NOT ALL CNC MACHINES SOLVE THE SAME PROBLEM.

A PRACTICAL MAP OF CNC MACHINE TYPES



MACHINE ARCHITECTURE FOLLOWS PROCESS LOGIC.

SWIPE. START WITH THE PROCESS.

START WITH THE PROCESS. NOT THE MACHINE.

GEOMETRY / MATERIAL / TOLERANCE / SIZE / VOLUME



THE PART DOESN'T CARE HOW IMPRESSIVE THE MACHINE LOOKS.

It needs accuracy, repeatability and an economic process.

01 — MILLING

SAME CUTTING PROCESS. VERY DIFFERENT ARCHITECTURES.

5-AXIS
3 linear + 2 rotary axes.
Indexed or simultaneous.

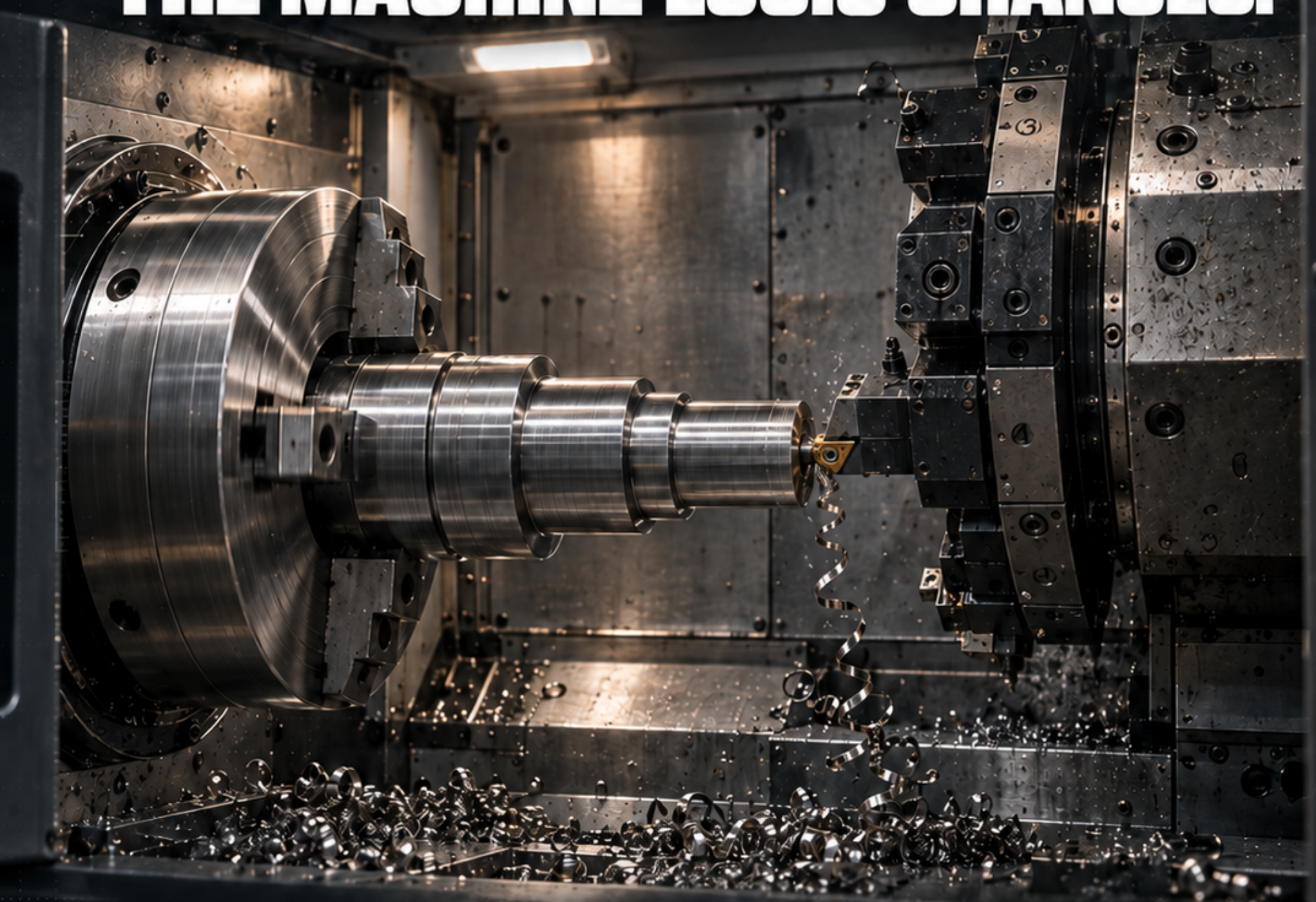
VMC
Vertical spindle.
General-purpose milling.

