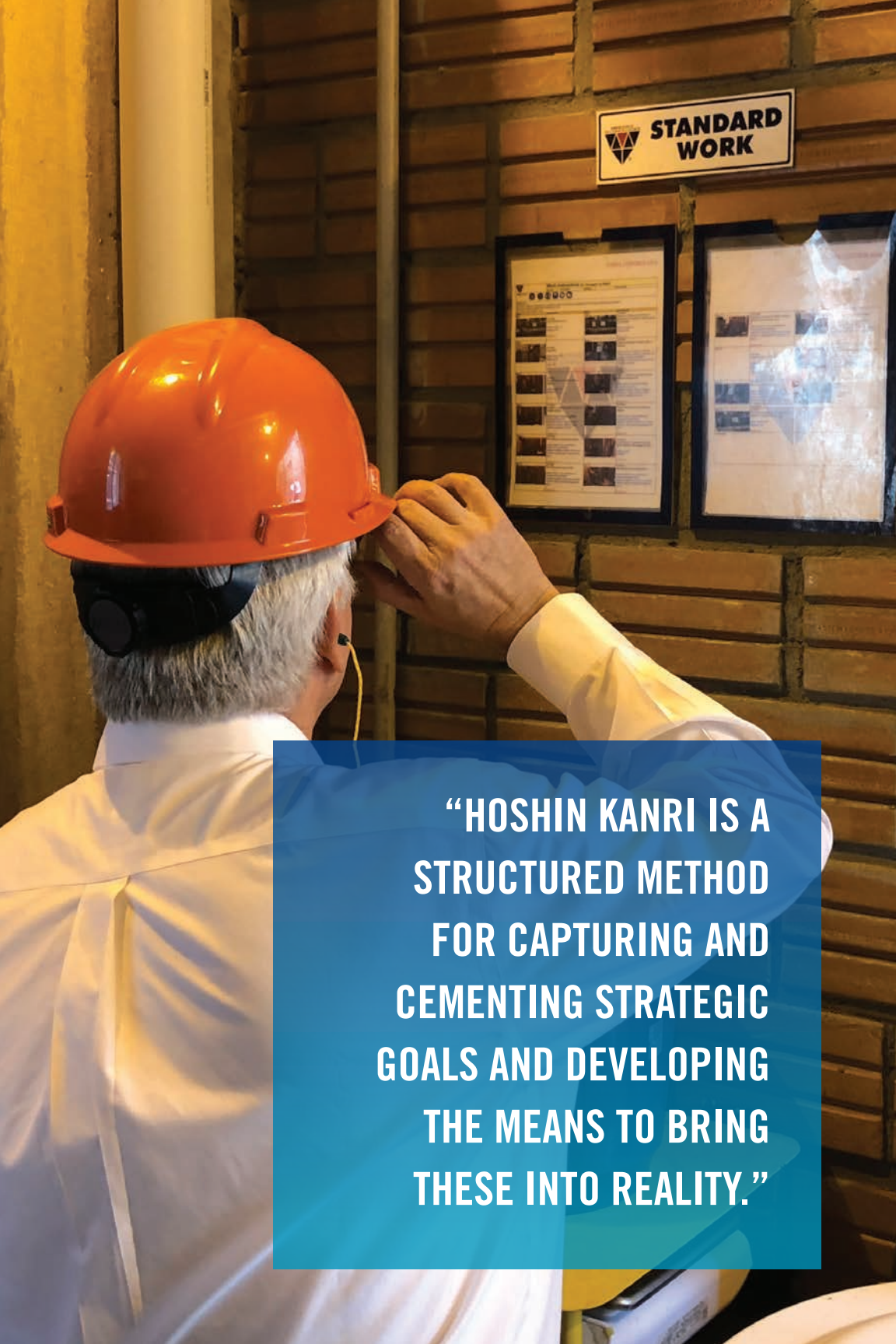
STANDARD WORK

"HOSHIN KANRI IS A STRUCTURED METHOD FOR CAPTURING AND CEMENTING STRATEGIC GOALS AND DEVELOPING THE MEANS TO BRING THESE INTO REALITY."

