Fixtures Built While You Wait

By Rick Dove, Paradigm Shift International, e-mail: dove@well.com, 575-586-1536, Senior Fellow, Agility Forum

We're back in Pittsburgh again, at the GM service-parts metal-fabrication plant. We've already looked at their just-in-time assembly concept (this column, Aug. '97). Now we'll look at a check-fixturing technique for auto-body-part contour verification. Two very different aspects of production - both exhibiting uncommonly high degrees of adaptability.

Is there a common set of design principles responsible for this adaptability? That is precisely the quest in the workshops (explained here Feb. '97) that are revealing these secrets to us . A warning: we're going to look pretty closely at the architecture of this check fixture concept . . . and there will be a test later.

Picture this - a room about 30 by 40 feet. In the middle, on the floor, is a 9 by 23 foot cast iron slab one foot thick. You can't see much of this slab because it's mostly covered with four smaller plates of aluminum, each 3 by 7 feet and four inches high. These plates are punctured by a pattern of holes on a 55 mm grid; looking like an industrial strength Lego sheet, just waiting for some imaginative construction.

This story is not about check fixturing - it's about generic design principles.

Actually, some construction appears to have started. Maybe 75% of this grid is covered by swarms of identical little devices called punch retainers - in no discernable pattern. Ten or twelve are grouped together in one place, twenty or so in another, six or eight somewhere else - maybe 40 islands all told on this Cartesian sea. It turns out that these groupings have evolved over six years of use, and continue to grow as new retainers are occasionally added to the collage - slow motion art.

Maybe the picture needs some help. A punch retainer looks like a metal cam - sort of a triangle with rounded points, and about an inch and a half thick - almost as high as it is wide. You lay it down flat on its side and bolt it to the grid; and thereby establish a virtually perfect repeatable coordinate position - with a quick disconnect socket.

A few of these true-position sockets have a 5/8ths diameter drill rod sticking straight up out of them, all with different lengths, most with a positioning detent and a spring clamp to hold a sheet metal part against the detent. They're called details - these rods with clamps and detents.

Remember the 20 foot cast iron slab? On each side of this slab are cantilevered rails supporting a traveling coordinate measuring machine. These two Zeiss CMMs are program driven and can reach anywhere in the 9x23 foot space. Each base plate has a spherical fiducial reference point fixed to it. The machines find these 3-axis reference points in preparation for measuring relative distances thereafter.

So now the phone rings. Bill Marincic picks it up, listens, grunts affirmative, hangs up, and yells to his brother Bob. An '85 Pontiac left front fender is coming in hot off the press - and needs an immediate check.

The Marincic brothers swing into action. Bill goes over to one of the four base plates, inserts a stiff wire into a hole in one of the retainers, and removes the unlocked detail rod. He repeats this process a dozen times in the next 45 seconds, placing each of the freed details in a blue plastic container about the size of a shoe box. We know its 45 seconds because Bob has been looking at his watch the whole time.

Bill disappears with the container into a side room. In here is a shelving unit that holds 540 identical containers in labeled rows and columns. Bill puts the one he has into its home slot, reads slot labels until he finds the new one he needs, and returns with a new blue box in hand. This adds another 45 seconds to the time. We know because Bob has finished his first cup of coffee now.

Bill heads over to the base plate while Bob heads over to the coffee pot. Bill removes one detail from the blue box and examines it - he notes the coordinate position stamped into the bottom of the holding detail, and inserts it into the corresponding retainer. In two minutes flat he has placed 14 details into their respective coordinate locations. We know its two minutes because Bob's coffee break just ended - just in time for him to open the door as the fender arrives. He points they guy toward Bill.

Three and a half minutes after the phone call, Bill clamps the fender into the newly-constructed holding fixture and enters the fender code into the Zeiss console. Bob presses the start button and the verification begins.

Remember that side room - the one with the 540-slot shelving? When you figure the 20x2 foot foot-print of the shelf space and add a four foot access aisle you find that details for 540 check-fixtures need 120 square feet. Add to that the 3x7 foot holding device base plate and you have less than 150 square feet tied up for 540 checking fixtures. The existing side room is mostly empty and could easily accommodate three times the shelf capacity.

