



# Leading metrology facility in US academia to double in size

Expansion of The University of Hartford's metrology laboratory, the leading provider in the US of education and training in measuring technology for manufacturing, will be completed by mid-2021



In use at the University of Hartford for training graduates and local engineers, the Nikon Metrology iNEXIV VMA-4540 CNC video measuring system with Renishaw TP20 touch-trigger probe has a large field of view, long working distance and wide XYZ strokes, enabling automatic measuring of a wide range of 3D components.

Chittaranjan Sahay, Vernon D Roosa Distinguished Professor of Manufacturing Engineering at The University of Hartford ([www.hartford.edu](http://www.hartford.edu)), remembers with frustration how his old British-built Austin car broke down after every few hundred miles when he was studying in his native India in the 1960s and 1970s. He contrasts that level of unreliability with the 200,000 miles that many modern cars achieve with little attention other than routine maintenance. In his opinion, the difference between then and now comes down to one word - quality.

He became fascinated by the subject as it applies to manufacturing while he was teaching in India and learned the principles of engineering metrology from books published by the then famous author, KJ Hume. It is not surprising, therefore, that he jumped at the chance in the summer of 2012 to set up and become the director of a Center for Manufacturing and Metrology when UHart's College of Engineering, Technology, and Architecture (CETA) was asked to establish the facility by aero engine manufacturing giant Pratt & Whitney (P&W), headquartered in nearby East Hartford, CT.

METROLOGY



The advanced LC15Dx laser scanner from Nikon Metrology is closing the gap with tactile probing accuracy and its unique ESP3 technology maintains speed and data quality by adapting the laser settings in real-time.

The company was owned by United Technologies Corporation, which merged with Raytheon in April 2020 to form Raytheon Technologies, which also owns Collins Aerospace. Both P&W and Collins engineers as well as staff from the supply chains around the globe are trained at the metrology laboratory. A good proportion of the component parts are made by local manufacturers, which underlines the importance of upgrading the skills not only of in-house engineers but also those of the many subcontractors supplying the group.

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Dr. Chittaranjan Sahay PhD, PE, CMfgE, University of Hartford

Undergraduates and postgraduates at the university additionally take full advantage of the facility. The Certificate in Manufacturing Metrology program developed by Prof Sahay is designed to prepare students with skills in engineering metrology focusing on manufacturing. It encompasses the principles of dimensional metrology, GD&T (geometric dimensioning and tolerancing), gage quantification

and specific certificate courses like the fundamentals of airfoils, coupled with significant hands-on learning in the metrology laboratory. The course culminates in a comprehensive project to provide students with an essential set of tools for increasing manufacturing competitiveness in the companies that are destined to employ them.

Coincidentally it was at the beginning of 2012, in the Center for Manufacturing and Metrology’s inaugural year, that Nikon Metrology, Inc ([www.nikonmetrology.com](http://www.nikonmetrology.com)) invited more than 100 manufacturing professionals to the opening of its new technology center at the company’s headquarters for the Americas in Brighton, MI. Later that year, the industrial measuring and inspection solutions company became the largest provider of equipment to UHart’s metrology laboratory.

Supplied on free loan under a partnership agreement, the multi-sensor coordinate measuring machine (CMM), laser scanners for non-contact inspection, video measuring machines, offline programming software and optical microscope delivered by Nikon Metrology coupled with its ongoing technical support are valued at hundreds of thousands of dollars. Pratt & Whitney has donated equipment and a few other suppliers have consigned some metrology equipment as well. The Connecticut Center for Advanced Technology is also heavily involved, as are various suppliers of turning, milling, grinding and 3D printing machines.

Prof Sahay comments, “The ability to measure properly, as well as to evaluate measurement systems in use, is becoming increasingly important in today’s competitive landscape, as it underpins the needs of global manufacturing with its tighter product tolerances and process controls.



Another Nikon Metrology CNC video measuring machine with 15x zoom optics in use in the metrology laboratory at Uhart is the VMZ-R4540 Type 1. Its magnification, AF and LED episcopic / diascope illumination can be finely adjusted, while working distance and field of view are both large.

“Our lab was conceived to bridge the worlds of academia and manufacturing in order to help US producers address the shortage of skilled labor in the area. It has achieved this by providing companies across the board with graduates having expertise in the core discipline of metrology, and specifically by elevating the abilities of aerospace engineers in what are now Raytheon Technologies group companies here and around the world.

“There are not enough US universities that teach in dedicated metrology labs and those that do tend to run isolated courses. Even fewer focus on the subject as it relates to manufacturing, yet it is so important because it defines whether a product will be reliable or not.

“UHart is leading the way in US academia in teaching quality in manufacturing as a separate discipline and there is a constant demand for courses. All our students leaving with a metrology degree find employment or go on to study for a doctorate either here or elsewhere.”

In 2018, part of the metrology laboratory resource was given over to pure research, unsurprisingly with the accent on

aerospace. An ongoing project for P&W involves studying the surface finish of a machined airfoil using the Nikon LK 10.7.6 HA multi-sensor CMM and a Nikon LC15Dx laser scanner. The latter achieves a measuring accuracy normally associated with using a tactile probe but at much faster data acquisition rates. Having a nominal working volume of 39 by 28 by 20 inches, the CMM is an ultra-high precision reference CMM featuring repeatability and volumetric accuracy that are both to within microns.

The purpose of the UHart research study is to investigate the relationship between fixturing on a machine tool and the resulting tolerances and surface smoothness of the airfoil after production. In a parallel study, modern software is being used to determine the thermal and structural integrity of the component to establish how it will behave in use. A paper on the findings will be published by Prof Sahay and others in 2021.

He continues, “I could find enough work to run three shifts in the metrology lab if the staff was available. Our new research activities are taking up part of the resource, while the internal graduate

courses are becoming increasingly popular due to their practical applicability in industry. We have run thirty-three courses over the past three years and a further eight are scheduled for this year.

“Training of P&W and Collins engineers is also a large part of our activity. We currently do not have enough time to provide a similar service to other industrial companies, even though there is a lot of interest from local firms and from some further afield, like General Electric 100 miles away.

“That is why UHart’s Center for Manufacturing and Metrology is opening a new teaching laboratory on campus next summer that will be double the size of our existing faculty. All our sponsors will be involved in this exciting new project.”

In this connection, as an example of the advantages of closely involving supplier companies, Prof Sahay points to the relationship that the laboratory has developed with Nikon Metrology and how it benefits both parties.

He says, “It is very much a two-way partnership. They have supplied cutting-edge metrology equipment and software that is invaluable to our students, who get real-world hands-on experience, and it allows us to conduct meaningful research. In return, they regularly bring potential customers into our lab to demonstrate the equipment we have.

“Even that activity benefits us. Often it is not just Nikon sales staff that come in but also their applications engineers and we have a chance to work with and learn from them. Sometimes they even make detailed presentations in our courses, which is a big help when we are busy.”

As a final point, he wryly recalls that the Sino-Japanese expression for continuous improvement - kaizen - adopted with great success by Japanese businesses like Toyota after World War II to improve quality and reduce waste in manufacturing, was largely influenced by business and quality management teachers in the US. The establishment and success of UHart’s Center for Manufacturing and Metrology and its imminent expansion indicates that the concept continues to come full circle. He believes that US manufacturers have for many years been using their intellectual energy to harness modern technology and become more productive and nowhere is this more apparent than in the integration of quality throughout their supply chains.