HMC
Horizontal spindle.
Multi-face machining.
Strong chip evacuation.

GANTRY / DOUBLE-COLUMN
Bridge architecture.
Large envelope. Rigidity.

ONE PROCESS FAMILY. DIFFERENT WAYS TO REACH THE PART.

02 — TURNING
WHEN THE PART ROTATES, THE MACHINE LOGIC CHANGES.



TURNING CENTRE
Rotating workpiece.
Shafts. Bushes. Flanges.

MILL-TURN
Turning + milling.
Fewer re-clampings.

SWISS-TYPE
Sliding headstock.
Small, slender parts.
Guide-bush and non-guide-bush versions.

WHAT MUST ROTATE — AND WHY?

03 — HOLEMAKING

SOMETIMES THE BEST MACHINE DOES LESS — FASTER.

DRILL. TAP. REAM. REPEAT.



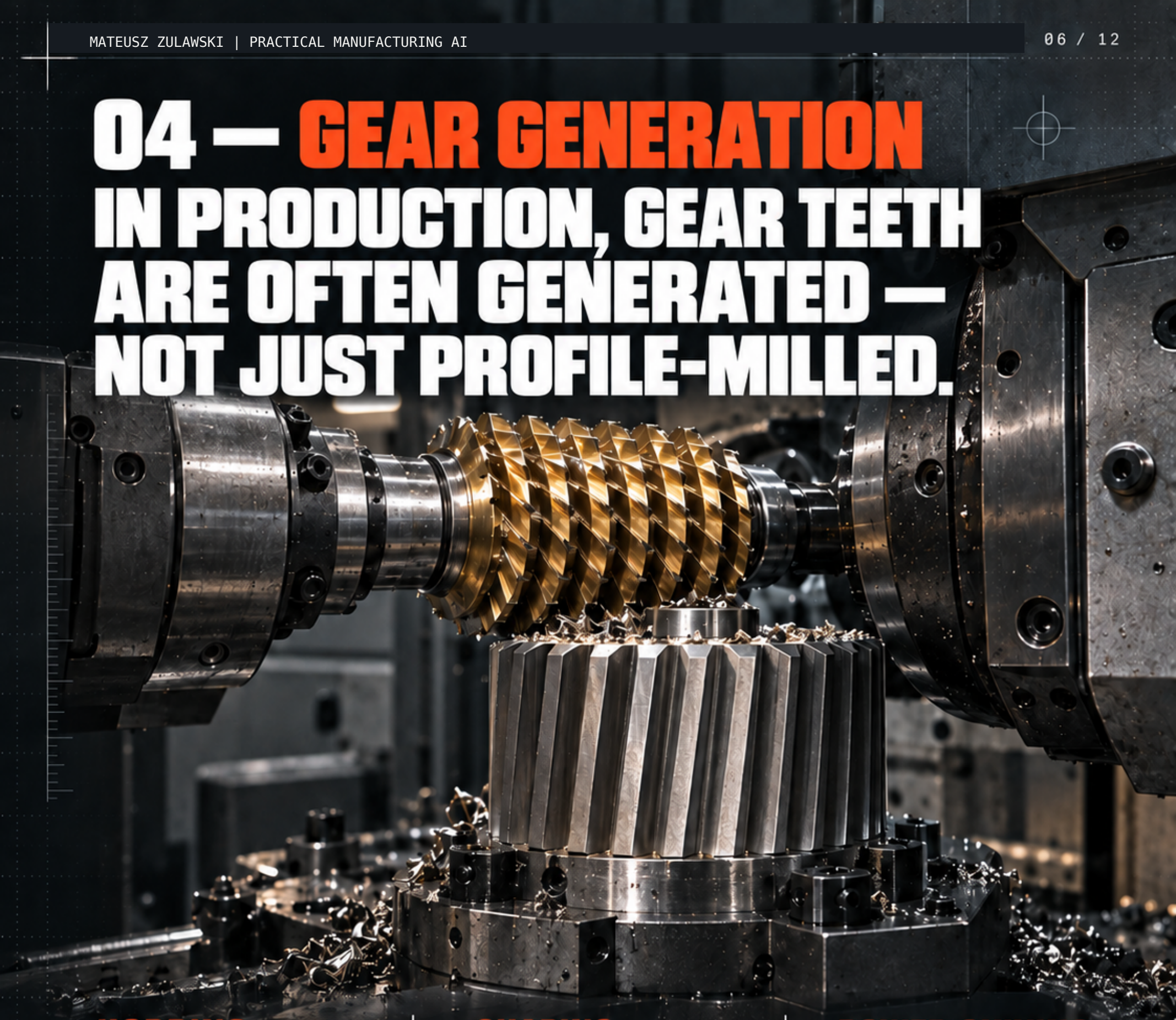
DRILLING / TAPPING CENTRE

Fast tool changes.
Fast spindle acceleration.
Short non-cutting times.

FLEXIBILITY IS NOT ALWAYS THE FASTEST ANSWER.

04 — GEAR GENERATION

IN PRODUCTION, GEAR TEETH ARE OFTEN GENERATED — NOT JUST PROFILE-MILLED.



HOBBING
Rotating hob + work.

SHAPING
Reciprocating cutter.
Timed rotation.

POWER SKIVING
Crossed-axis rotation.

TOOTH GEOMETRY COMES FROM CONTROLLED RELATIVE MOTION.