方針管理

HO　　SHIN　　KAN　　RI

HO = DIRECTION　**SHIN** = NEEDLE　**KAN** = CONTROL, CHANNELING　**RI** = REASON, LOGIC

"POLICY, DIRECTION"　　　　　　　**"MANAGEMENT"**

HOSHIN KANRI (STRATEGY DEPLOYMENT) – ALIGNING IMPROVEMENT EFFORTS WITH KEY STRATEGIC INITIATIVES

"Hoshin Kanri is a structured method for capturing and cementing strategic goals and developing the means to bring these into reality." Also called policy deployment or Hoshin planning, it's a strategic planning and management methodology, first developed by Dr. Yoji Akao, that uses the Shewhart PDCA cycle (Plan-Do-Check-Act) to create goals, choose control points (measurable milestones), and link daily control activities to company strategy.

The discipline and method of Hoshin Kanri helps MTI to:

- Focus on a shared goal
- Communicate that goal to all employees
- Involve affected and appropriate employees in planning to achieve the goal
- Support and hold participants accountable for achieving their part of the plan

Hoshin Kanri involves the following key steps on an annual basis:

- Identifying the organization's vision – and the key business goals for the near term;
- Translating those goals into key Hoshin objectives for each business and staff (resource unit);
- Cascading the Hoshin objectives so that each successive level in the organization is focused on supporting the achievement of key business goals;
- Establishing daily management controls and measurement systems to ensure that key performance indicators are being tracked and achieved;
- Leaders reviewing Hoshin objectives regularly with each "Hoshin owner" to discuss what is working well and what requires improvement.

At Minerals Technologies, all business units and resource units (e.g., finance, treasury, human resources, legal) have identified key goals that have been cascaded to successive levels in the organization. Through monthly review meetings, the company stays keenly aware of progress in implementing key Hoshin objectives in support of overall business direction.

We use a software application called HoshinOnline to assist in integrating and tracking our Hoshin Kanri efforts at the enterprise and operating levels.
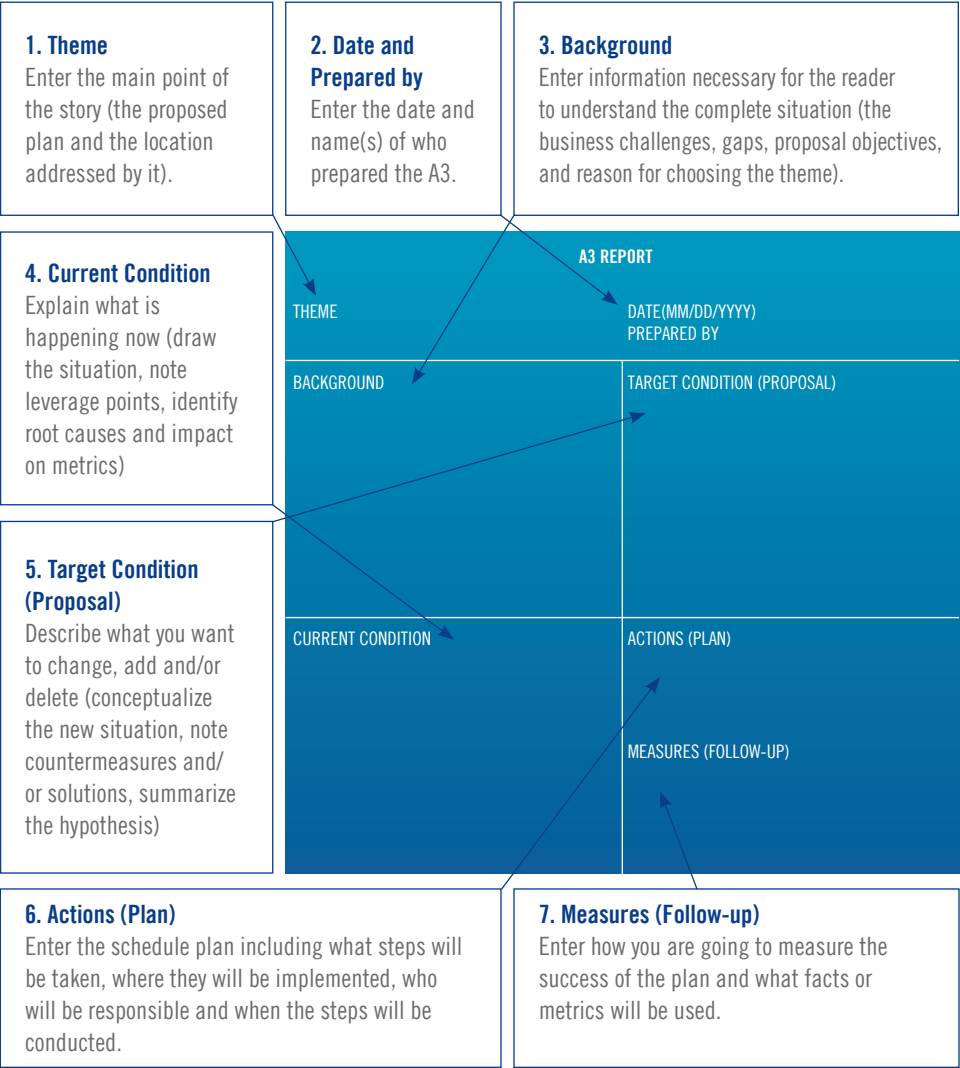
THROUGH MONTHLY REVIEW MEETINGS, THE COMPANY STAYS KEENLY AWARE OF PROGRESS IN IMPLEMENTING KEY HOSHIN OBJECTIVES IN SUPPORT OF OVERALL BUSINESS DIRECTION.

