



**PRESENTS
LIVE WEBINAR
IN COLLABORATION WITH**



AND



ON

METAL INJECTION MOLDING

An Emerging Manufacturing Technology

WELCOME SPEECH



Mr. S Janakiraman
President – IJCCI K





METAL INJECTION MOLDING (MIM)

Presented By:
Mr. Manoj Kabre
Vice President



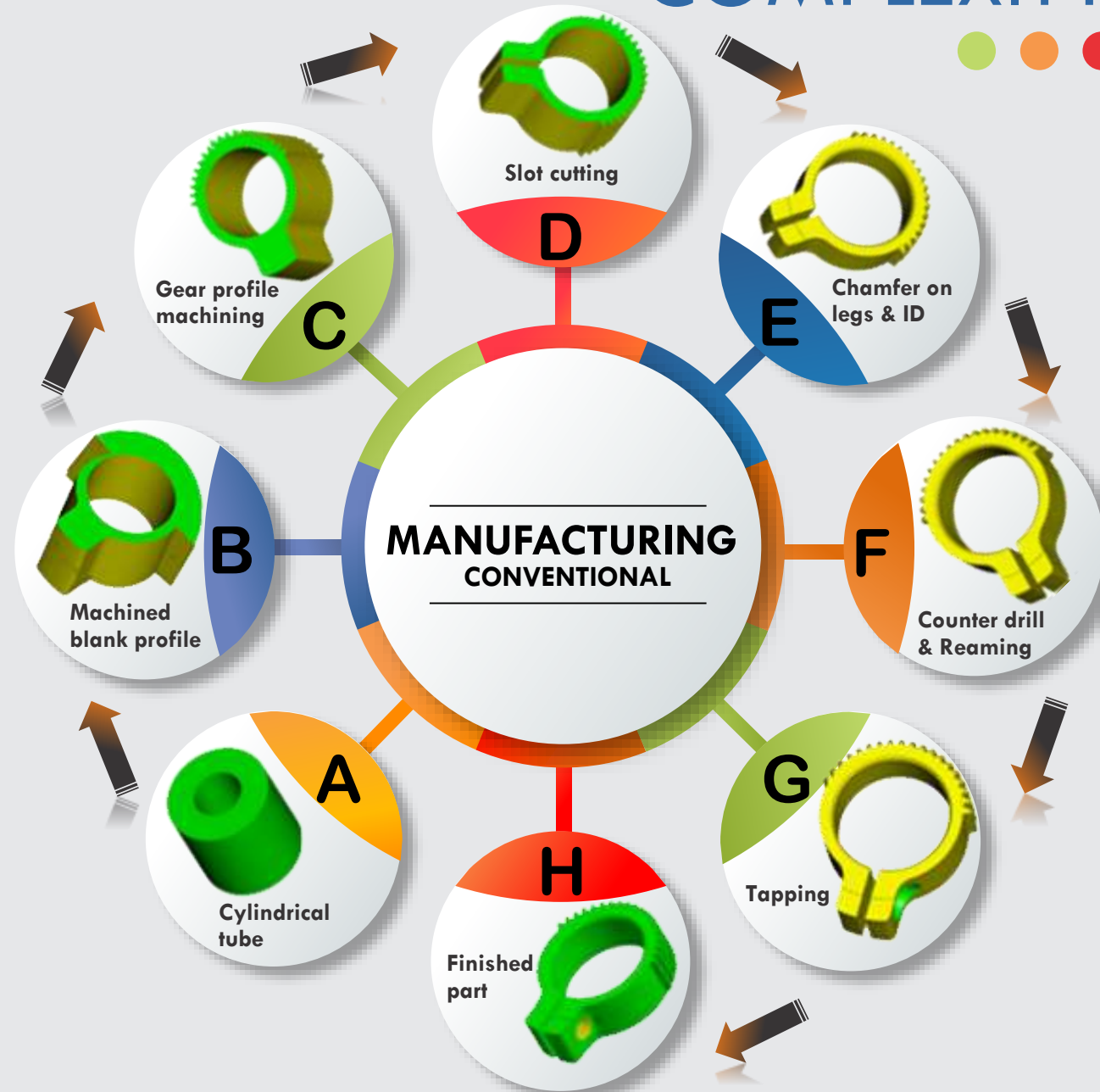
CONTENT



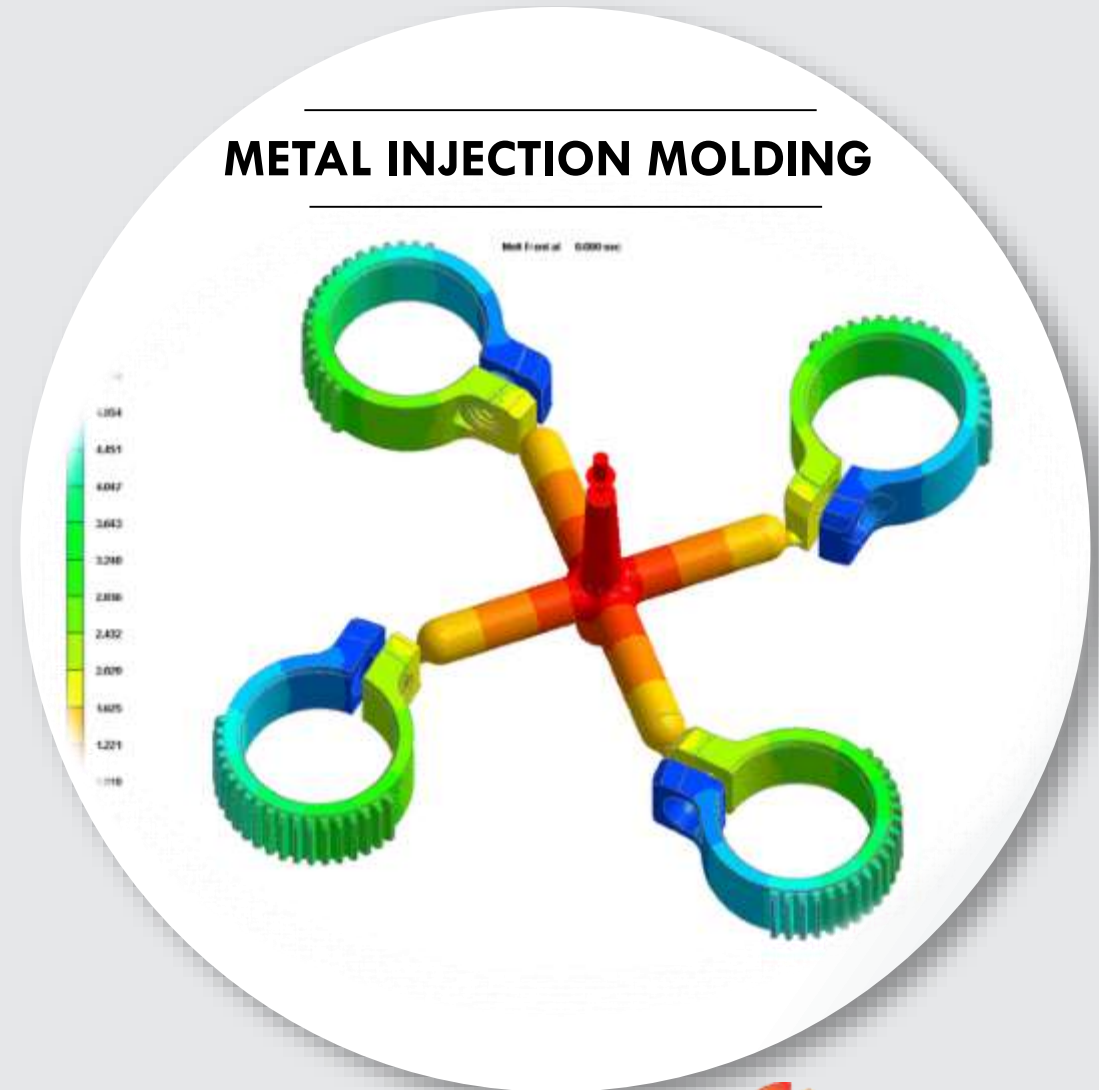
1. Metal Injection Molding (MIM) Process
2. Why MIM?
3. MIM VS Other Manufacturing Methods
4. MIM Materials
5. MIM Guidelines
6. MIM Design Tolerances
7. MIM Part Features
8. MIM Case Studies
9. About INDO-MIM