SPUR / HELICAL / SPLINES

05 — EDM
NO TOOL CONTACT.

STILL REMOVING METAL.



WIRE EDM

Moving wire electrode.
Through profiles.
Punches. Dies. Inserts.

SINKER EDM

Shaped electrode.
Blind cavities.
Moulds. Hardened tooling.

CONDUCTIVITY IS THE REQUIREMENT.
NOT MATERIAL HARDNESS.

Illustrative section view. Discharge gap not to scale.

06 — ROUTING / 07 — THERMAL CUTTING

SAME 2D PROFILE. DIFFERENT PHYSICS.



ROUTER

Mechanical cutting.
Wood. Plastics. Composites.
Aluminium panels.

LASER

Focused laser energy.
Sheet profiling.

PLASMA / OXY-FUEL

Plasma: conductive metals.
Oxy-fuel: mainly
thick carbon steel.

ALSO CONSIDER ABRASIVE WATERJET.

Erosion cutting without a heat-affected zone.

08 — ABRASIVE MACHINING

GRINDING IS MORE THAN “THE LAST FINISHING PASS.”



ABRASIVE MATERIAL REMOVAL

MILL / TURN

Create bulk geometry.

GRIND

Control geometry + surface.

Some grinding processes also remove substantial material.

WHEN MICRONS AND SURFACE INTEGRITY MATTER, THE PROCESS CHANGES AGAIN.

DON'T ASK: "WHICH CNC IS BEST?" WHAT DOES THIS PART NEED?