Many problems that arise in organizations are addressed in superficial ways, what some call "first-order problem solving." The A3 process allows organizations to plan initiatives to address the root causes of a problem to prevent its recurrence. It promotes collaborative, in-depth problem solving, and can be used for almost any situation.

The A3 process is a system based on building structured opportunities for people to learn in the manner that comes most naturally to them: through experience, by learning from mistakes and through plan-based trial and error.

THE A3 PROCESS

1. Theme
Enter the main point of the story (the proposed plan and the location addressed by it).

2. Date and Prepared by
Enter the date and name(s) of who prepared the A3.

3. Background
Enter information necessary for the reader to understand the complete situation (the business challenges, gaps, proposal objectives, and reason for choosing the theme).

4. Current Condition
Explain what is happening now (draw the situation, note leverage points, identify root causes and impact on metrics)

5. Target Condition (Proposal)
Describe what you want to change, add and/or delete (conceptualize the new situation, note countermeasures and/or solutions, summarize the hypothesis)

A3 REPORT

THEME

DATE(MM/DD/YYYY)
PREPARED BY

BACKGROUND

TARGET CONDITION (PROPOSAL)

CURRENT CONDITION

ACTIONS (PLAN)

MEASURES (FOLLOW-UP)

6. Actions (Plan)
Enter the schedule plan including what steps will be taken, where they will be implemented, who will be responsible and when the steps will be conducted.

7. Measures (Follow-up)
Enter how you are going to measure the success of the plan and what facts or metrics will be used.

NEW PRODUCT DEVELOPMENT

We drive our New Product & Process Development (NPPD) stage gate process and technology roadmaps with ideas that originate from our customers. This is a formalized development process, separated into five parts, with clearly defined goals and tracking metrics to ensure the process is closely tied to interactions with our customers. At each stage, from idea generation through to scale-up and commercialization, there is a gate check that involves screening and evaluation of the idea and feasibility of the product with potential customers. This highly structured process allows MTI to fail early and often, ensuring that those products that reach commercialization are specified to meet customers' evolving demands in the marketplace.

