Modular & Automated Tool Handling

ITCD – 301-001

Design

- Cutter accessibility
- Clamp placement
- Effect of clamp placement – tool diameter, cycle time, finish and accuracy
- Fixture and clamping to a low profile
- Prevent interference
- Keep clamping low
- Savings – Cycle time, permits tool to be chucked as short as possible

Cutter accessibility

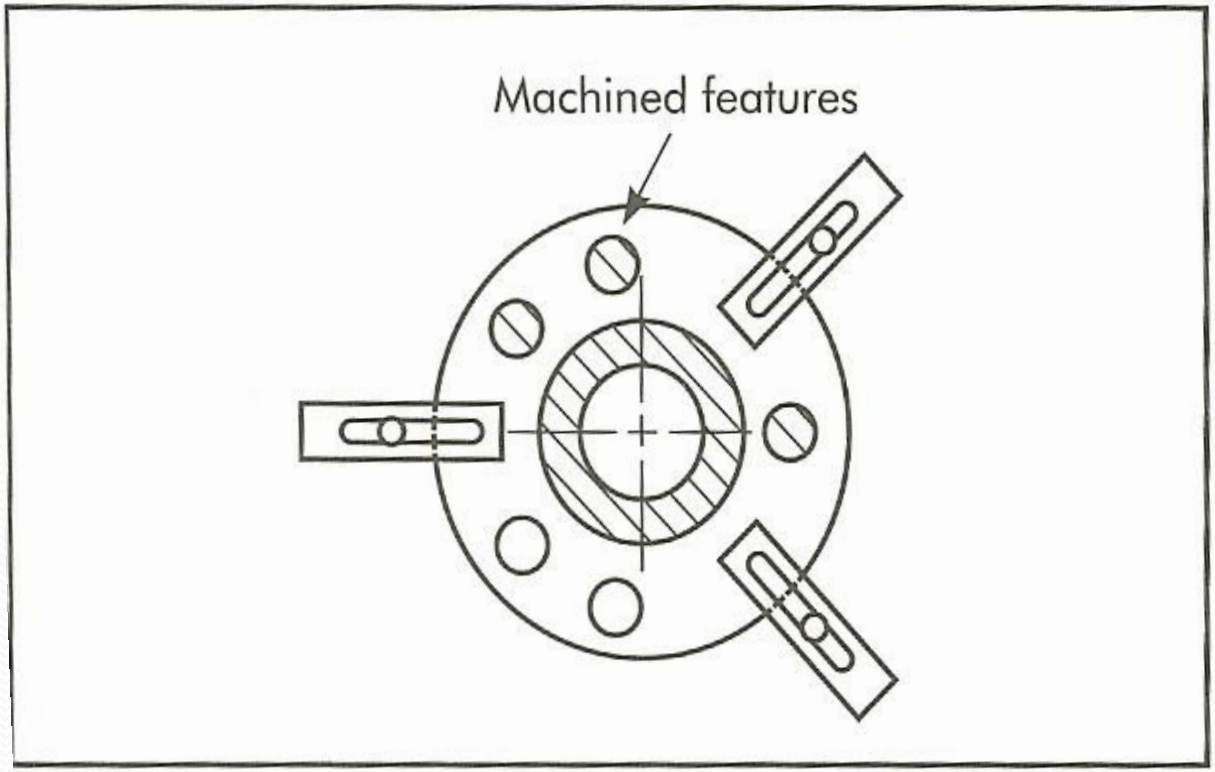

Figure 11-1. *Cutter accessibility.*

Accuracy

- Extremely close tolerances
- Repeatability (programmed coordinates)
- Fixtures for CNC have an equal role in transferring this accuracy to the workpiece
- Closer tolerances increase the cost
- But deliver a more accurate, consistent product
- Flatness and parallelism very important while designing fixtures for CNC

