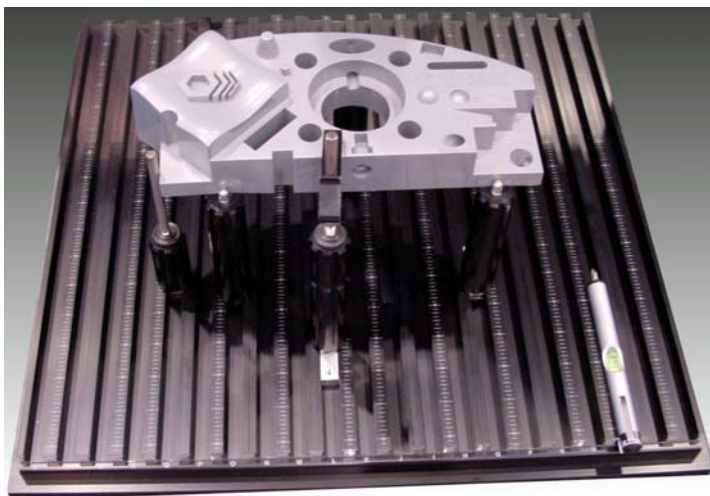


## New Economical Modular CMM Fixtures Shake up the Market

The **National Bureau of Economic Research** determined that the US economy entered a recession in December 2007. That is the same month that **FixLogix LLC** introduced a new low-cost modular fixture system for 3D coordinate metrology. The first question one might ask is: why would anyone start a new metrology-based business in this economic climate? Secondly why in Michigan, the epicenter of the automotive industry recession”? The short answer is that the founders of FixLogix identified a clear need in the marketplace for an economical modular fixture system for metrology, then developed and brought to market a product to meet that need.

Modular fixture systems for CMMs were introduced in the late 1980's. Since that time there have been tremendous advances in CMM technology. Advances in computer systems and software led to the development of new machine designs. Software based 3D error compensation allowed for simpler, less expensive machine structures. Graphical user interfaces greatly simplified software based alignments, reducing the need to square the work-piece up to the machine axis. Meanwhile modular fixture systems for CMMs remained relatively unchanged, based on the obsolete concept of building the holding fixture to “gage” tolerances. As time went on, and CMM prices declined, the cost of a modular fixture system became a much greater percentage of the total solution.

The modular fixture industry failed to adapt to the changes in the CMM industry. In their defense they had little incentive to develop new products. The CMM manufacturers largely ignored the modular fixture niche, leaving their customers to find their own solutions. Domestic manufacturers that were later entrants to the niche basically copied the original manufacturer. The foreign competition was primarily from Germany, and had an even higher price structure. The result is that a significant portion of the market remained under-served. The majority of CMM owners were reluctant to pay the high price for a modular fixture system. Approximately 20% of CMMs currently in use have modular fixtures, while easily 85% would benefit from the technology. Here lay the opportunity that brought **FixLogix** into being.



Current best practice dictates that the measuring machine should be the gage, and the fixture is simply a stage. The role of the modular fixture is to present the part to the measuring device, and hold it still without distorting the part, so the CMM can do the job. This holds true in all cases where the part to be measured is rigid enough to maintain its shape without a fixture that provides mating surfaces that simulate the nominal shape.

It is commonly accepted that over-restrictive tolerancing and excess material raise manufacturing costs. This applies to CMM fixture designs as well. Consider the two following examples:

- A) The holding fixture is built to gage tolerances
- B) The fixture structure is a design more suited to withstand machining forces

In the vast majority of cases the metrologist would prefer to use the CMM to establish datums, not a holding fixture. This suggests that in most cases the added cost of a fixture built to gage tolerances is inappropriate. Contrast example (B) with the ideal fixture from the CMM programmer's standpoint: no fixture at all! The CMM programmer would prefer that the part float motionless in space, giving the CMM complete unobstructed access to the features of the part. From both standpoints logic dictates that a modular fixture should be a simple unobtrusive structure whenever possible.