We have a robust pipeline of innovative value-added products across each of our businesses that has been strengthened through our close alignment with customers and the application of Operational Excellence principles to improve the speed of development. We have also instilled more metrics to track our alignment and product value proposition, such as customer pull, to ensure that our products are helping our customers achieve their objectives. **Many of our newest products are geared toward meeting our customers' evolving needs for higher value solutions to address their environmental, waste and recycling requirements.**

ROBUST PIPELINE FROM DEVELOPMENT TO COMMERCIALIZATION REPRESENTING OVER $600M POTENTIAL REVENUE

COMMERCIALIZED 35 NEW VALUE-ADDED PRODUCTS IN 2018

INCREASED SPEED OF DEVELOPMENT BY 21%

AMOUNT OF REVENUE GENERATED FROM OUR NEW PRODUCTS INCREASED BY 13% IN 2018

VOICE OF THE CUSTOMER

The term "Voice of the Customer" (VOC) refers to the process that focuses on capturing and eventually exceeding customers' expectations. The process is designed to identify customers' wants and needs in order to develop, produce and deliver value-added products and services in an efficient and reliable manner.

Companies that are driven by the Voice of the Customer process have the mindset, processes and capability to capture customer requirements and use that information to provide higher value-added services and products that meet their customers' stated and unstated needs. The Voice of the Customer process supports our key strategic initiatives and is embedded throughout our service and product value chain. This includes directing MTI resources to processes that are driven by customer priorities.

Our approach to driving VOC throughout the company includes the use of Quality Function Deployment (QFD) (see chart on page 22), ongoing loyalty and satisfaction surveys, close customer contact by Strategic Account Managers, linkages between the customer and internal development resources, and customer support staff located in field and administrative organizations.

The VOC team, which consists of key leaders in commercial and R&D roles, receives guidance from the OE Lead Team and develops the tools, processes, metrics and educational activities to drive VOC deployment across MTI.
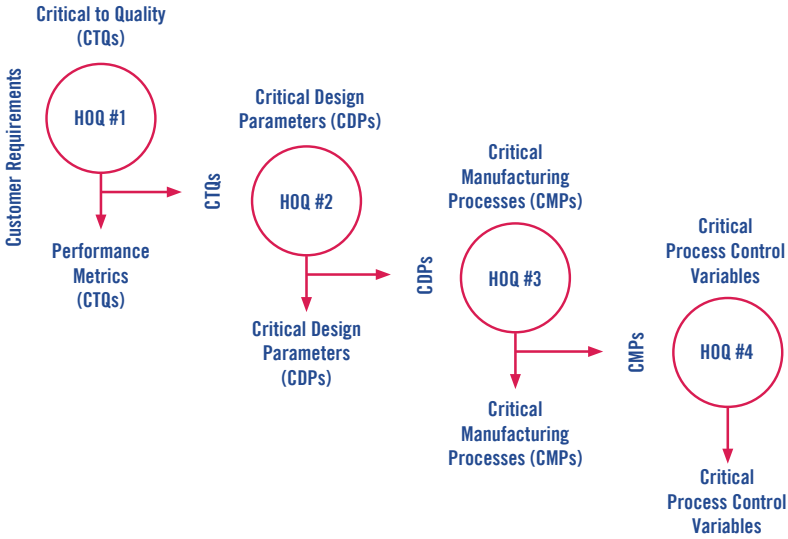
DEPLOYING THE VOICE OF THE CUSTOMER

The first principal of OE is to specify value from the point of view of the customer – to know who your customers are and to understand what they want. MTI has long had unique and synergistic relationships with customers. We have now integrated the organizational discipline we have achieved on our Lean journey into the customer-facing processes by adapting a series of QFD tools.

The first of these tools is the Kano model, which allows us to understand the different types of customer needs. It is our goal to meet the more straightforward "must-have" needs, but we also want to uncover the "attractive quality" needs, which sometimes the customer is not able to articulate, but will "know it when they see it."