Accuracy

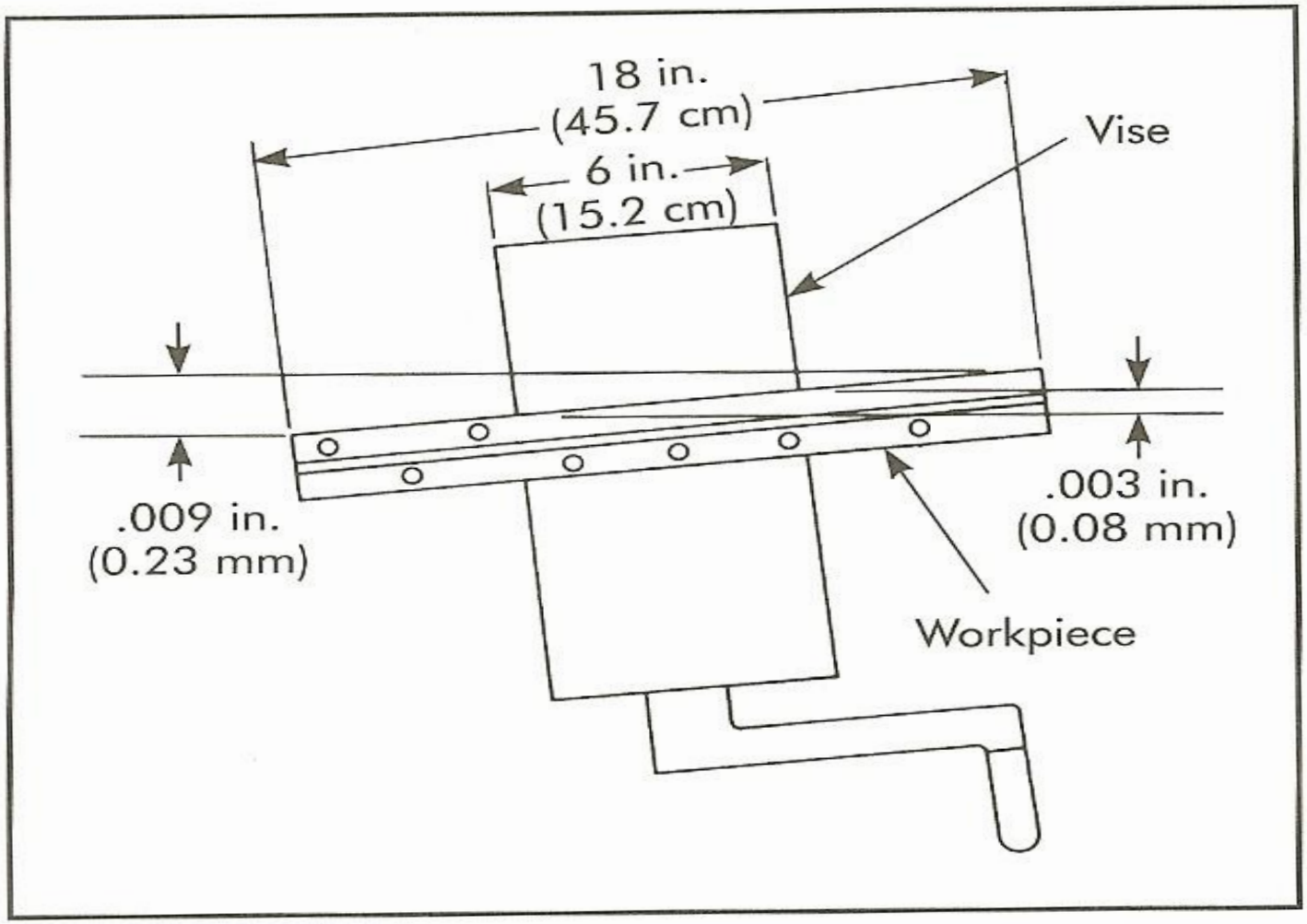

Figure 11-2. *Angular misalignment.*

Rigidity

- Rigidity affects accuracy, surface finish and productivity
- Severe shock, vibration and pressure on the workpiece
- Alleviated by good fixturing
- At least 1 or 2 solid surfaces should be designed into the fixture to take the shock of the cutting tool
- Strong and steady clamps to hold the workpiece without distorting it

Rigidity

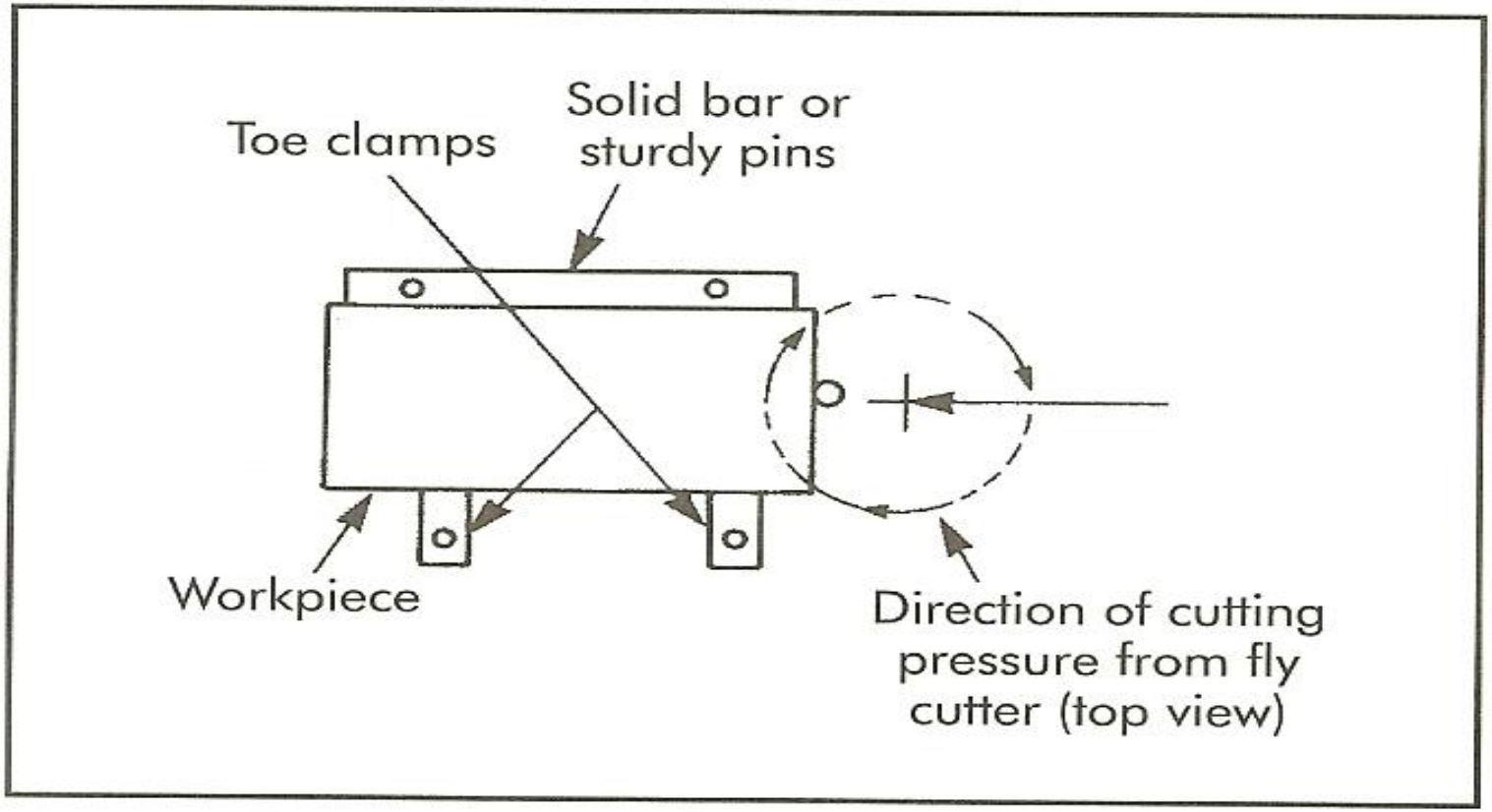

Figure 11-3. *Rigidity in tool design.*

Speed and ease of workpiece changing

- Consideration of loading and unloading the workpiece
- Use standard fixture components whenever possible
- Sophisticated mechanical, pneuamatic and hydraulic clamping systems may be used
- Fluid-operated systems have certain advantages
- Dedicated fixtures not feasible – storage, process and time involved
- Modular tooling systems – designed to solve the above problems
- Kits of tooling components used together in various combinations to locate and clamp workpieces for machining, assembly and inspection.