There's nothing magic about those base plates. You can put one on a cart and take it to a press on the floor and check a part every 60 seconds. Not with the Zeiss machine - with traditional gauges.

Bill and Bob invented this concept while car pooling to work together. They call it the Pittsburgh Universal Holding Device. They're die-makers by background - and a product of the innovative take-charge culture at GM's Pittsburgh plant.

OK, remember the part about the test? Go find last month's column about the assembly system and re-read it, and then this one again. The site-team we took to the Discovery Workshop at GM dissected this check-fixturing concept, and cataloged the design characteristics into the accompanying table. Can you find the same principles at work in the assembly system? Long time readers will notice some name changes among the ten principles - an early suggestion from the Discovery Workshops that are currently testing these principles.

This story is not about check fixturing - it's about generic design principles for making any production process or business practice highly change proficient - able to turn on a dime at a moment's notice. In future columns we will look at a wide variety of other business areas exhibiting these same generic principles. The sooner you find them and see them in their abstract example-independent form, the sooner you will apply them unconsciously to the next improvement or reengineering or start-from-scratch project you attack.

Key Definitions
System: A group of interacting modules sharing a common framework and serving a common purpose.
Framework: A set of standards constraining and enabling the interactions of compatible system modules.
Module: A system sub-unit with a defined and self-contained capability/purpose/identity, and capable of interaction with other modules.

When looking at the tabled example you might notice that the contents are not pure - there is a mixture of multiple "system" levels. The Zeiss machines, for instance, are not really a part of the check fixture system, but rather a part of the next higher level system: contour verification. Similarly, the detents and clamps on the drill rods are a part of a lower-level detail system. At this stage the distinction is not important - but it will become so as we continue our exploration next month.

Pittsburgh Universal Holding Device	
System(s)	Body-part contour check fixtures.
Framework	Base plate coordinate gridwork, 4x8x12 shoe-box shelving, 5/8ths punch retainer.
Modules	Punch retainers, 540 containers, fixture detail collection, two Zeiss Machines, base plate units, drill rods, detail clamps, detail detents.

Principles Observed in System Design	
Self Contained Units: System composed of distinct, separable, self-sufficient units not intimately integrated. • Base plates. • Retainers. • Details. • Containers. • Shelf slots.	**Flexible Capacity:** Unrestricted unit populations allow large increases and decreases in total unit population. • Base plate can be extended to any size. • Unlimited shelving can be added. • Details for a large or complex single fixture could occupy multiple containers.
Plug Compatibility: Units share common interaction and interface standards, and are easily inserted/removed. • Standard retainers bolted to base plate. • 5/8ths drill rods inserted in retainers. • Common form factor containers in shelving slots. • Coordinate gridwork.	**Unit Redundancy:** Duplicate unit types or capabilities to provide capacity fluctuation options and fault tolerance. • Base plates. • Blue containers. • Shelf slots. • Retainers. • Multiple CMM machines.

Facilitated Re-Use: Unit inventory management, modification tools, and designated maintenance responsibilities.
• "Zeiss Room" personnel are responsible for:
  • Pool of common retainers.
  • Pool of common containers.
  • Common off-the-shelf shelving.
  • Details for new fixtures machined as needed.
  • Additional base plates machined as needed.
	Evolving Standards: Evolving, open system framework capable of accommodating legacy, common, & new units.
	• Base plate can be any size or shape.
	• Retainers are installed as needed when needed.
	• Can be used with traditional layout table and gauges as well as CMMs.

Non-Hierarchical Interaction: Direct negotiation, communication, and interaction among system units. •	**Distributed Control and Information:** Decisions made at point of knowledge; data kept locally, accessible globally. • Coordinates stamped on rods.
Deferred Commitment: Relationships are transient when possible; fixed binding is postponed until necessary. • Fiducial sphere provides real-time zero point. • Rods inserted in retainers when fixture needed. • Retainers bolted to plates as needed when needed.	**Self Organizing Relationships:** Dynamic alliances and scheduling; open bidding; other self-adapting behaviors. • Fiducial sphere provides real-time zero point.