The FixLogix team started with the concept of the fixture "as a stage, not a gage" as a central tenet of the system. The goal was to develop a fixture system with improved functionality while reducing the cost to manufacture the product as well. Starting with a clean slate, we considered first what was really required of a modular metrology fixture. Our goal was to develop a system that could adequately fixture 90% + of the part holding applications in the field with a standard product line. Existing CMM fixture systems were evaluated, as well as part fixturing methodology from a variety of industries and applications. Best practices were considered from a multi-disciplinary approach, and evaluated relative to the requirement of presenting a part to a CMM and other measuring systems. To optimize the cost/benefit ratio of the system, lean manufacturing and a streamlined corporate structure were adopted for the business model.

The team developed a new fabricated T-slot fixture plate that can be produced for 1/4<sup>th</sup> the cost of traditional tooling plates with a grid of threaded holes. Extruded T-slot components were already being used in a myriad of applications from room construction to machine structures with great success. T-slots are also used on many machine tool stages to fasten part and fixture components. Combining the versatility of the T-slot with the cost advantage of extruded structures led to the decision to produce a new type of fabricated T-slot plate.

T-slot systems offer infinite positioning of locating components, which simplifies fixture construction. For use with a DCC measuring machine, infinite positioning also needs to be combined with a method to repeat the setups. To meet that requirement the FixLogix plates have a laser engraved reference system. This provides clear documentation of the fixture setup for easy repeatability. The T-slots are alpha-identified, with engraved reference scales along the T-slots in either English or Metric versions.



Photo #1 shows the T-slots and laser engraved reference system with T-nuts. The T-nuts have two threaded holes to allow the nut to remain locked in place while components are removed for other setups. Documentation of the fixture setup can be done with some simple notes and a digital photograph linked to the inspection program.

Some customers choose to develop the fixtures and inspection programs offline. This especially applies to certain higher volume applications where a modular fixture may be used to create a semi-dedicated fixture for production inspection requirements. To facilitate this application all the FixLogix components are 3D modeled in

SolidWorks. The CAD models are provided to customers upon request. In this case the documentation for the fixture setup is an actual CAD design.



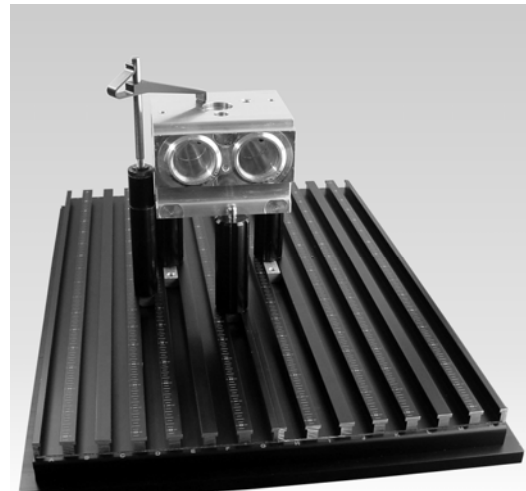
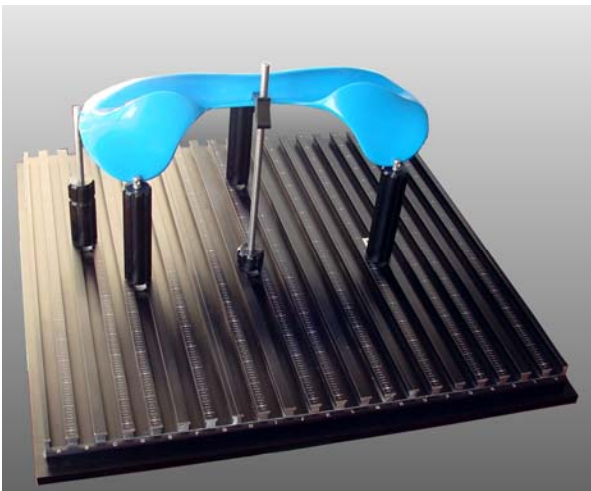
A metrology fixture should hold the part without distorting it. The team developed a new type of clamp to that end. Legacy systems used wedge clamps that required the clamp to be forced down onto the part surface to push the clamp into the wedged condition. The new FixLogix clamps (shown in photo #2) use a spring at the back to “pre-wedge” the clamp. This allows the clamp to trap the part in position, with the option of using “near zero” force. This is tremendously useful for soft, fragile, and thin-walled parts. This also allows the

body of the clamp itself to be more rigid, in turn lending more rigidity to the fixture.

