

**AUTOMATED RESIDUAL
STRESS ANALYSIS**

X-ray Diffraction Residual Stress Measurement **AEROSPACE STRUCTURES**



SOME OF THE PLATFORMS THAT PROTO HAS WORKED ON - PHOTOS COURTESY OF USAF AND NASA

A world of solutions

AEROSPACE STRUCTURES



HISTORY

Since its founding in 1968, Proto Manufacturing (Proto) has been involved in the development and application of non-destructive evaluation (NDE) technology.

In the early eighties, Proto recognized that many of the problems requiring the palliative application of NDE had undesirable residual stresses as their root cause. It was reasoned that measurement and management of residual stress could prevent these problems altogether, or at least more efficiently direct additional NDE efforts.

Proto selected x-ray diffraction (XRD) technology because of its promise for providing quantitative measures of residual stress (RS) both safely and non-destructively. Proto set a goal to develop XRD technology sufficiently to allow practical problem solving in laboratory, factory and field environments.

A continuous and considerable development effort has over the years succeeded in advancing the state-of-the-art to achieve this goal.

It is safe to say that Proto's XRD systems are the lightest, fastest and most advanced in the world today and are successfully applied in many sectors; aerospace (including military and civil) automotive, marine, power generation, nuclear and structural.

Residual stresses play a key role in the life of aerospace structures. Proto provides both measurement services and x-ray diffraction residual stress measurement instrument sales, enabling our customers to obtain residual stress measurements in the lab or in the field on aerospace components such as:

- Skins • Wings • Frames • Landing Gears • Engine Supports • Engine Casings • Engine Cowlings

Some of the platforms Proto has worked on include:

C-141, B-2, Space Shuttle, Joint Strike Fighter, Boeing 777, Dash 7

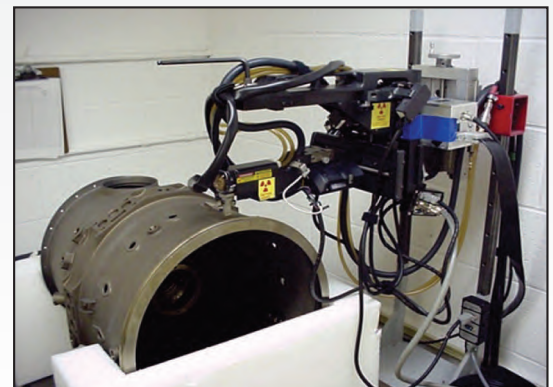
Aerospace problems that can be addressed using Proto Systems and Services include:

- Distortion • Fatigue life • SCC potential*
- Total stress (Residual + Applied)
- Weld residual stress maps
- Holes - effectiveness of cold work
- Fastener thread stress characterization
- Detect abusive machining
- Evaluate shot peening, LSP and LPB effectiveness
- Localized stress distribution characterization around fasteners
- Oil canning stress distribution due to machining practices

*Proto has been selected as the prime contractor for USAF DUS&T Program "Development of Bonded Repair Guidelines for Stress Corrosion Cracking using Residual Stress Measurement Techniques".



MEASURING RESIDUAL STRESS ON A LANDING GEAR



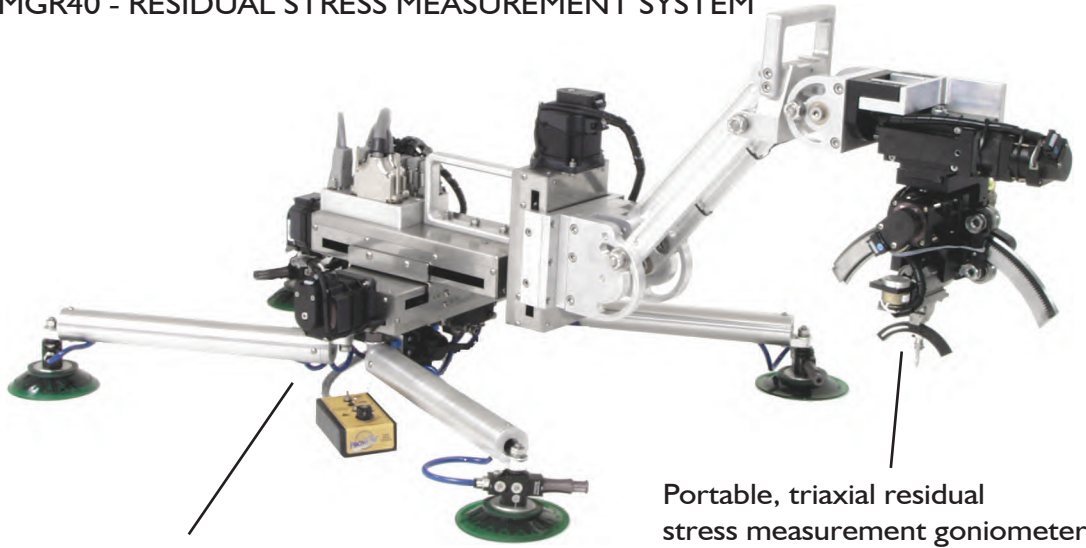
MEASURING RESIDUAL STRESS ON AN ENGINE CASING

Proto Manufacturing engages in continuous research and development. Therefore specifications in this publication are subject to change. Please call for details. Various items and methods in this brochure are covered by patents or patents pending.