Starter kit for modular fixturing

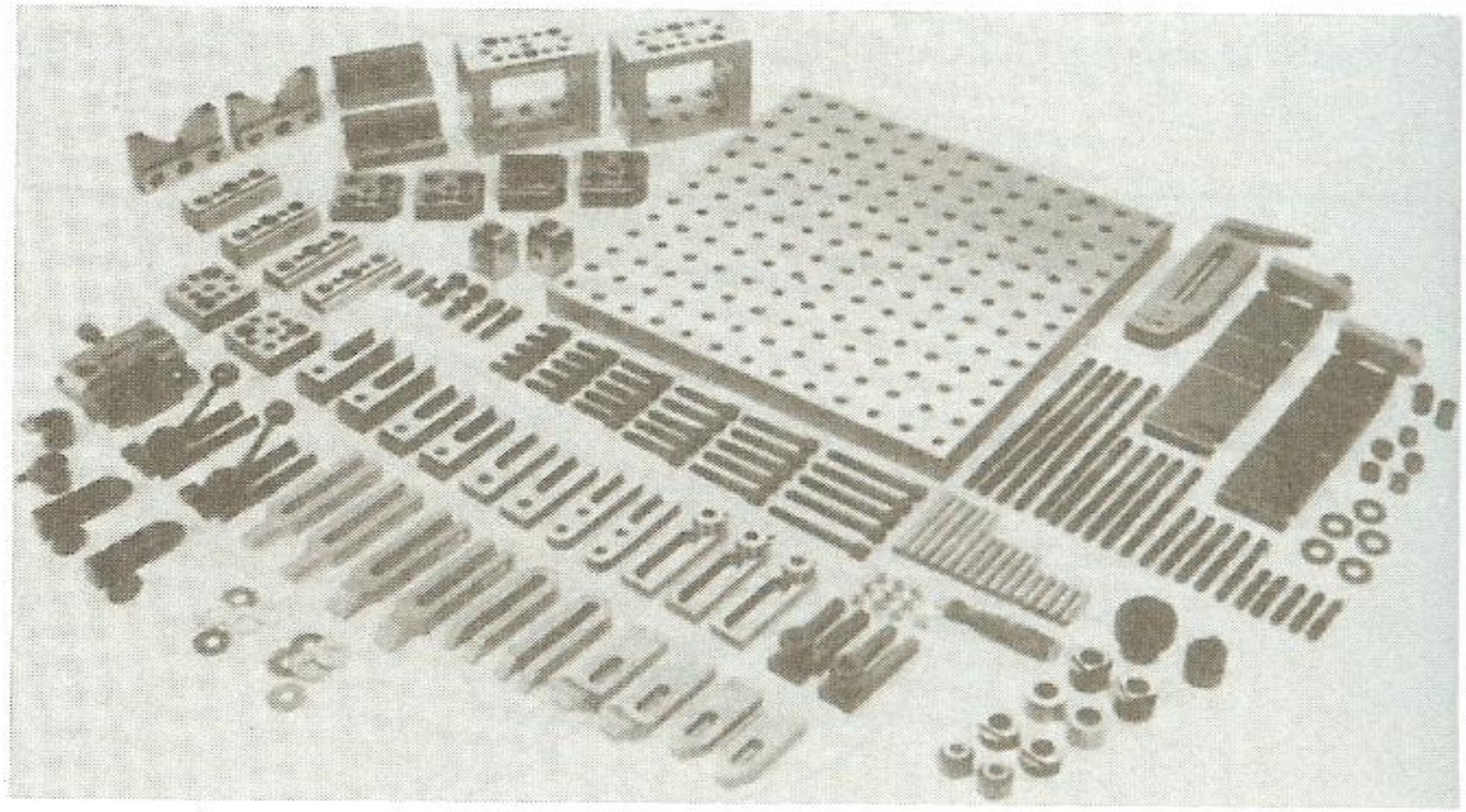

Figure 11-4. *Starter kit of modular fixturing components.* (Courtesy Fritz Werner Machine Tool Corp.)

Construction

- First step in assembling a jig or fixture – Select a base large enough to handle the workpiece
- Main structure constructed with riser blocks and reinforced with stop-thrust elements
- More specialized elements are added to properly locate and clamp the workpiece for machining
- Sample parts – Ideal method for constructing a jig or a fixture with a modular tooling kit. Position the sample part on the base and add locators, supports and clamps as needed. Reduces construction time, expedite frequent assemble and disassembly of jigs and fixtures
- Template – Template of the part around which a jig or fixture is assembled, useful for checking interference that might occur on loading and unloading