GEOMETRY / MATERIAL / TOLERANCE / SIZE / ACCESS / VOLUME

PRISMATIC / MULTI-FACE
VMC / HMC / 5-AXIS

LARGE PRISMATIC PARTS
GANTRY / DOUBLE-COLUMN

ROTATIONAL GEOMETRY
TURNING / MILL-TURN / SWISS

HOLE-DOMINANT PRODUCTION
DRILLING / TAPPING

GEAR TOOTH GEOMETRY
GEAR GENERATION

CONDUCTIVE COMPLEX FEATURES
WIRE EDM / SINKER EDM

LARGE PANEL / NON-METAL PROFILE
ROUTER

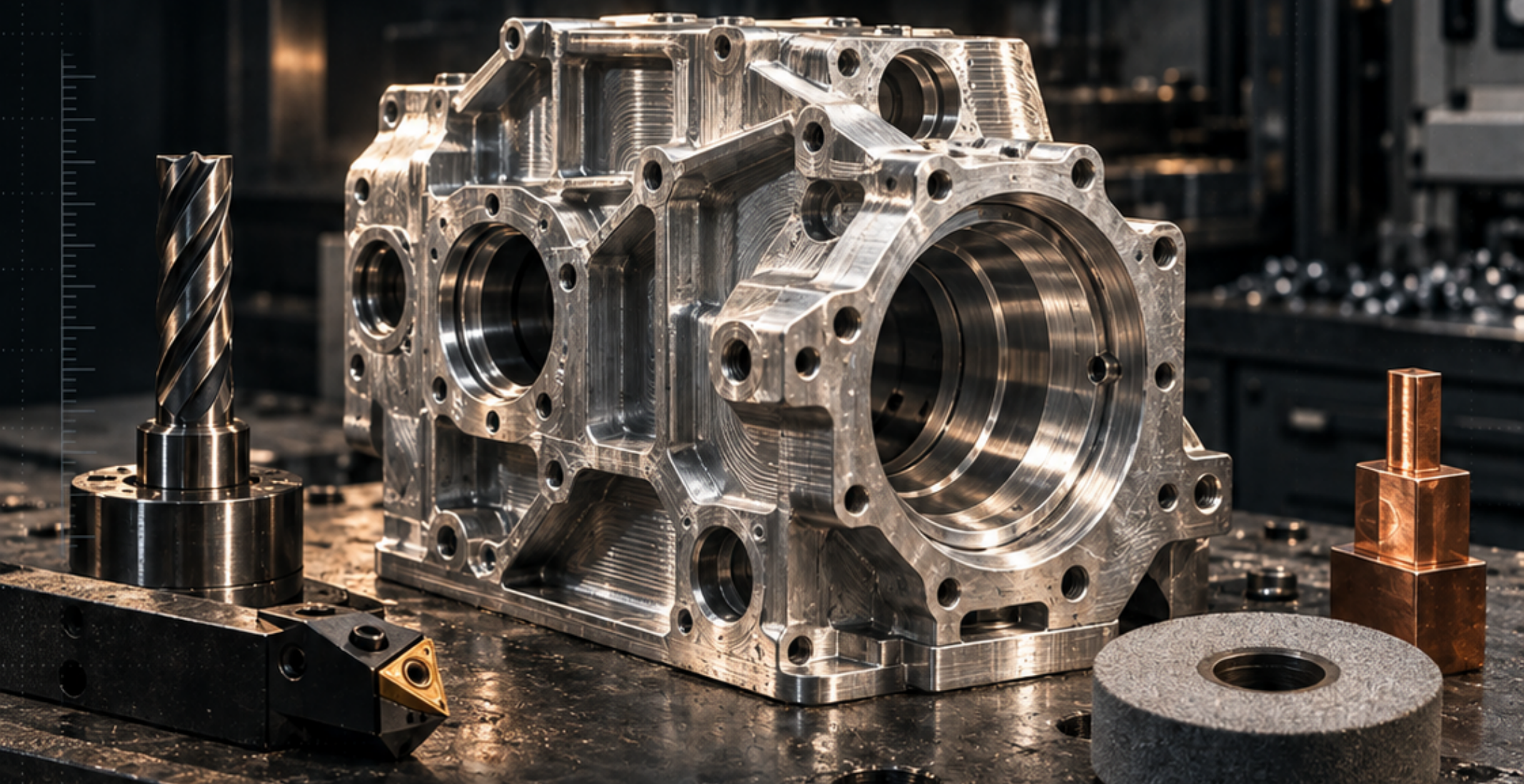
SHEET / PLATE THERMAL PROFILE
LASER / PLASMA / OXY-FUEL

FINAL GEOMETRY / SURFACE
GRINDING

A SHORTLIST, NOT A SUBSTITUTE FOR A PROCESS STUDY.