COMPLEXITY SIMPLIFIED



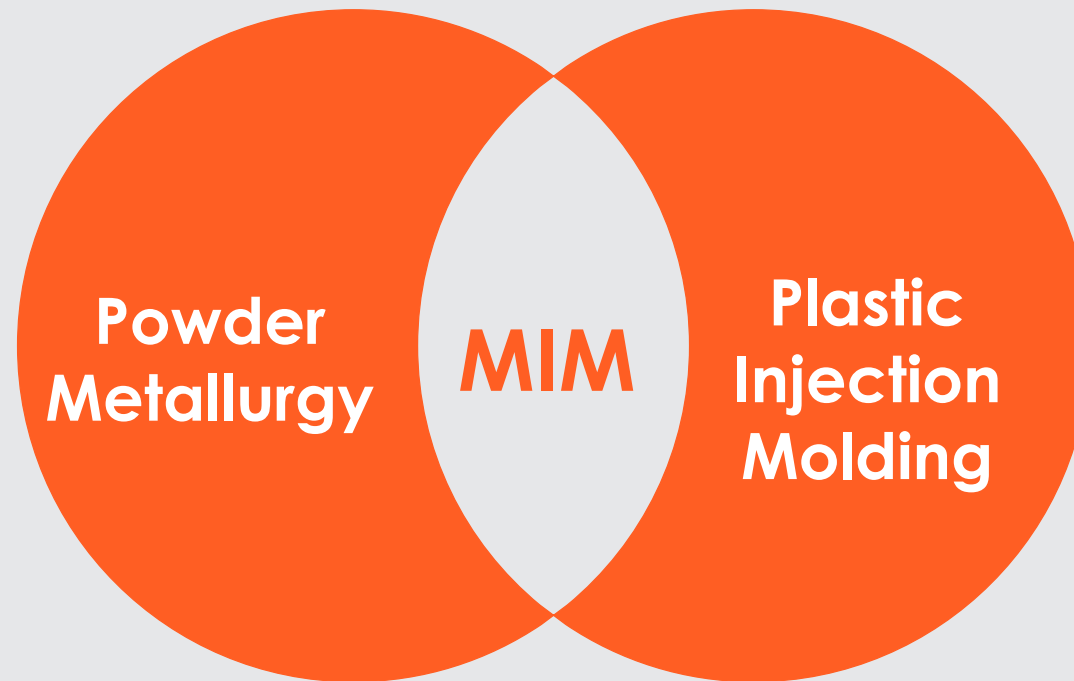
METAL INJECTION MOLDING



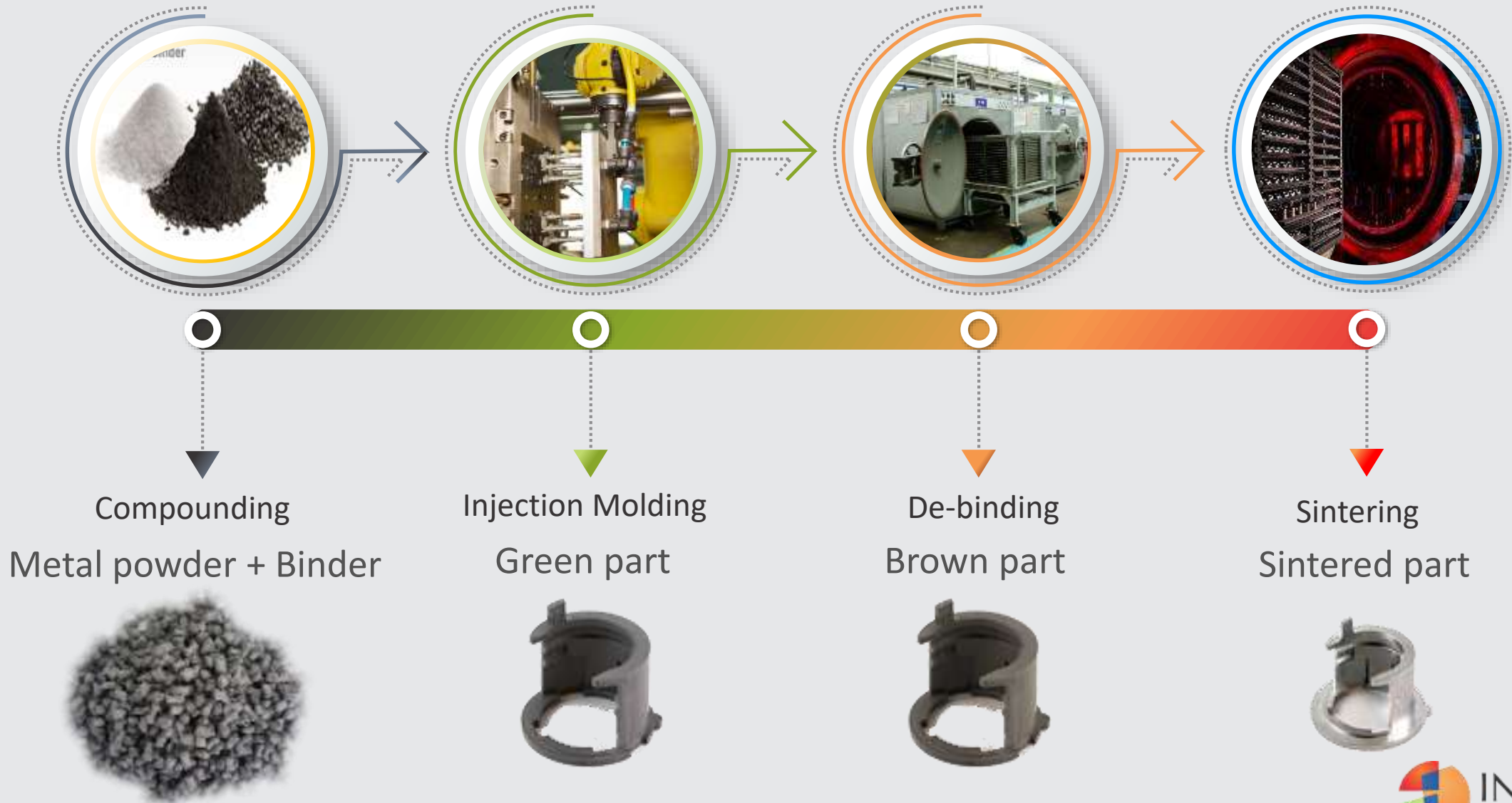
MIM PROCESS



Metal Injection Molding is a process that combines Powder Metallurgy and Plastic Injection Molding



MIM PROCESS



COMPOUNDING



“Fine metal powder less than 20 μ particle size is blended with thermoplastic and wax binders in precise amounts to form feedstock”

Feedstock is the input for molding the part

MOLDING

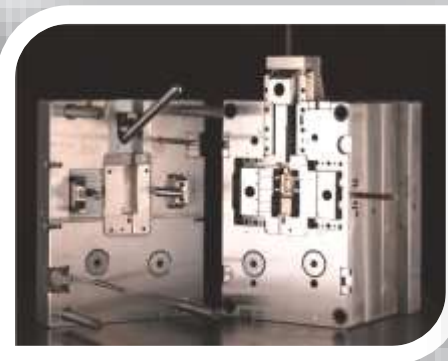


**Feedstock is injected into a metal mold
to form the net shape**

Molding Machine



Molding Tool



Green Parts



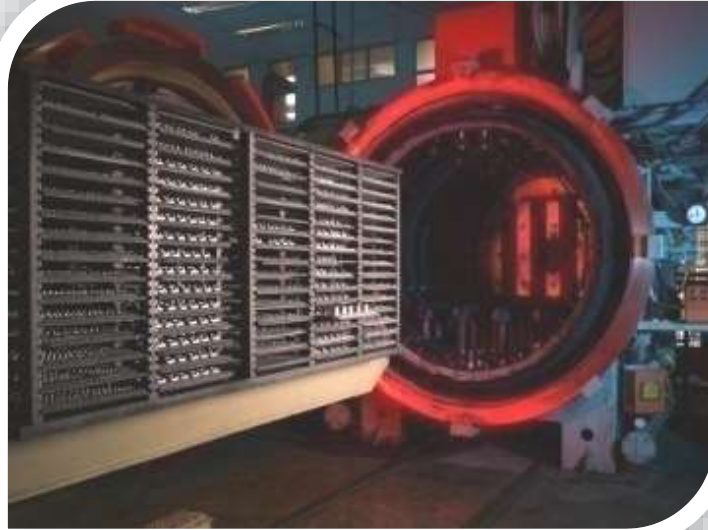
DEBINDING



**Primary binders are removed
from the molded part**



SINTERING



The parts are slowly heated in a protective atmosphere to drive out the remaining binders. Once the binders are evaporated, the part is heated to high temperature where the void space between the particles is eliminated as the particles fuse together.