Erector-set fixture

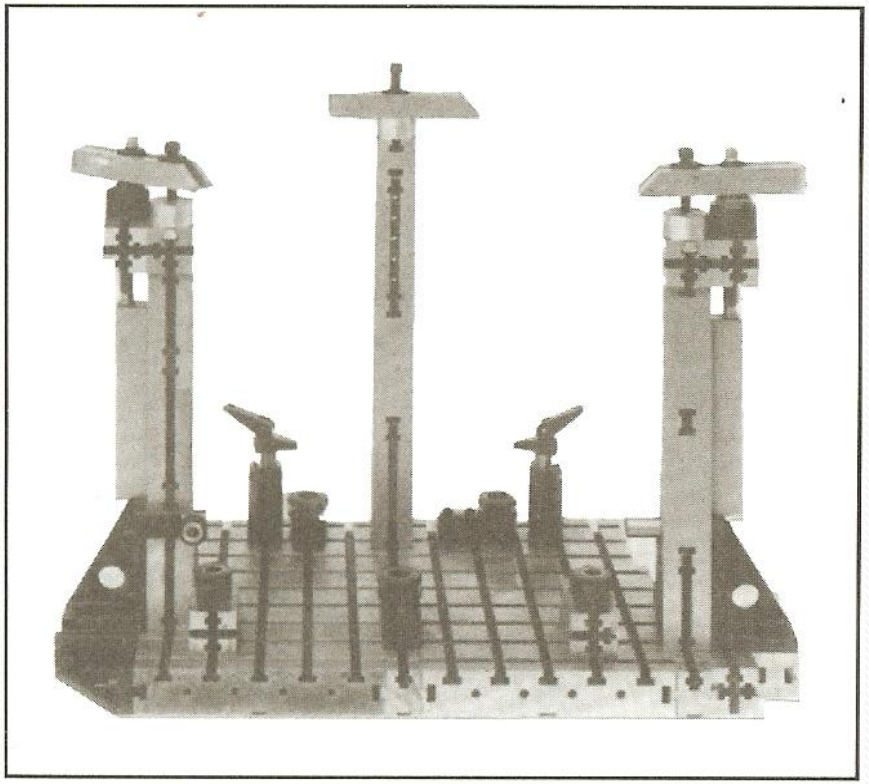

Figure 11-5. *Erector-set fixture.*

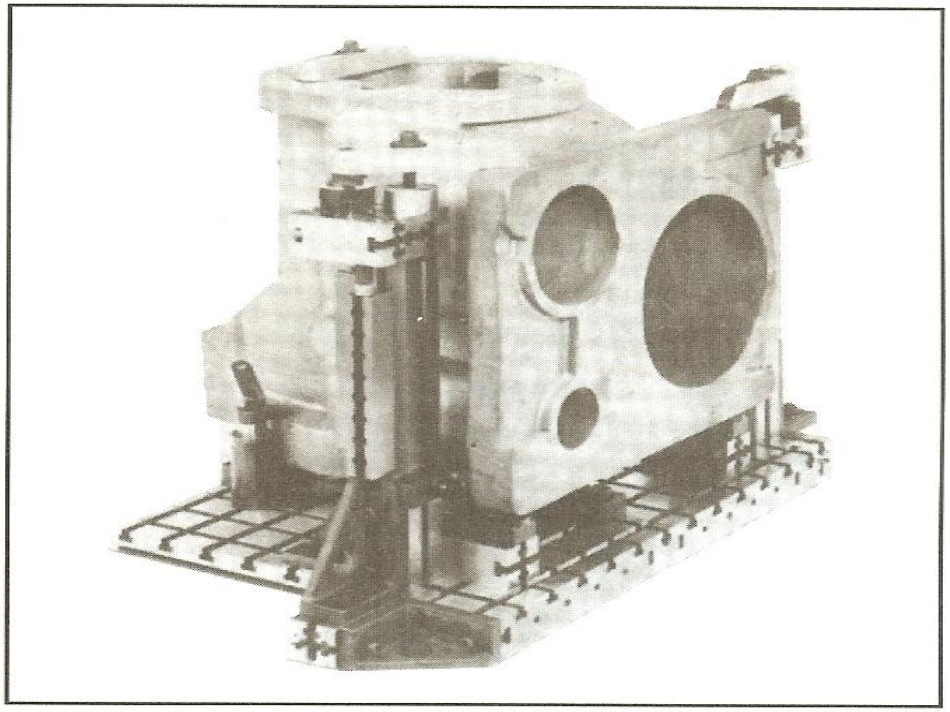

Figure 11-6. *Erector-set fixture with a workpiece in place.* (Courtesy Flexible Fixturing Systems, Inc./Erwin Halder, Ltd.)

Machining on modular fixtures

- Seldom need machining
- Occasional limited machining may be needed
- Excessive machining should be avoided
- It eliminated the economic advantage of the system
- Modular tooling should not be used if excessive machining is needed
- Tool assembler – Imagination to foresee potential problems and plan accordingly
- Careful consideration when selecting a tool assembler
- Jigs and fixtures made with modular tools should withstand strong machining forces, built to use adjustable components and accommodate an in-process part

Pallet/Fixture changers

- JIT production
- Smaller lot sizes necessary
- More frequent changeover is required
- Result – Machine sits idle for 30-40% of the time
- Manual pallet/fixture changers
- One pallet slides away from the spindle – allows unloading, loading, cleaning and setup work
- Other pallet – machine continues making parts
- Effective on small or large lot sizes and allows changeover in less than a minute
- Operator has more time to inspect work
- Standard equipment with new machining centers

Pallet changer

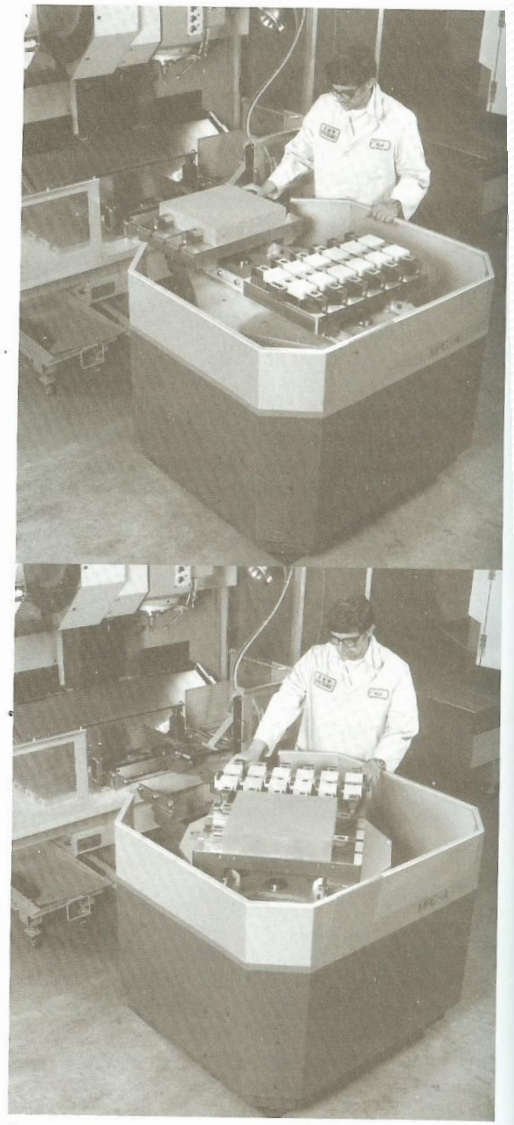

Figure 11-7. *Pallet changer.* (Courtesy SMW Systems, Inc.)

Advantages of modular tooling

- Reduces lead time
- Adaptability
- Reusability
- Backup ability

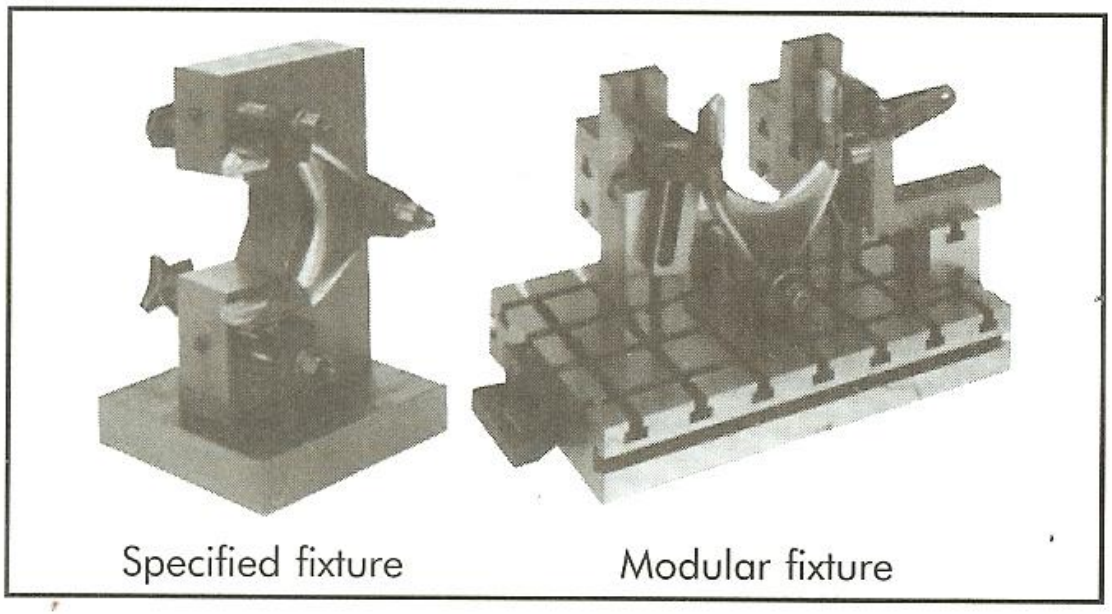

Figure 11-8. *Two methods of constructing a milling fixture.* (Courtesy Flexible Fixturing Systems, Inc./Erwin Halder, Ltd.)