PROCESS CAPABILITY. ACCESS. WORKHOLDING. CYCLE TIME.

THE BEST MACHINE IS NOT THE ONE WITH THE MOST AXES.



PROCESS CAPABILITY > APPEARANCE
GEOMETRY DRIVES MACHINE SELECTION
PRODUCTIVITY = MACHINE + WORKFLOW
FIT THE PART — NOT THE HIGHEST AXIS COUNT.

DIFFERENT MACHINES. DIFFERENT STRENGTHS. SAME GOAL: ACCURATE PARTS.

NEXT: SAVE THE COMPLETE REFERENCE MAP.

MATERIALS
PROCESSES
MACHINES
PEOPLE
BETTER PARTS

A PRACTICAL MAP OF CNC MACHINE TYPES.

MACHINE FAMILIES. PROCESS LOGIC. REAL-WORLD APPLICATIONS.

CHOOSE THE PROCESS FIRST. THEN CHOOSE THE MACHINE.

MATEUSZ ZULAWSKI
PRACTICAL MANUFACTURING AI

PROCESS FIRST.

01 MILLING

ROTATING CUTTER • CONTROLLED MULTI-AXIS MATERIAL REMOVAL



VERTICAL MACHINING CENTRE (VMC)

VERTICAL SPINDLE
FLEXIBLE GENERAL-PURPOSE MILLING

PLATES / BLOCKS / FIXTURES
MOULD DETAILS



HORIZONTAL MACHINING CENTRE (HMC)

HORIZONTAL SPINDLE / MULTI-FACE WORK
STRONG CHIP EVACUATION

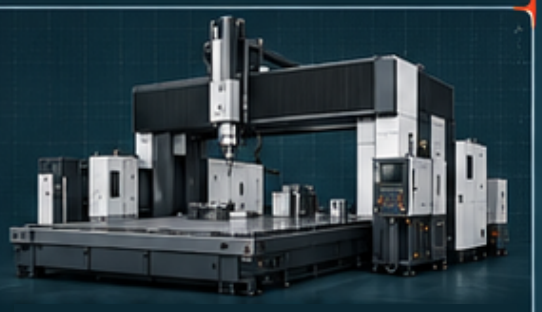
HOUSINGS / VALVE BODIES
TRANSMISSION PARTS / REPEAT PRODUCTION