FROM POWDER TO NET SHAPE



Challenge is in predicting the shrinkage to achieve final dimensions accurately first time right

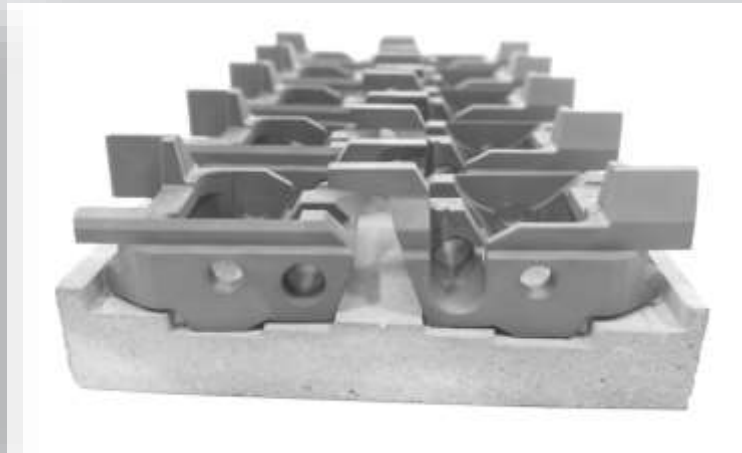
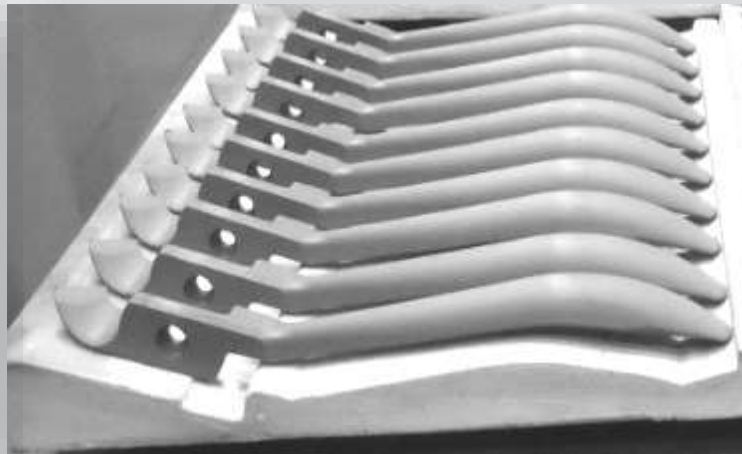
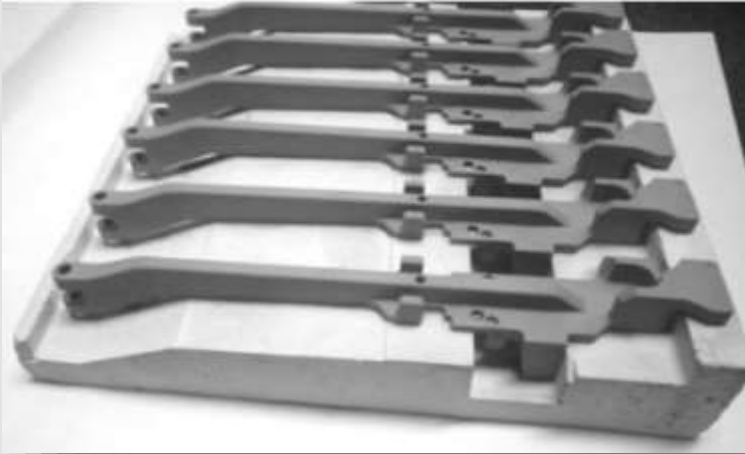
MANAGEMENT

TECHNICAL



INDO-MIM
CORPORATE SERVICES

CERAMIC STAGERS



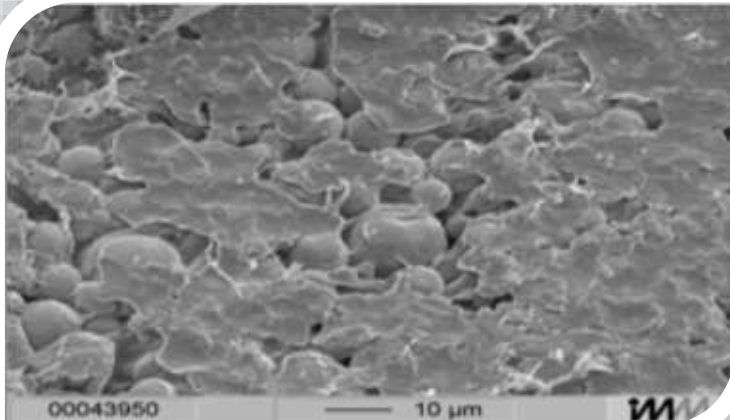
IN-HOUSE CERAMIC SETTERS

Customized staging setters
are designed and
manufactured for better
dimensional control and
capability leading to lower
post-MIM secondary
operations

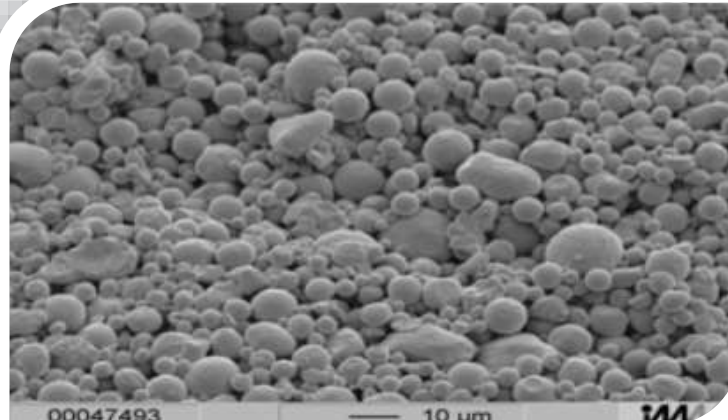
MICROGRAPHS



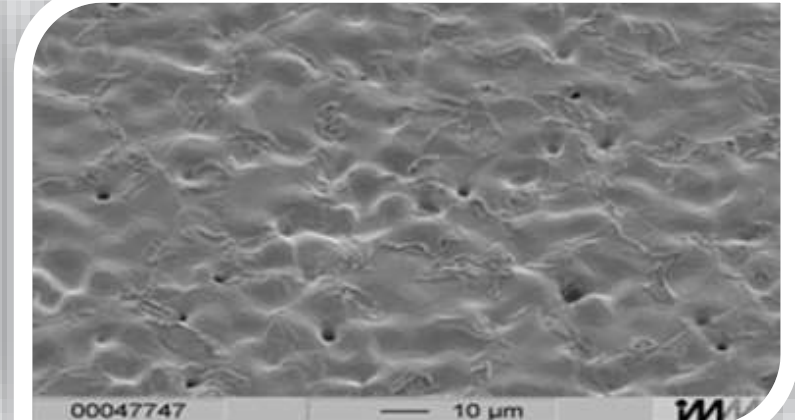
Scanned Electron Micrographs of MIM parts at various manufacturing stages