Modular tooling system design

Figure 11-9. *Subplates.* (Courtesy Mid-State Machine Products)

Modular tooling system design

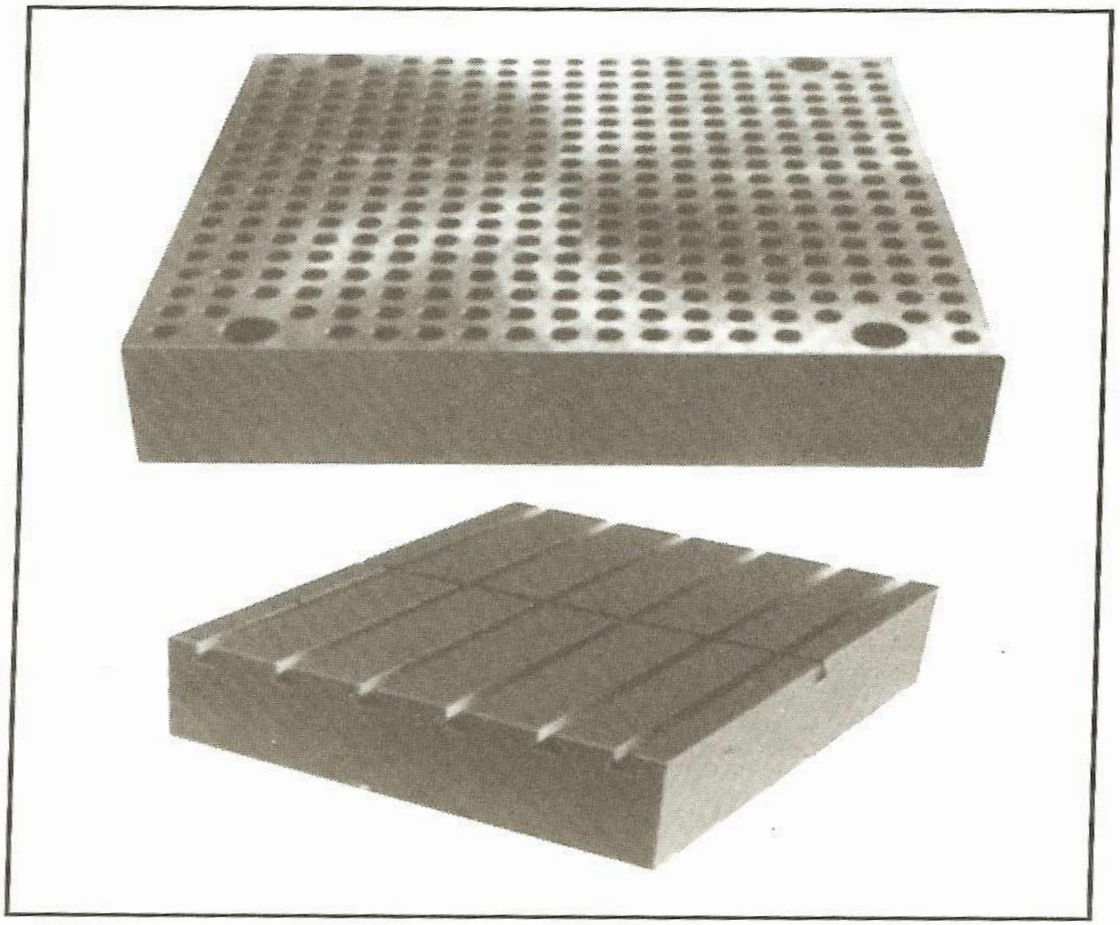

Figure 11-10. *Riser/tooling blocks.* (Courtesy Mid-State Machine Products)