Understanding the Voice of the Customer is an iterative learning process that requires we observe, ask the right questions and, in effect, walk in the customer's shoes. The first tool is called LAMDA, for Look, Ask, Model, Discuss and Act, and refers to the steps of the repetitive information-gathering process. This is very similar to the Plan-Do-Check-Act (PDCA) cycle used throughout our Operational Excellence initiative. With each cycle, more knowledge is gathered and resources are more effectively directed, bringing products and services closer to what the customer wants. LAMDA is the path that leads from goals to requirements, and use of this process helps decrease the risk that a product will not meet customer needs and ensures are designed with specifications that do not reflect what the customer really wants.

The knowledge generated in the LAMDA process creates the inputs to our next process, which is the House of Quality or HOQ. MTI adopted a four-house methodology to insure that customer requirements are driven through the organization from a commercial team to a development team to operations and our quality system. A graphic representation of the House of Quality tool we are using is shown on the next page.
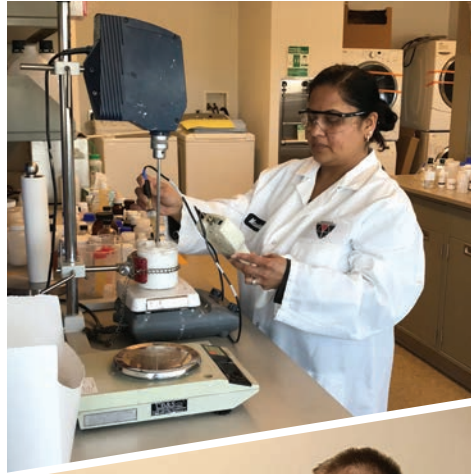
QUALITY FUNCTION DEPLOYMENT

Customer Requirements

Critical to Quality
(CTQs)

HOQ #1

CTQs

Performance
Metrics
(CTQs)

Critical Design
Parameters (CDPs)

HOQ #2

CDPs

Critical Design
Parameters
(CDPs)

Critical
Manufacturing
Processes (CMPs)

HOQ #3

CMPs

Critical
Manufacturing
Processes (CMPs)

Critical
Process Control
Variables

HOQ #4

Critical
Process Control
Variables

HOUSE OF QUALITY EXAMPLE

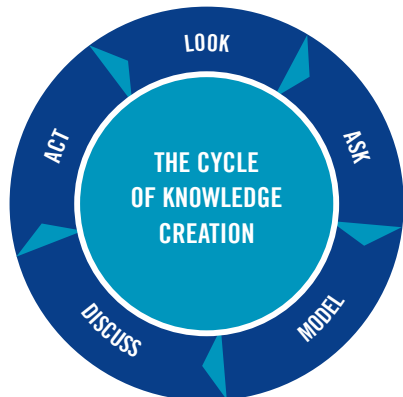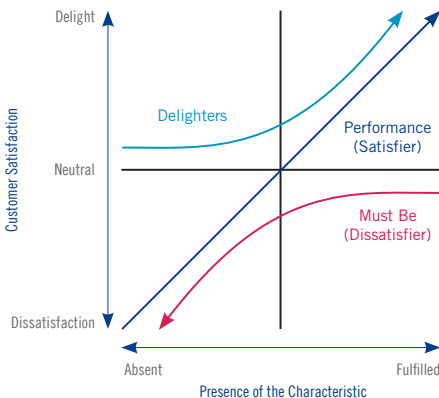| Maximize, Minimize or Target		Functional Product Requirements					Current Products (our & competitive)	Method	Target Range
		match	min	min		min			
Customer Needs	Customer Rating	Loading Level · PSD · Refractive Index · Dispersion · Impurities · Hardness · Surface Chemistry · Oil Absorption · Surface Area · Density · Morphology · Material Interactions					Polybloc · Optibloc · Diatomaceous Earth · Nepheline Syenite · Synthetic Silica · Feldspar · Calcined Clay · Calcium Carbonate		
Anti-blocking	9							Blocking/Re-blocking	
Film Slip	5							COF	
High Clarity	9							Haze Gloss Clarity	
Low Abrasion	1							Hardness Abrasion	
Low Color Bodies	1							Dry Color	
Gel-free	5							Gels	
Maintain Polymer Properties	5							Tensile Elongation Modulus	
Maintain Film Properties	5							Tear Puncture Impact	
Relative Importance									
Target Range									

MTI has a process in place for monitoring customer loyalty and overall satisfaction. We use a comprehensive customer satisfaction survey platform to understand customers' perceptions of our people, products and services, ease of doing business and overall commitment by the customer.