5-AXIS MACHINING CENTRE

3 LINEAR + 2 ROTARY AXES
INDEXED OR SIMULTANEOUS

AEROSPACE / IMPELLERS
MEDICAL PARTS / COMPLEX SURFACES



GANTRY / DOUBLE-COLUMN

BRIDGE ARCHITECTURE / LARGE ENVELOPE
HIGH STRUCTURAL RIGIDITY

LARGE MOULDS / DIES / STRUCTURES
MACHINE BASES

02 TURNING

ROTATE THE WORKPIECE • GENERATE AXISYMMETRIC GEOMETRY



CNC TURNING CENTRE

ROTATING WORKPIECE
AXISYMMETRIC MACHINING

SHAFTS / BUSHES / SLEEVES
PINS / FLANGES



MILL-TURN CENTRE

TURNING + MILLING
MULTIPLE OPS / ONE CLAMPING

COMPLEX SHAFTS / HYDRAULICS
AEROSPACE / MULTI-OP PARTS



SWISS-TYPE CNC LATHE

SLIDING HEADSTOCK
SMALL-DIAMETER BAR WORK

MEDICAL / INSTRUMENT PARTS
LONG SLENDER COMPONENTS

03 HOLEMAKING

DRILL • TAP • REAM • REPEAT



DRILLING / TAPPING CENTRE

HIGH-SPEED AXIAL MACHINING
FAST TOOL CHANGES / SHORT CYCLES

HOLE PATTERNS / TAPPED FEATURES
LIGHT PRISMATIC PRODUCTION PARTS

04 GEAR GENERATION

GENERATE TOOTH GEOMETRY THROUGH CONTROLLED RELATIVE MOTION



CNC GEAR GENERATION

SYNCHRONISED TOOL-WORK MOTION
DEDICATED TOOTH GENERATION

SPUR / HELICAL / SPLINES
CYLINDRICAL GEAR FORMS

05 EDM

CONDUCTIVE MATERIALS • CONTROLLED ELECTRICAL DISCHARGES



CNC WIRE EDM

MOVING WIRE ELECTRODE
CONTROLLED DISCHARGES
NO TOOL CONTACT

DIES / PUNCHES / INSERTS
CONDUCTIVE PRECISION PROFILES



CNC SINKER EDM

SHAPED ELECTRODE
ELECTRICAL DISCHARGE
BLIND CAVITY MACHINING

MOULD CAVITIES / DIE DETAILS
HARDENED TOOLING

06 ROUTING

HIGH-SPEED MECHANICAL PROFILING • LARGE FLAT WORK AREA



CNC ROUTER

HIGH-SPEED SPINDLE
LARGE-FORMAT
MECHANICAL ROUTING

WOOD / PLASTICS / COMPOSITES
ALUMINIUM PANEL WORK

07 THERMAL CUTTING

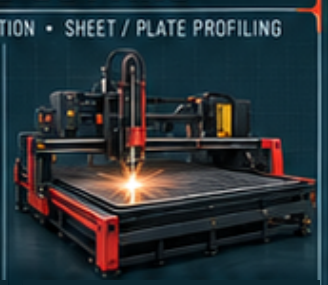
HEAT-BASED SEPARATION • SHEET / PLATE PROFILING



CNC LASER CUTTING

FOCUSED LASER ENERGY
PRECISE SHEET
PROFILE CUTTING

SHEET METAL / BRACKETS
ENCLOSURES / FLAT PROFILES



CNC PLASMA / OXY-FUEL

THERMAL PLATE CUTTING
PLASMA: CONDUCTIVE METALS
OXY-FUEL: MAINLY CARBON STEEL

STRUCTURAL PARTS / HEAVY PLATE
FABRICATION BLANKS

08 ABRASIVE MACHINING

BONDED ABRASIVE CUTTING • PRECISION GEOMETRY & SURFACE CONTROL



CNC GRINDING MACHINE

ABRASIVE MATERIAL REMOVAL
HIGH GEOMETRIC ACCURACY
FINE SURFACE CONTROL

SHAFTS / BEARING SEATS
HARDENED PRECISION FEATURES

HOW TO CHOOSE THE RIGHT CNC PLATFORM

KEY DECISION FACTORS

PART GEOMETRY | MATERIAL | TOLERANCE / FINISH | PART SIZE | PRODUCTION VOLUME

COMMON PART TYPES > RECOMMENDED CNC PLATFORMS

PRISMATIC / MULTI-FACE	VMC / HMC / 5-AXIS
LARGE PRISMATIC	GANTRY / DOUBLE-COLUMN
ROTATIONAL	TURNING / MILL-TURN / SWISS
HOLE-DOMINANT PRODUCTION	DRILLING / TAPPING
GEAR TOOTH GEOMETRY	GEAR GENERATION
CONDUCTIVE COMPLEX FEATURES	WIRE EDM / SINKER EDM
PANEL / NON-METAL PROFILE	ROUTER
SHEET / PLATE THERMAL PROFILE	LASER / PLASMA / OXY-FUEL
FINAL GEOMETRY / SURFACE	GRINDING

THE MACHINE IS ONLY HALF THE DECISION.

- PROCESS CAPABILITY > APPEARANCE
- GEOMETRY DRIVES MACHINE SELECTION
- PRODUCTIVITY = MACHINE + WORKFLOW
- THE BEST MACHINE FITS THE PART — NOT THE HIGHEST AXIS COUNT

DIFFERENT MACHINES. DIFFERENT STRENGTHS. SAME GOAL: ACCURATE PARTS.

UNDERSTAND THE PROCESS FAMILY FIRST — THEN THE MACHINE TYPE.

MACHINE CONFIGURATIONS, CAPABILITIES AND PROCESS ENVELOPES VARY BY BUILDER AND APPLICATION.



SAVE THIS MAP.

FOLLOW MATEUSZ ZULAWSKI
PRACTICAL MANUFACTURING AI