Four-sided tooling blocks

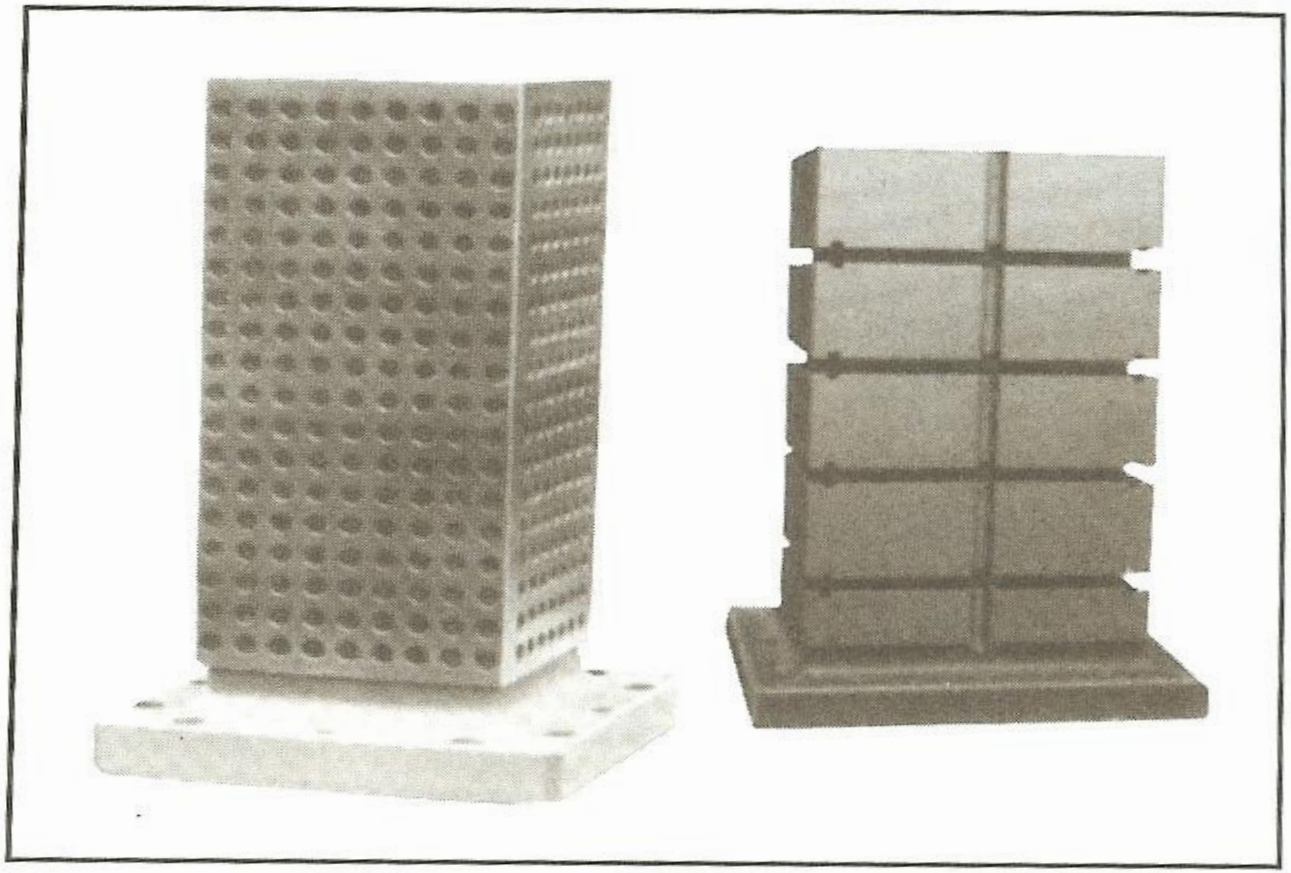

Figure 11-11. *Four-sided tooling blocks.* (Courtesy Mid-State Machine Products)

Six-sided tooling blocks

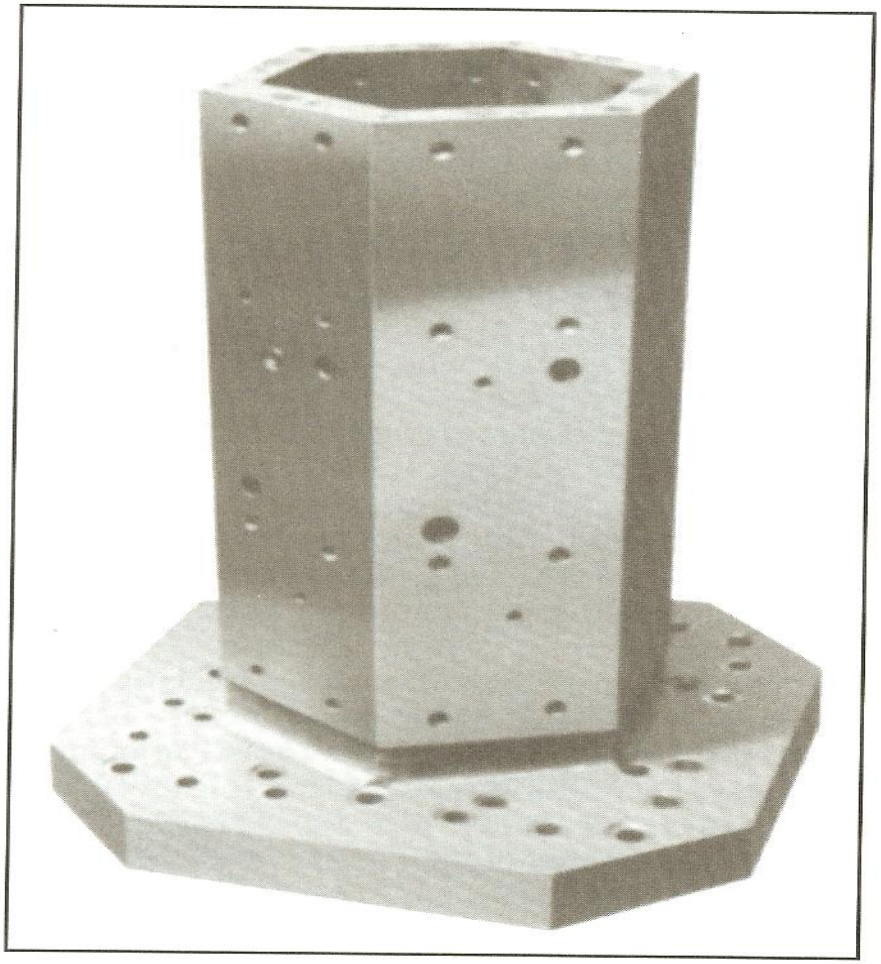

Figure 11-12. *Six-sided tooling blocks.* (Courtesy Mid-State Machine Products)

Two-sided tooling blocks

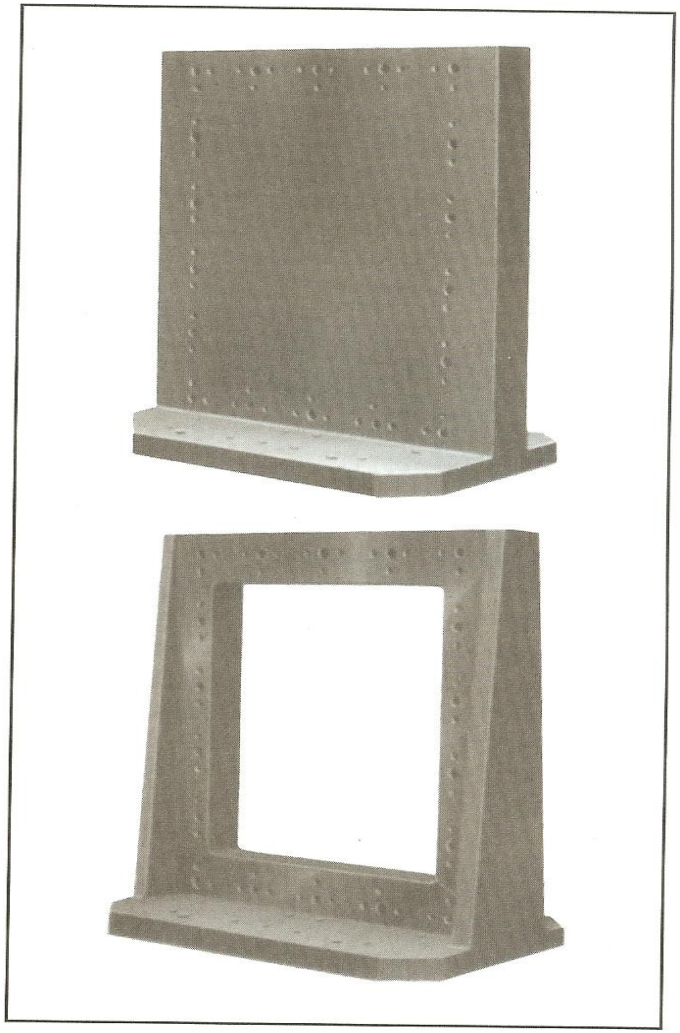

Figure 11-13. *Two-sided tooling blocks.* (Courtesy Mid-State Machine Products)