All VOC processes that we have in place are meant to maximize customer engagement with a goal to enhance the overall customer experience. Below are some key characteristics of our VOC system:

- Customer surveys are issued electronically.

- Surveys are issued on a quarterly basis across all business units.

- Customers are surveyed broadly to ensure that feedback of different functions is properly captured.

- Account managers are directly responsible for follow up with customers.

- The survey results are evaluated on a quarterly basis and summary reports are reviewed with senior management.

- New product development and product improvement projects are funneled through the House of Quality process in order to understand clearly customer needs and to minimize waste.

KANO MODEL

THE CYCLE OF KNOWLEDGE CREATION

LOOK · ASK · MODEL · DISCUSS · ACT

DAILY MANAGEMENT CONTROL

Daily management control is the Lean system that enables the quick identification of gaps between target conditions (i.e., standards) and current conditions (or operating performance).

Daily management control requires that key metrics are established for processes that serve as the basis for monitoring performance against standards on a regular basis. It allows for the early identification of deviations from standards.

Visual metrics and displays are an important component of daily management. Key operational data is collected, measured, and charted for visual tracking. Charting creates a picture of the data and accompanying trends. It facilitates rapid response to sudden operational issues or the creation of countermeasures to slowly developing, negative trends.

Charting occurs at all levels and areas of the company, from production boards at the facility level, to key process metrics in our shared services functions, to macro, business unit-level dashboards.

HIGH-PERFORMANCE WORK SYSTEMS AND SELF-DIRECTED WORK TEAMS

We are organizing people and technical systems to achieve the highest levels of operating performance. With Operational Excellence, we believe that our employees, and their capability to solve problems as close to where the work occurs as possible, can be a source of competitive advantage.

For example, some of our smaller facilities operate without an on-site manager, and many of our other worldwide facilities are organized into natural work groups or self-directed work teams. We are transitioning to this form of organizational design across all global operations. This high level of "built-in" empowerment enables employees to continuously improve standardized work, and at the same time use their capabilities to solve tough operating problems.

Our belief is that "those closest to the work almost always know the most about it." The central challenge in building sustained levels of high-performance is to create a path - a vehicle for tapping into the collective wisdom of the workforce. Our high-performance work systems provide that path, while at the same time furthering the aims of Operational Excellence.

WE ARE ORGANIZING PEOPLE AND TECHNICAL SYSTEMS TO ACHIEVE THE HIGHEST LEVELS OF OPERATING PERFORMANCE.
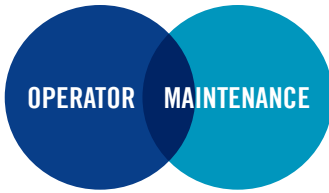
TOTAL PRODUCTIVE MAINTENANCE (TPM)

TPM is a systematic approach to equipment maintenance that optimizes equipment effectiveness, reduces breakdowns, and promotes autonomous operator maintenance through day-to-day activities involving the total workforce.

TPM can be traced back to 1951 when preventive maintenance was introduced into Japan from the U.S. In preventive maintenance, operators produced goods using machines and the maintenance group was dedicated to the work of maintaining those machines. However, with the high level of automation of Nippondenso, maintenance became a problem because so many more maintenance personnel were required. Management decided that routine maintenance of equipment would be carried out by the operators themselves (this is autonomous maintenance, one of the features of TPM). The maintenance group then focused only on maintenance works for upgrades.