Green Part



Brown part

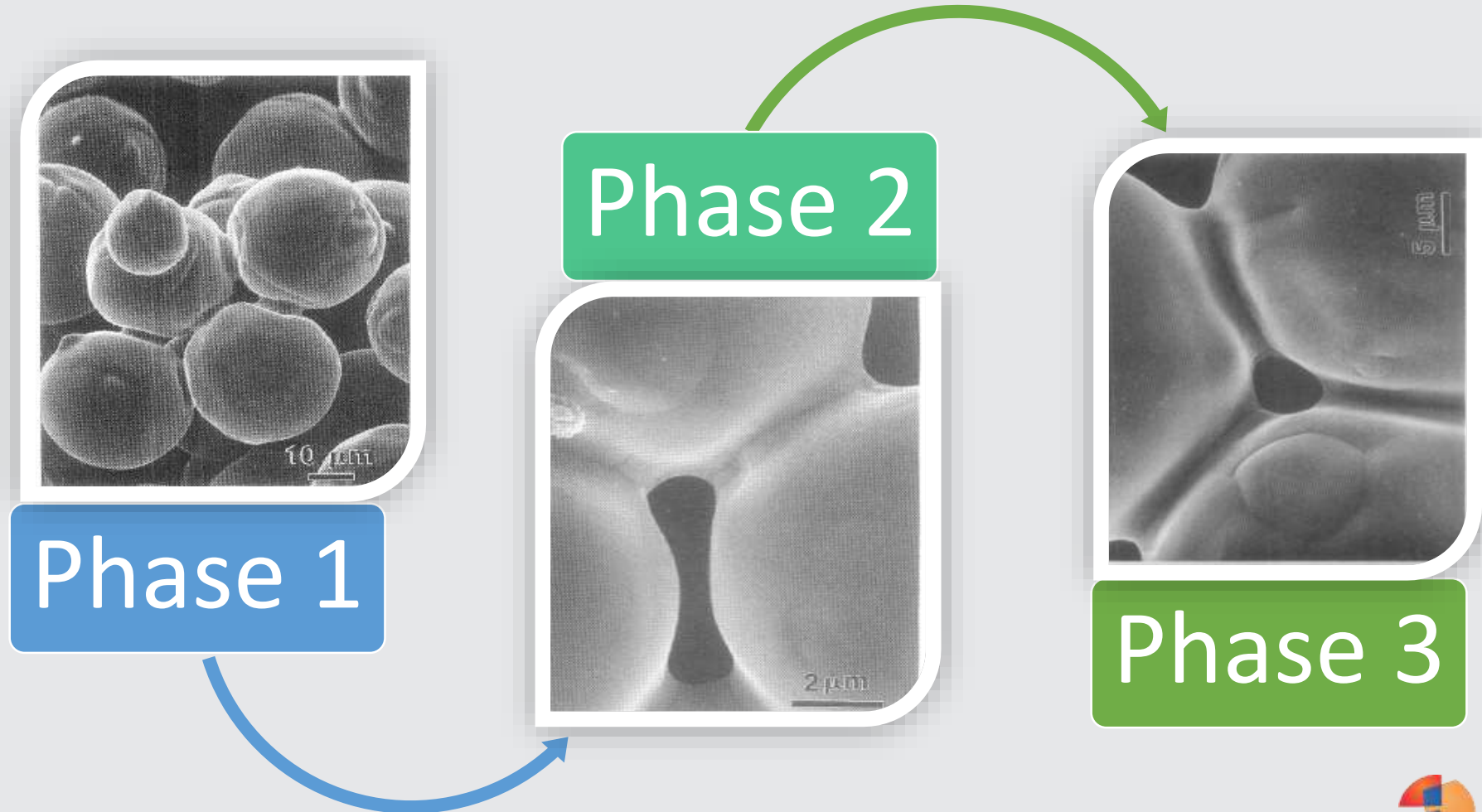


Sintered part

WHAT HAPPENS DURING SINTERING?



Scanned Electron Micrographs of MIM parts at various manufacturing stages



SIMILARITY BETWEEN MIM AND POT MAKING



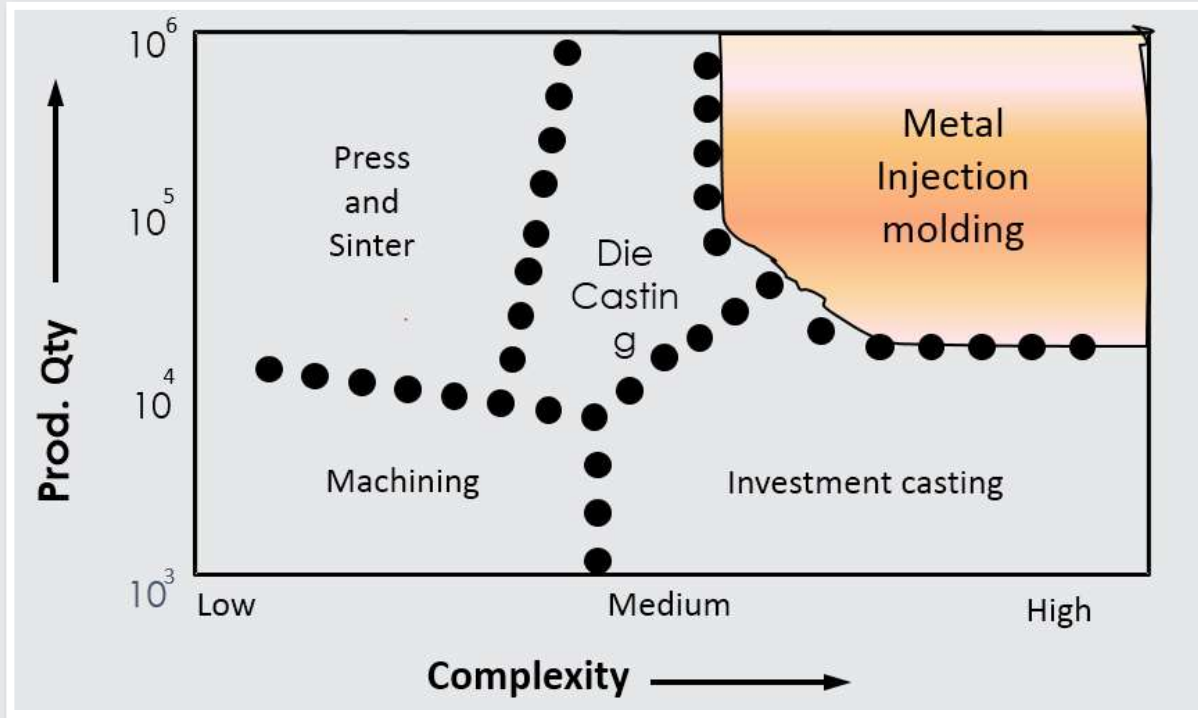
<u>The MIM Process</u>	<u>Pot Making</u>
Compounding / Mixing (metal powder & polymer)	Mixing (clay & water)
Injection Molding	Shaping
De-Binding	Drying
Sintering	Firing
Finishing	Finishing



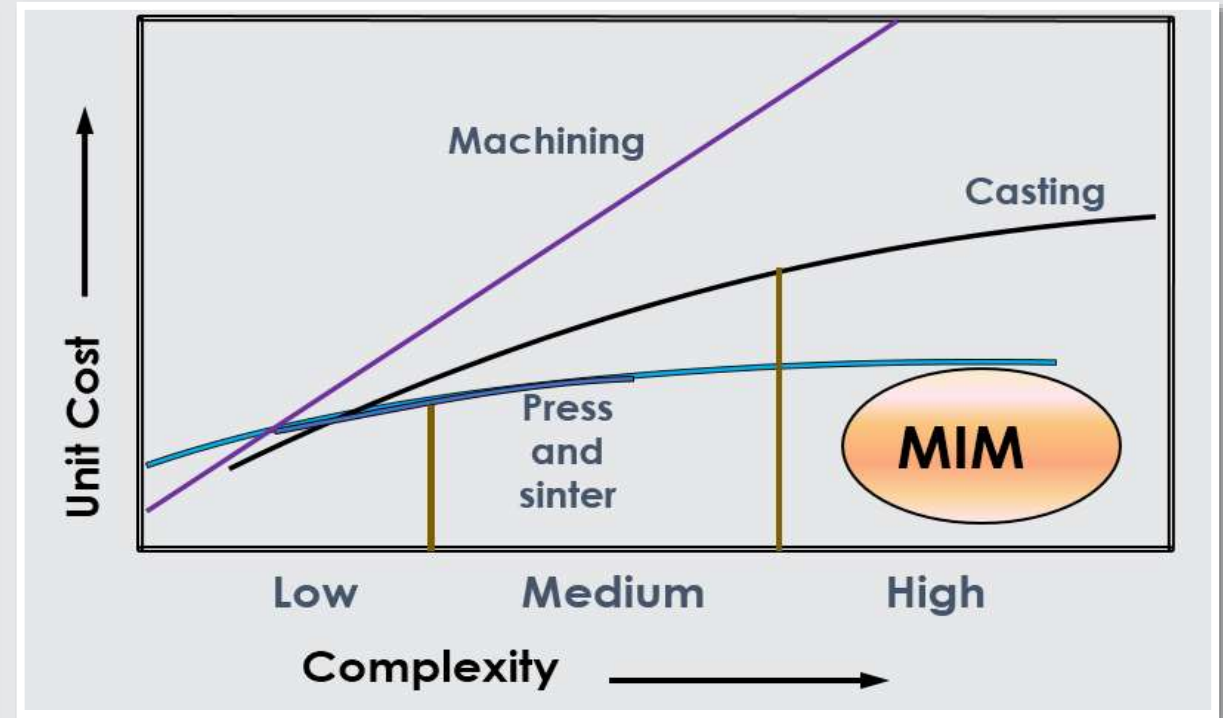
WHY MIM?