Angle plates

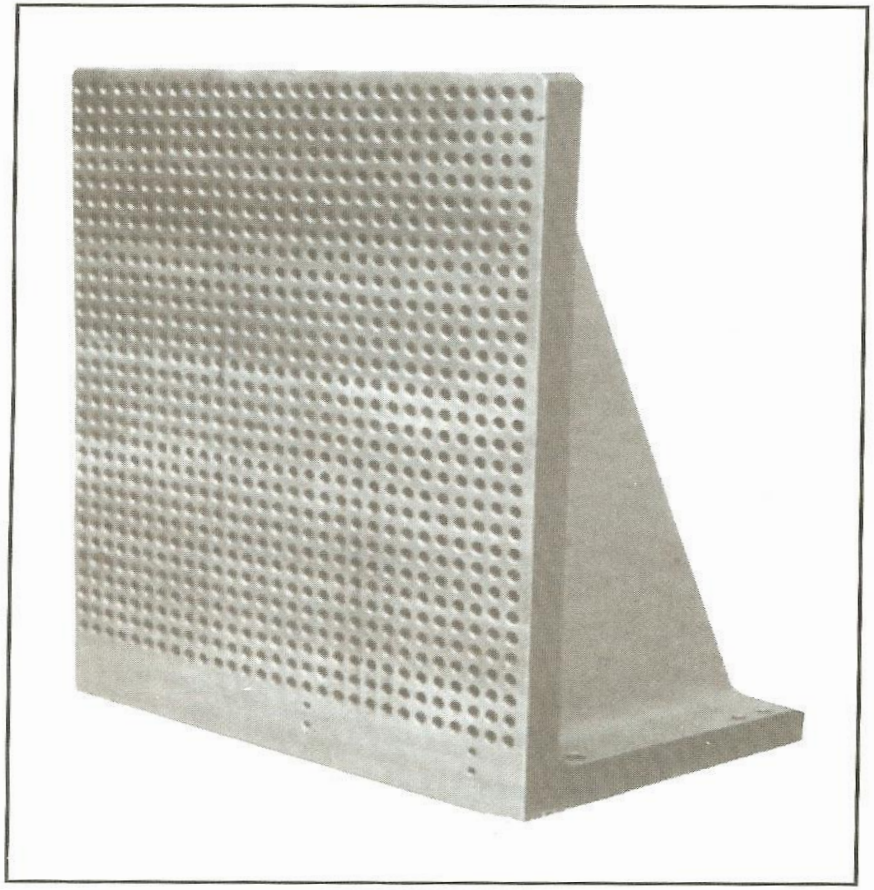

Figure 11-14. *Angle plates.* (Courtesy Mid-State Machine Products)

Tooling cubes

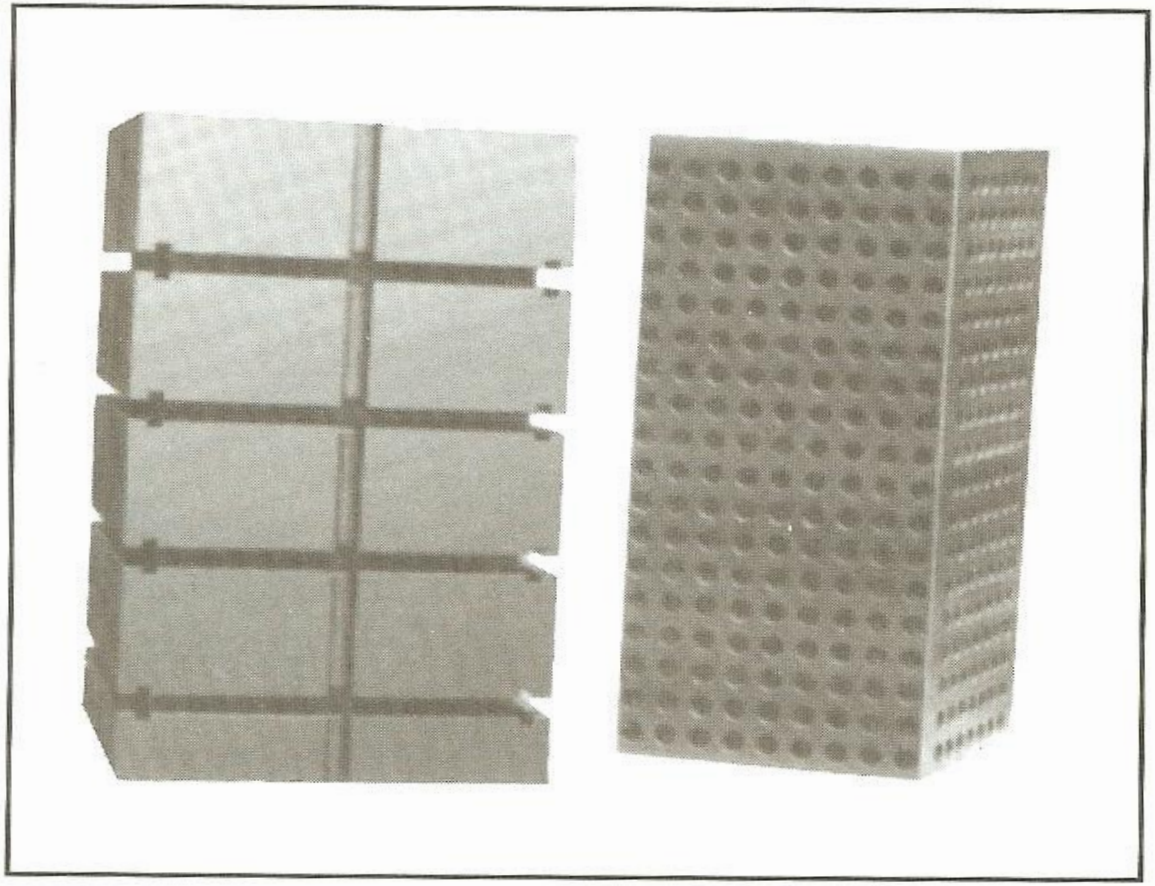

Figure 11-15. *Tooling cubes.* (Courtesy Mid-State Machine Products)