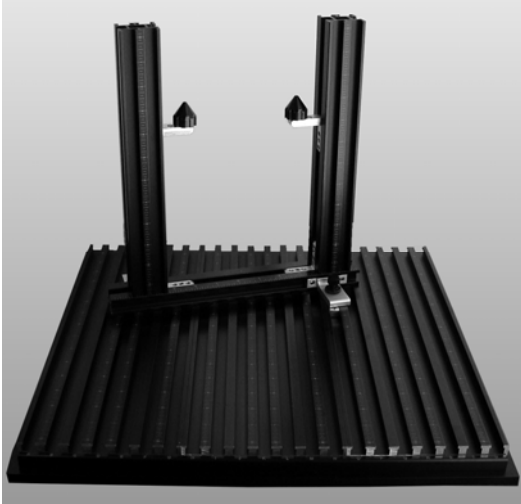


A component kit was developed to maximize the advantage of the T-slot design. The major objective of the component kit composition was the ability to be able to fixture virtually any part style in a 24” x 24” x 12” volume with the standard kit. To accomplish this, unique new extrusion profiles were also developed for t-nuts, standoffs, vertical risers, and cross-slides. The initial tooling investment paid off. The result is a component kit more versatile than legacy systems, while at a much lower cost. A typical FixLogix system comprising a plate and kit has a price point approximately 1/3 that of other competing systems.

Shown in the photos below are examples of a simple six point nest (or 3-2-1 nest), being used for both a precision machined prismatic part, and a more sculpted free-form part. Both fixtures take advantage of the t-slot plate to utilize a “pinch” technique, whereby one opposing pin-standoff pinches the part against the two opposing pin-standoffs. A single point end stop and a single over-head clamp are used to provide a very rigid holding fixture. The minimalist approach allows the CMM maximum access to the part features during the inspection program.



The T-slot components combined with the T-slot plate provide multi-axis infinite adjustment.



Shown in the left photo are vertical risers mounted on a cross-slide. The cross-slide can be positioned at an angle to allow more complex fixtures for parts like tubing assemblies with compound bends. Unique t-nut tooling block extrusions are machined into a variety of tooling components. They are used both for locking the fixture frame together, and for providing infinite adjustment for tooling details.

The fixture system can be used for rapid development of semi-dedicated fixtures as well. Fixtures as shown in the photos can be built and shipped in two days. Using an 18" x 18" plate, a typical fixture will cost under \$750.00

Designed initially for CMMs, the system is being utilized in a variety of coordinate metrology applications. Users of portable coordinate inspection systems such as articulating arms have found the fixture system to be very useful, and the economical price point is appropriate for the application. One Japanese automaker is using the system to stage engine parts on a CT scanning system. The reverse-engineering community is also beginning to adopt this technology. Laser scanners and other non-contact systems benefit from good part presentation to the scanner. This allows more accurate and more complete data sets without missing areas to be modeled.

In today's challenging business environment some long-held assumptions are falling hard. This doesn't mean proven methods and technology should be discarded. Instead they should be re-evaluated, and revised to keep pace with new technical developments. T-slots, extruded tooling, and the wedging principle are certainly not new. FixLogix merely applied these tried and true concepts in novel ways to better meet the requirements of modern CMM users.

Versatile low-cost solutions make technology more accessible. FixLogix estimates that the demand for modular fixtures could more than double. Companies with CMMs will now have an opportunity to acquire these systems for about 1/3 the cost of legacy systems. This offers the quality department a much easier justification for the expenditure. Given today's lean staffing, simplified fixture solutions will improve throughput and reduce the chance of bad data coming off the measuring instrument.

### **About the author**

Dan Smith is a co-founder of FixLogix LLC, a manufacturer of modular fixture systems for metrology. Smith has a diverse background in the metrology field, with 23 years experience. He is a graduate of the University of Michigan with a bachelor's degree in multi-disciplinary studies. The company maintains a website at: [www.fixlogix.com](http://www.fixlogix.com)

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