MIM VS OTHER MANUFACTURING METHODS



Productivity



Cost

COMPETING MANUFACTURING METHODS



MIM OVERCOMES



Property limitations inherent to Plastics



The shape limitations of traditional Powder Compaction (Powder Metallurgy)



The cost of Machining

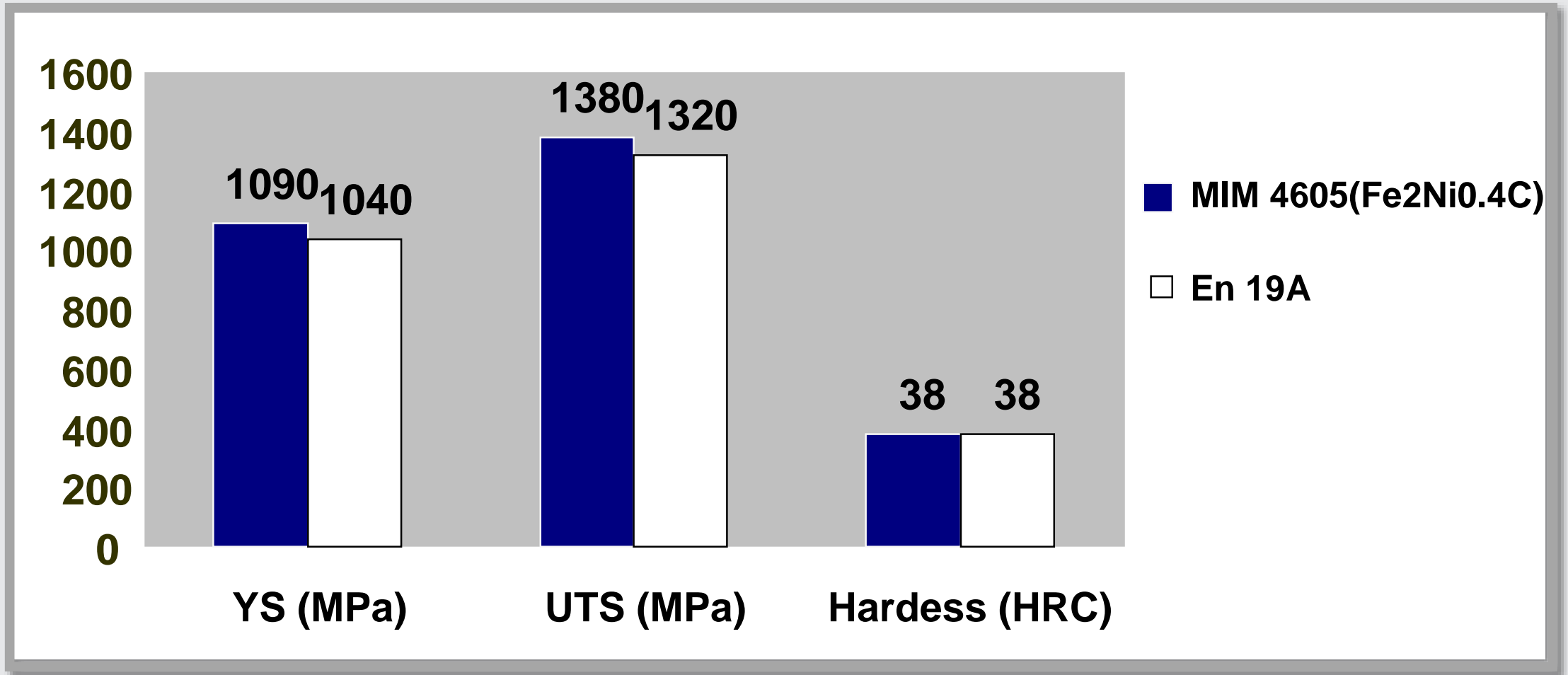


The productivity limits of Isostatic Pressing



The defect & tolerance limitations of Casting

MATERIAL STRENGTH SIMILAR TO WROUGHT MATERIAL



MATERIALS



ADVANCED MATERIALS

85+ MATERIALS DEVELOPED

TOOL STEEL

Power tools, Anti drill lock products, transmission system parts, sporting goods, Firearm parts



TITANIUM & COBALT CHROME

Medical, Electronics, Watch & Implants
Implants, Wearable devices



CERAMICS

High wear & temperature
Multiple applications



SUPER ALLOYS

Turbochargers, Fuel injection
Systems, aerospace



SOFT MAGNETIC STEEL

3C, Printers, Electrical, Automotive



STAINLESS STEEL

Medical Devices, Locks, Industrial,
Automotive, 3C etc.



CARBON STEEL

Automotive and Industrial
Bearing and High compression load



MIM GUIDELINES



- **“Plastics mold design” principles apply**
- **Corner radii of greater than 0.3 mm**
- **Up to 2° draft on walls longer than 10 mm**
- **Minimum hole diameter 0.50 mm**
- **Minimum wall thickness 0.50 mm**
- **Maximum 5 mm (coring recommended beyond 5 mm)**
- **Gradual section thickness transitions**
- **Uniform wall thickness recommended as far as possible**
- **Stiffening ribs/coring normally adopted**



MIM DESIGN TOLERANCES



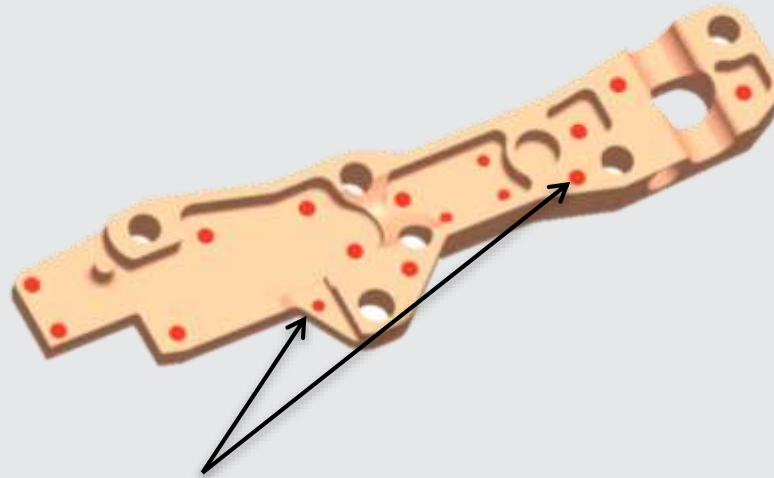
Feature	Typical	Best
Angle °	+/- 1	+/- 0.5
Density %	+/- 1	+/-0.5
Weight %	+/-0.5	+/-0.25
Dimension %	+/-0.5	+/-0.3
Flatness mm	0.3	0.15
Surface Finish	1~2 Ra	1.3 Ra

General Thumb Rule:

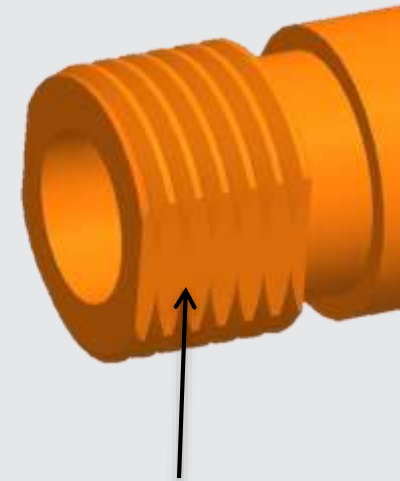
On a 10 mm dimension, a tolerance of +/-0.05 mm is possible

On a 20 mm dimension, a tolerance of +/-0.1 mm is possible

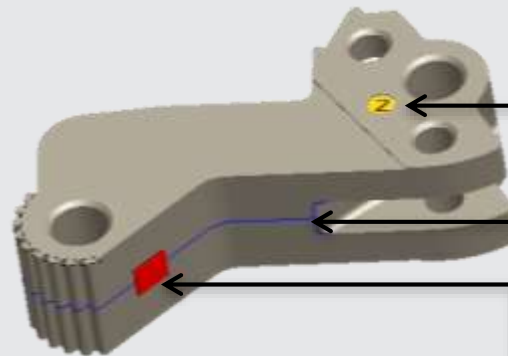
MIM PART FEATURES



Ejector pin marks



Flat land on external thread



Cavity ID

Parting Line

Gate mark

DESIGN ADVANTAGES



THREADS



CALLIGRAPHY



ANGULAR HOLES

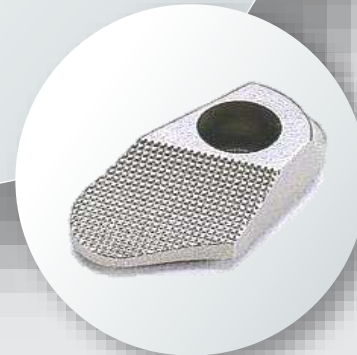


MIM

**COMPLICATED
PROFILES**



KNURLING



WHAT IS AN IDEAL MIM PART



Length limit < 200mm
Ideal < 60mm

Wall thickness 0.5mm to 5mm
If >5mm, coring is essential

Annual Requirement
from 50,000 to 50M is
possible

Tolerances as per ISO 2768
(M) and thumb rule of $\pm 0.5\%$
of nominal dimension

Weight limit <200gms
Ideal 0.1 to 50gms

All the high melting point alloys
are possible.
(Materials like Brass, Aluminum,
Magnesium is not MIM feasible)

MIM

MIM FITS EVERYWHERE



Power tools



Computer hardware



Aerospace



Sanitary



Electronic connector



Medical



Automotive



Locks



Mobile phones

PRODUCT PORTFOLIO



AUTOMOTIVE

Turbo charger Vanes, Sensor housings, auto door locks, Seat belt parts, fuel injector, shock absorber components etc.



CONSUMER

Fashion accessory, Hand/Power Tools, Lock parts, faucet components, crossbow parts, cellphone components etc.



DEFENSE

Handgun, Rifle, Shotgun parts, Parts for firearm accessories, silencer components etc.



AERO & MEDICAL

Parts for Endoscopic, laparoscopic, dental, robotic and orthopedic surgical devices. Aircraft seat and instrumentation components etc.

ROAD MAP-AUTOMOTIVE



VANES



GEAR SEGMENT



PAWL

**AUTOMOTIVE
PARTS**



ROCKET ARM



CONNECTORS



HOUSINGS



Sensors



Mechatronics



Powertrain



Braking and
Hydraulics



Emission
Control

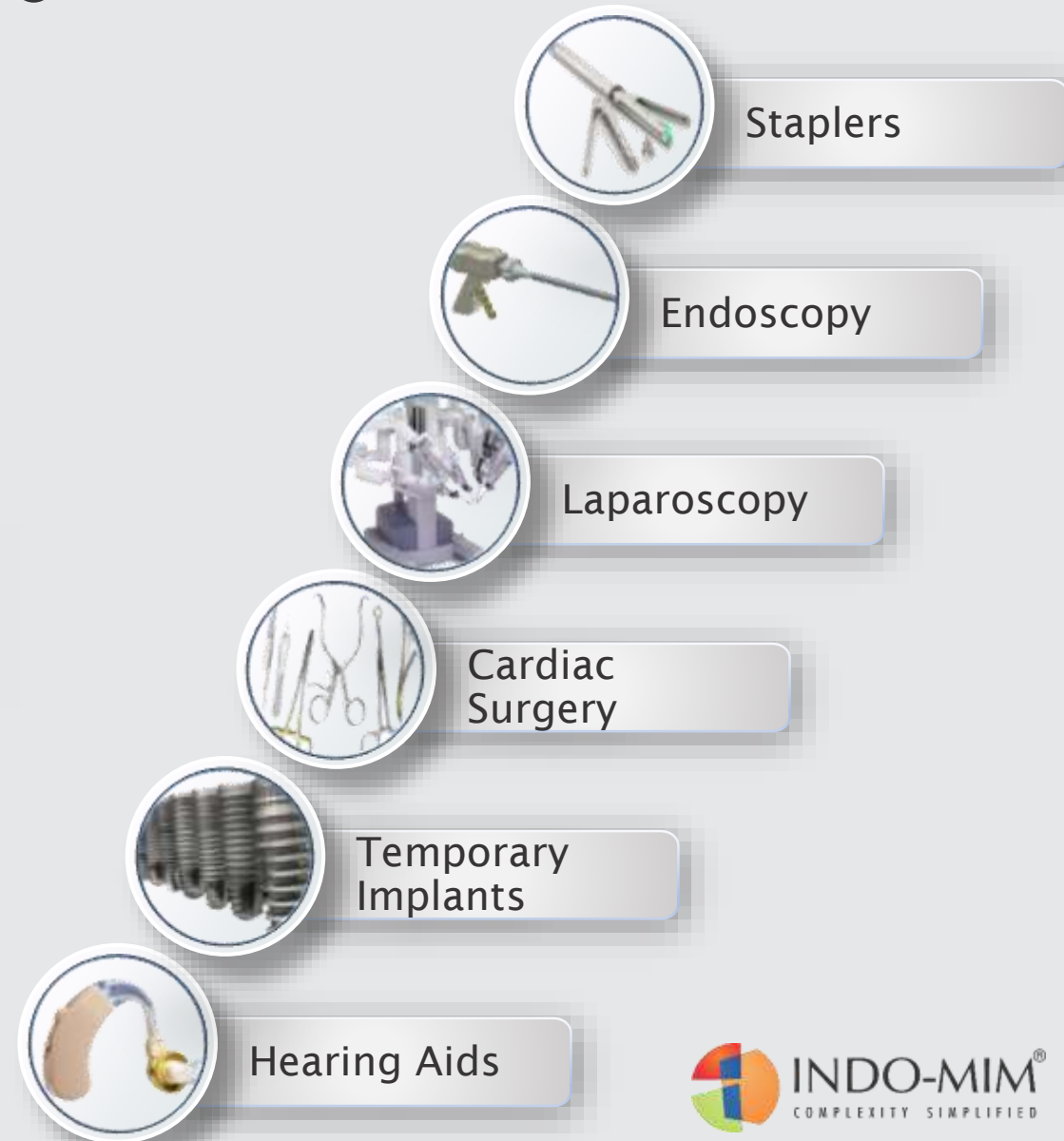


Turbochargers

ROADMAP - CONSUMER



ROAD MAP-MEDICAL



CASE STUDIES



CASE STUDY – PISTON COOLING NOZZLE



APPLICATION – PISTON COOLING NOZZLE



- Net shape of hole directly formed in MIM even for 0.8 to 1 mm dia.
- No presence of burr.

SOLUTION

PRODUCT DESCRIPTION

- Material :- MIM 4605 (Medium Carbon Steel) with Heat treatment
 - Weight :- 5gm
 - Segment :- Automotive
 - Annual Required :- 120K
-
- Inconsistency in machined hole dimension & position.
 - Additional problem of burr removal.