We prepared our company to use the methods of TPM effort through a "train the trainer" approach, beginning with a few events that served a dual purpose – conducting an actual TPM event, plus preparing individuals to lead future events at their host locations. This learning through "practice and coaching" approach was also followed with our kaizen implementation.

TPM

TPM consists of these six major activities:

1. **Elimination of six big losses** based on project teams organized by the production, maintenance, and plant engineering departments;

2. **Planned or preventive maintenance** carried out by the maintenance department, which is regular, and based on equipment run hours or calendar time;

3. **Autonomous maintenance** carried out by the production department, with the technical assistance of maintenance personnel;

4. **Maintenance elimination** involving the design of equipment to reduce the amount of required maintenance;

5. **Predictive maintenance** using various forms of monitoring equipment to detect the beginning stages of equipment failure or necessary maintenance;

6. **Education and training** to support the above activities.

SEVEN STEPS TO AUTONOMOUS MAINTENANCE

At Minerals Technologies, we continuously strive to eliminate the six "big losses" through the practice of the following seven steps to autonomous maintenance:

- Step 1 – Initial cleaning
- Step 2 – Countermeasures to sources of contamination
- Step 3 – Cleaning standards
- Step 4 – Overall inspection
- Step 5 – Autonomous maintenance standards
- Step 6 – Process quality assurance
- Step 7 – Autonomous supervision

OPERATOR

MAINTENANCE
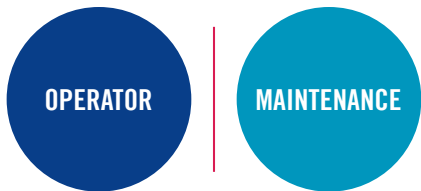
CONVENTIONAL

TPM aims to reduce six "big losses" that reduce the overall effectiveness of equipment:

- Breakdown losses due to equipment defects;

- Setup and adjustment losses caused by changes in operating conditions, change-over, and production start-ups;

- Minor stoppage losses as a result of machine halting, jamming and idling;

- Speed losses due to reduced operating speed;

- Quality defect and rework losses caused by off-specification or defective products manufactured during normal operation;

- Yield losses caused by unused or wasted raw materials and are illustrated by the quantity of rejects, scrap and other factors.

These six big losses are presented in three factors Their combined or multiplicative effect is represented as overall equipment effectiveness (OEE). OEE is a strong proxy for measuring the effectiveness of our TPM activities.

OEE is a metric that identifies the percentage of planned production time that is truly productive. An OEE score of 100% represents perfect production: manufacturing only good parts, as fast as possible, with no down time.

OEE is calculated from three underlying factors: Availability, Performance, and Yield. Each of these factors represents a different perspective of how close your manufacturing process is to perfect production.