Self-adjusting fixturing elements

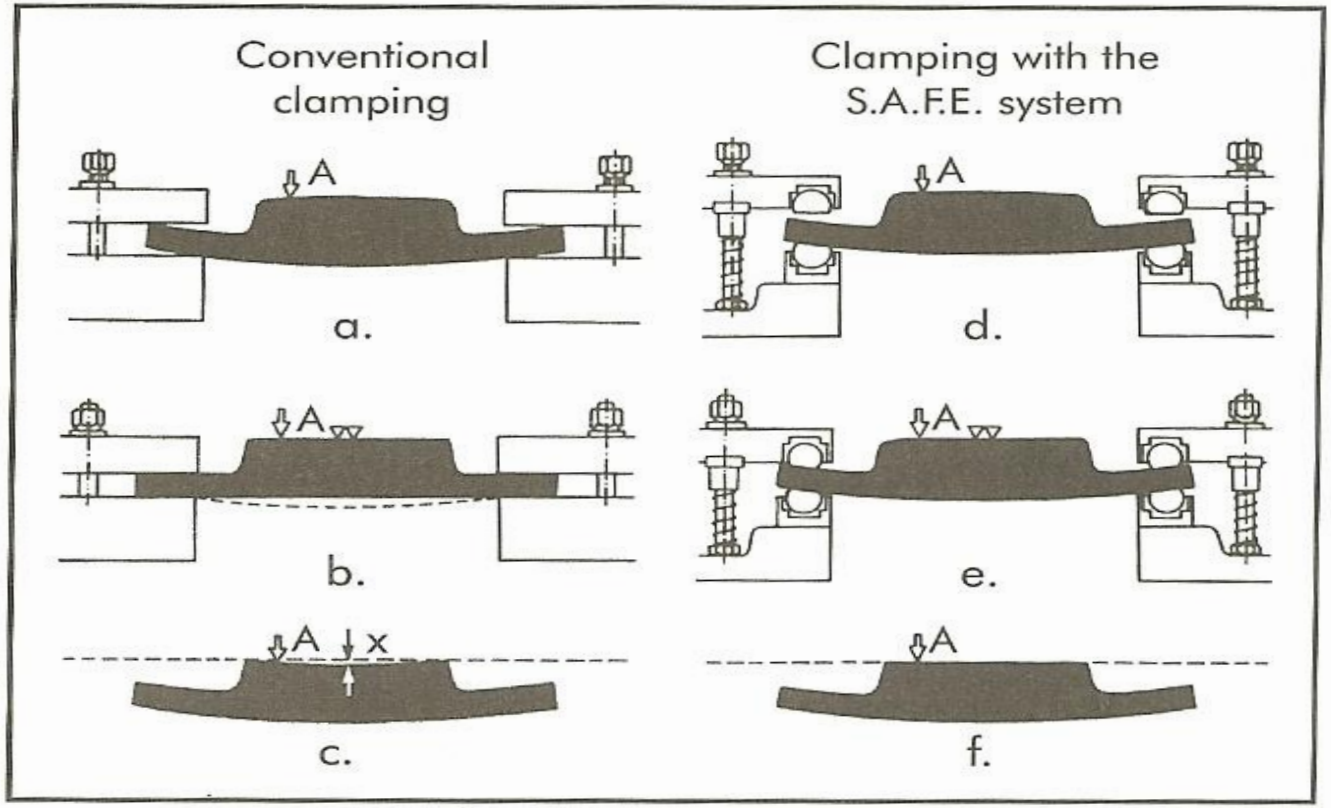

Figure 11-16. *Modular tooling system with self-adjusting fixturing elements.* (Courtesy Enerpac Group, Applied Power, Inc.)

Quick change tooling

- Clamping unit – mounts to the machine tool, receptacle for ICU
- Interchangeable cutting unit

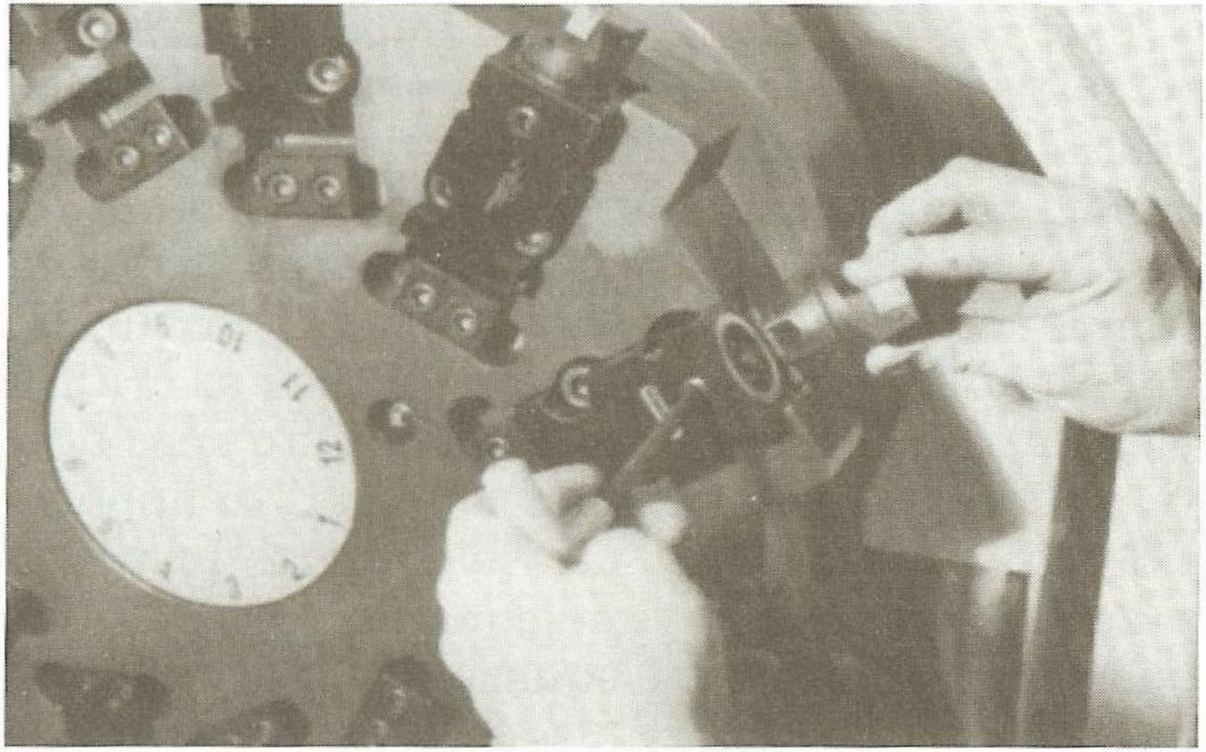

Figure 11-17. *Quick-change clamping unit and cutting head.*

References

- Fundamentals of tool design, fifth edition, Society of Manufacturing Engineers
- Donaldson, and Lecain, Tool Design, McGraw Hill

Questions?