CUSTOMER PAIN POINTS

CASE STUDY – GEAR ASSEMBLY



APPLICATION – GEARS FOR SUV DOOR



- Component molded as a single assembly eliminating the joining operation and improving strength.

SOLUTION

PRODUCT DESCRIPTION

- Material :- MIM4605(Medium carbon steel)
- Weight :- 14gm
- Segment :- Automotive
- Annual Requirement :- 240K



- Gear and pin machined separately and welded to make a single component.
- Welding area prone to fracture due to Torque

CUSTOMER PAIN POINTS

CASE STUDY – BELAY DEVICE



APPLICATION – ROCK CLIMBING



- Near-net shape achieved in the tool itself with all the complex profile features, eliminating all the secondary machining operations.

SOLUTION

PRODUCT DESCRIPTION

- Material :- MIM 17-4PH
- Weight :- 15gm
- Segment :- Consumer
- Annual Required :- 30K



**MPIF AWARD
WINNER – 2018**

- Complex profile with features like curved profile , undercut and inclined geometry is difficult for conventional machining.

CUSTOMER PAIN POINTS

CASE STUDY – TRIMMER & CLIPPER BLADE



APPLICATION – TRIMMER & CLIPPER



- Near-net shape achieved in the tool itself
- Lesser part price
- Material properties enhanced with modified material

SOLUTION

PRODUCT DESCRIPTION

- Material :- MIM SS420
- Weight :- 14gm
- Segment :- Consumer
- Annual Required :- 150K



- Critical teeth profile
- Higher lead time
- Corrosion and hardness

CUSTOMER PAIN POINTS

CASE STUDY – VESSEL SEALING



APPLICATION - VESSEL SEALING DURING ENDOSCOPIC SURGERY



- Part consistency is an inherent capability of MIM, resulting in best fit parts.
- High volume easily achievable.

SOLUTION

PRODUCT DESCRIPTION

- Material: MIM 17-4PH (SS)
- Weight: 0.3gm
- Segment: Medical
- Annual Requirement: 200K



- Improper alignment of matching jaws during assembly due to inconsistency in the machining process.
- Challenging to meet high volume conventional process.

CUSTOMER PAIN POINTS

CASE STUDY – SOUND TUBE



APPLICATION - WIRELESS HEARING AIDS



- Tooling mechanism designed to form curved hole in mold
- All dimensions achieved without machining

SOLUTION

PRODUCT DESCRIPTION

- Material: MIM 17-4PH
- Weight: 3.5gm
- Segment: Medical
- Annual Requirement: 100K



- Existing plastic part not ideal for sound transfer
- Manufacturing limitations to achieve design in metal

CUSTOMER PAIN POINTS

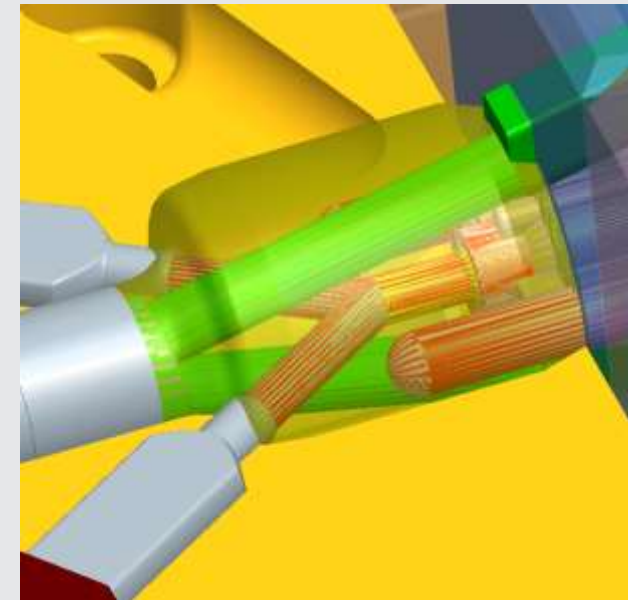
ENGINEERING MILESTONES



Challenge	INDO-MIM solution
Y junction hole cross section	Tool made with 6 slides for all the cross holes

Market Segment

Automotive



Pictorial image of Tool Design

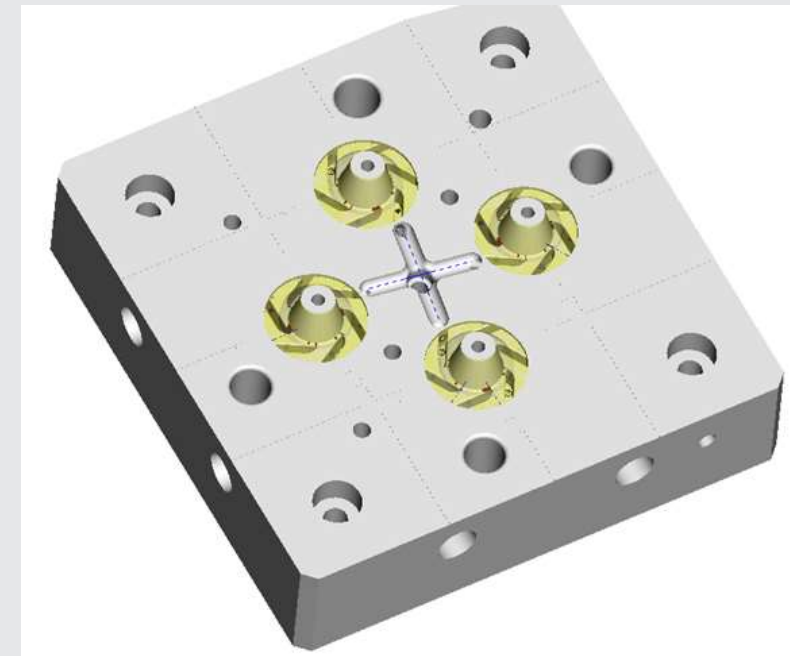
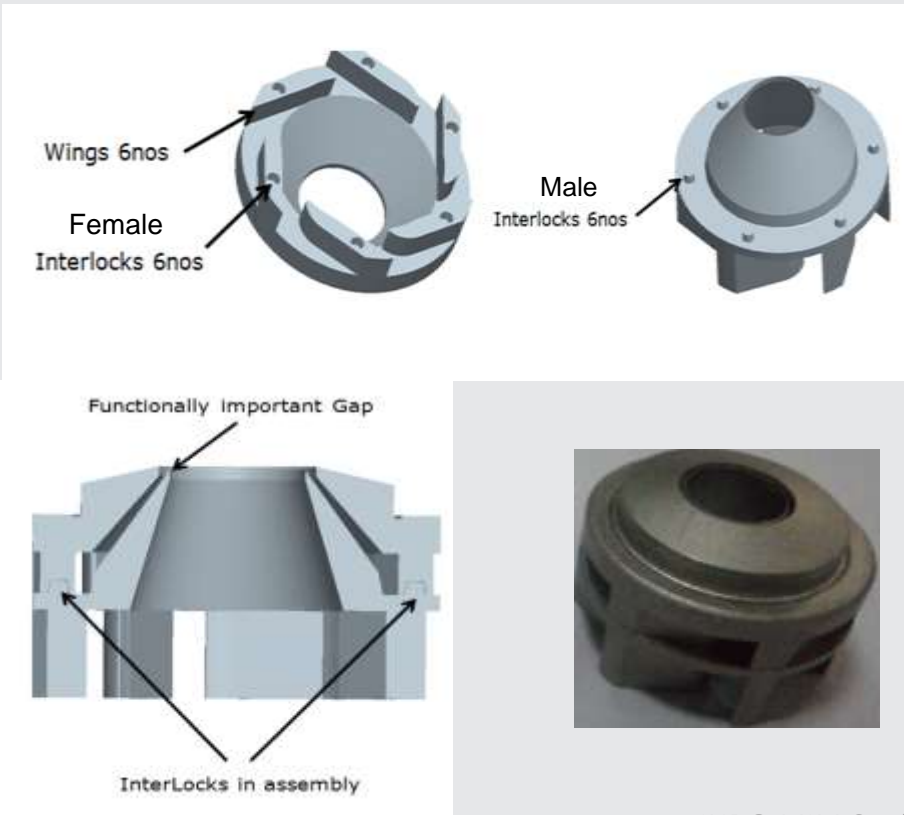
ENGINEERING MILESTONES