OEE FACTOR	PERFECT PRODUCTION
Availability	An Availability score of 100% means the process is always running during planned production time (it's never down)
Performance	A Performance score of 100% means when the process is running it is running as fast as possible (at the theoretical maximum speed; each part at the Ideal Cycle Time)
Yield	A Quality score of 100% means there are no defects (only good parts are produced)
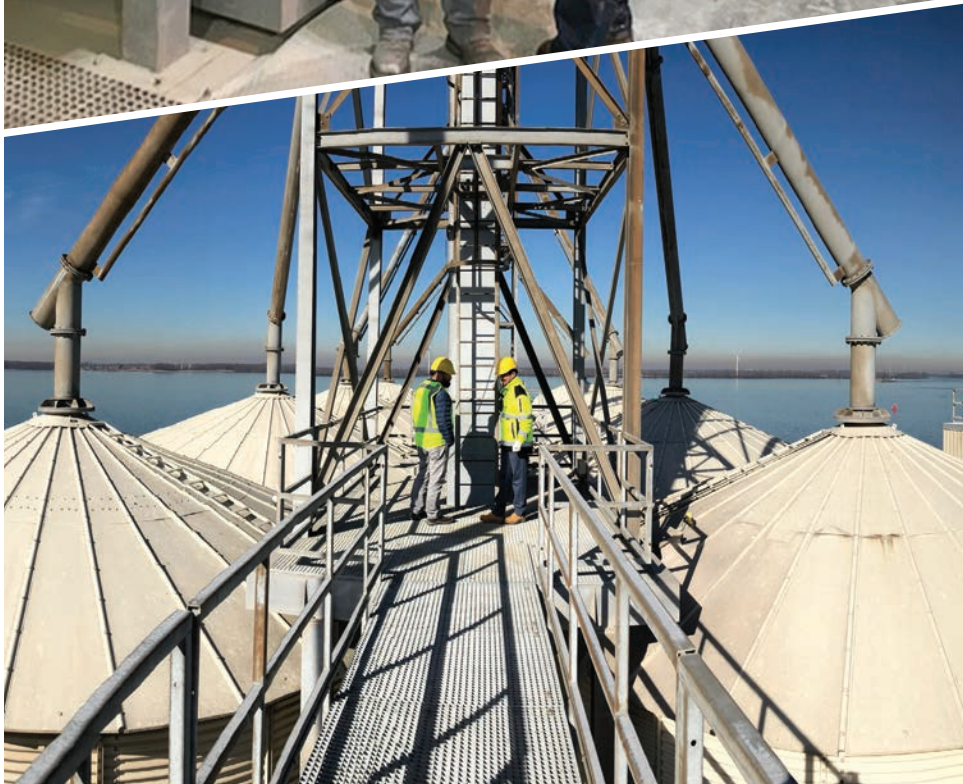
KANBAN

At MTI, Kanban has become a critical component of our OE operating model. It is used to help create better process flow by limiting work-in-progress (WIP), and limiting inventory in finished product, raw materials, and maintenance, repair and operations (MRO). Kanban principles also have application in offices and other work environments at MTI.

Kanban is based on the principles of pulling vs. pushing production. There are different design approaches for Kanban, some of which employ information technology. Kanban's base design involves cascading production and delivery instructions from downstream to upstream activities in which nothing is produced by the upstream supplier until the downstream customer signals a need.

OPERATIONAL EXCELLENCE ACHIEVEMENT AWARD

The Operational Excellence Achievement Award is presented annually to MTI organizational units that have demonstrated superior application of the principles of Operational Excellence.

While the Award process is modeled in some respects after the Malcolm Baldrige National Quality Award and the Shingo Prize, it is based on the important elements of the Operational Excellence process as practiced at MTI. As a result, the Award is not only used for recognition purposes, but it's also a valuable tool for educating applicants on the many important facets of the Operational Excellence system. Each applicant receives feedback on their submission and specifics on how they can further improve upon their current level of deployment. The level of achievement that the award recipients as well as the applicants have obtained continues to increase year after year, meeting a strict scoring threshold for a defined level of excellence. The number of applicants for the award across MTI's locations has also substantially increased, leading to a very competitive and engaging process for our teams to share their progress along the OE journey.

Business and Resource Units are invited annually to submit comprehensive applications to a cross-functional team representing various areas of the company.

The criteria contained in the application for the Award are divided into the following sections, and collectively help to gauge the level of maturity and deployment of Operational Excellence:

- Work culture
- Continuous improvement
- Quality and customer service
- Business results
- Environmental, health and safety

OPERATIONAL EXCELLENCE CATEGORY	RATING CRITERIA	
WORK CULTURE	• Employee Involvement • Recognition and Reward • Training and Education	• Cultural Transformation • Leadership and Coaching
CONTINUOUS IMPROVEMENT	• 5S • Visual Management • Overall Equipment Effectiveness (OEE) • Problem Solving • Statistical Process Control	• Standard Work • Kaizen • Total Productive Maintenance (TPM) • Hoshin Kanri
QUALITY AND CUSTOMER SERVICE	• Customer Service • Product Quality	• Supplier Management
BUSINESS RESULTS	• Inventory Performance • Productivity	• Financial Performance
ENVIRONMENTAL, HEALTH AND SAFETY	• Safety and Environmental Processes	• Safety and OE Activities

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