Challenge	INDO-MIM solution
Integration of parts after sintering	Both the parts were molded separately and integrated together before sintering

Market Segment

Automotive



Pictorial image of Tool Design

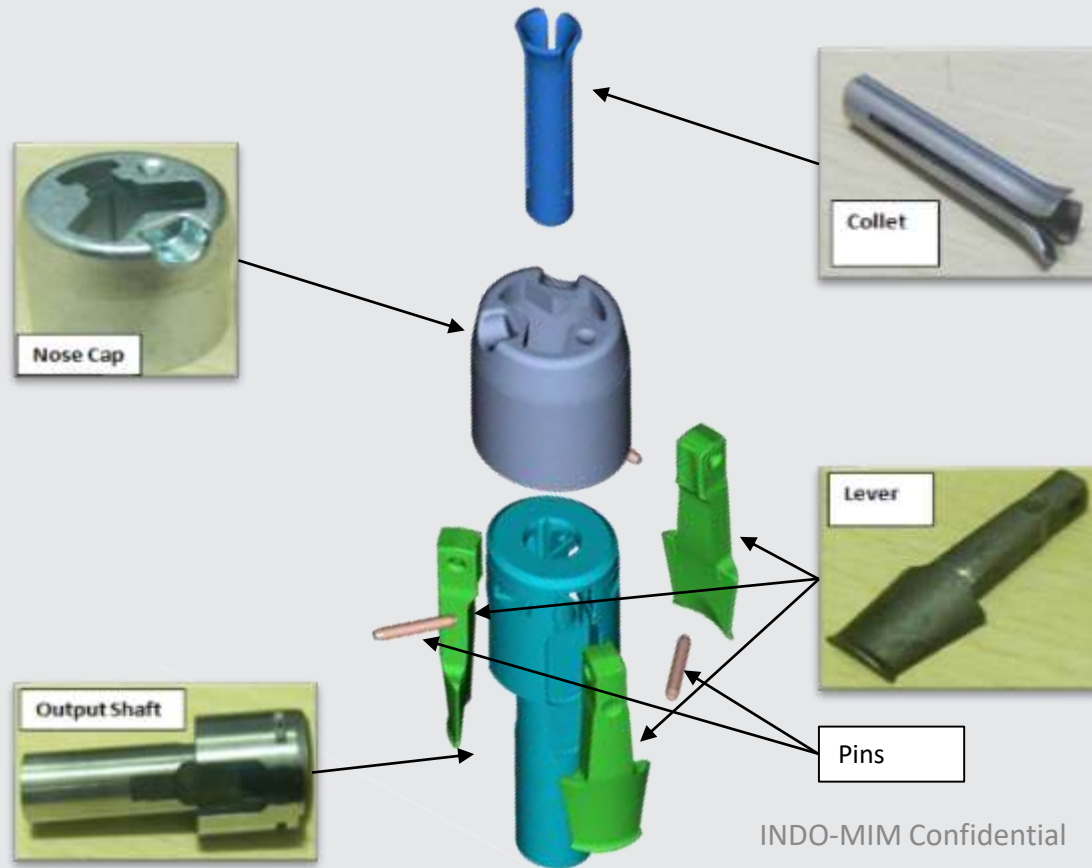
ENGINEERING MILESTONES



Challenge	INDO-MIM solution
Complex shape, Assembly	All the 5 parts are manufactured in-house and assembled

Market Segment

Consumer



INDO-MIM Confidential

ABOUT US



World's Largest MIM Company

85+

Material
Options

24

MPIF
Awards

6000+

MIM Parts
Variety

650+

Customers
Globally



Ship To

Five Continents



150M+

Parts Shipped
Annually



3000+

Employees

MANUFACTURING FOOTPRINT



Over 890,000 sq. ft. of manufacturing in multiple locations in 2 countries



MIM MANUFACTURING FACILITY: BENGALURU

- 650,000 sq. ft. area
- MIM, Aerospace Machining & Powder Plant
- 700 million parts capacity
- 2500 employees



INVESTMENT CASTING FACILITY: TIRUPATI

- 100,000 sq. ft. area
- Investment Casting, Machining
- 300 employees



MIM MANUFACTURING FACILITY: USA

- 140,000 sq. ft. area
- 90 million parts capacity
- 150 employees
- Expandable up to 365k sq. ft.

SMALL TO MEDIUM COMPLEX METAL PARTS? THAT'S US !



MIM

**METAL INJECTION
MOLDING**

Largest installed
capacity



CIM

**CERAMIC INJECTION
MOLDING**

ISO 9001 and
ISO 14001 Certified



IC

**INVESTMENT
CASTING**

Best in Class State of
art Facility



PMG

**PRECISION
MACHINING**

Aerospace, Oil & Gas,
Medical Parts



**SURFACE
TREATMENT**

**SPECIAL
PROCESSES**

AS9100 & NADCAP
Approved



MBJ

**METAL BINDER JET
3D PRINTING**

New Addition to
INDO-MIM



GLOBAL PRESENCE



CERTIFICATIONS



							
AS 9100:2016	IATF 16949:2016	ISO 13485:2016	ISO 14001:2015	ISO 9001:2015	ISO CLASS 8	OHSAS 18001:2007	GC-MARK
AEROSPACE	AUTOMOBILE	MEDICAL	ENVIRONMENT	QMS	CLEAN ROOM	HEALTH & SAFETY	ENERGY EFFICIENT

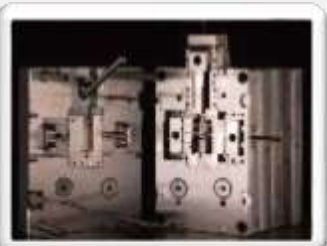
UNIQUE DIFFERENTIATORS



TOOL ROOM

STATE-OF-THE-ART FACILITY

- Largest MIM tooling capacity in the world
- 30% capacity allocated for DCNs/ECNs & maintenance



QUALITY

MISSION ZERO PPM

- In-process POKE-YOKE
- Process parameters mapped to part output & defect probability
- Companywide SPC



MATERIALS

85+ MIM MATERIAL OPTIONS

- Constant R&D effort to develop new varieties
- Custom material offering
- Proto-Tooling solutions



CAPACITY

LARGEST AVAILABLE MIM CAPACITY

- Stock-to-order model for high volume parts
- Fastest program ramp up capability in the industry



LEAD TIME

FLEXIBLE LEAD TIME

- 4 to 6 weeks from PO release
- FA samples typically submitted in 8 to 10 weeks in most cases



INDUSTRY 4.0 AT INDO-MIM



Smart & Connected Manufacturing

BEST SUPPLIER AWARDS



SHIMANO

 **Tyco Electronics**



brose



BOSCH

**ROYAL
ENFIELD**

Danfoss

Paslode

MPIF – 2019 GRAND PRIZE WINNER



“INDO-MIM won 5 Grand Prize Awards and
1 Award of Distinction in 2019 at MPIF
Conference held at Phoenix, Arizona, US”

CORPORATE SOCIAL RESPONSIBILITY



INDO-MIM group companies proudly support a variety of charitable organizations that share our vision of making a positive contribution to the society



Mid Day Meal Scheme

Through the local schools, INDO-MIM feeds over 2,500 students in the mid day meal scheme.



The Chivukula Wing

The Chivukula wing was built at the Bangalore Baptist Hospital Through Support from Mr. Chivukula. Annual contributions to support treatment needs for the disadvantaged have been provided.



Asha Foundation

INDO-MIM continues to support the Asha foundation in the fight against HIV/AIDS in India.



Deenabandhu & Vishranthi Trust

INDO-MIM extends its support towards rural education through the Deenabandu Trust. It also supports the welfare of the old and the orphans through the Vishranthi Trust.

COMPLEXITY IS SIMPLIFIED



The word “simplicity” exists because of “complexity”

So, don't think that your design is complex. We are here to make it simple



MORE THAN 3000 HEARTS – ONE TARGET

THANK YOU

ANY QUERIES?

Creating Value :

In-depth technical competence

International presence

Application and Industry Expertise

Long-term Relationships

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