X-ray Diffraction Residual Stress Measurement

Proto's patented Automated Residual Stress Mapping technology generates a comprehensive picture of the stress state of any sample. Even curved surfaces such as welds can be automatically mapped allowing designers and engineers to visualize and manage problem areas.

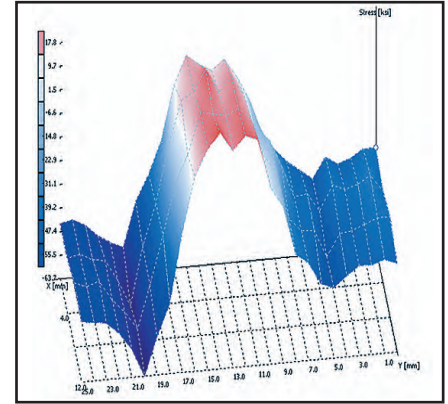
MGR40 - RESIDUAL STRESS MEASUREMENT SYSTEM



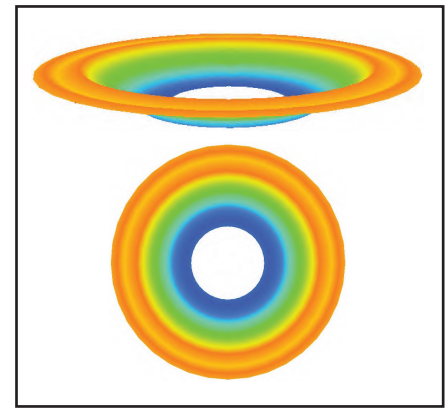
Fully automated X, Y and Z axes for portable residual stress mapping

Portable, triaxial residual stress measurement goniometer

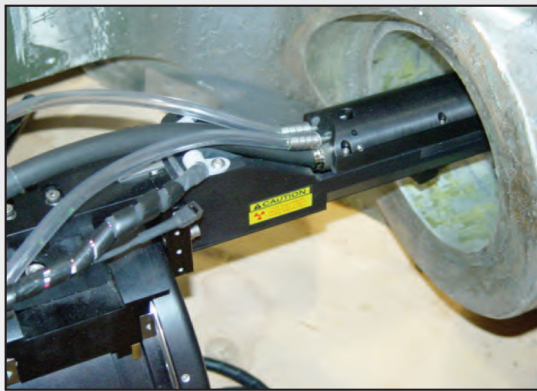
Suction cup field stand for attachment to aerospace structures such as skins and wings



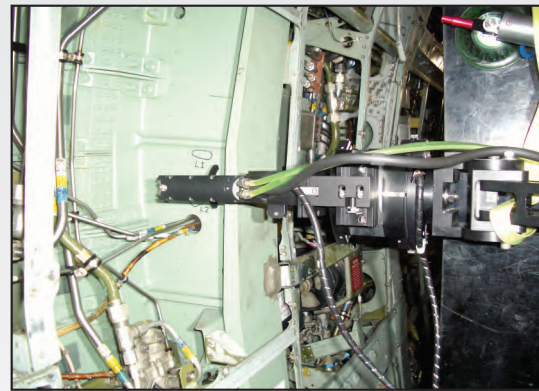
Residual stress map of a weld



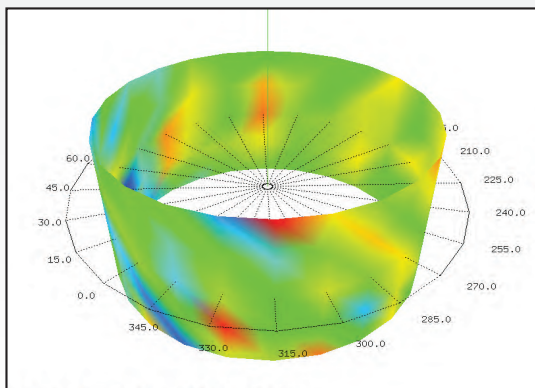
Residual stress maps of a cold expanded hole



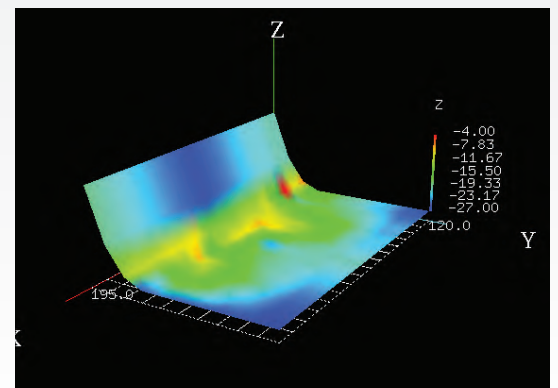
MEASURING RESIDUAL STRESS INSIDE A TRUNION



MEASURING RESIDUAL STRESS ON A C-141 FRAME



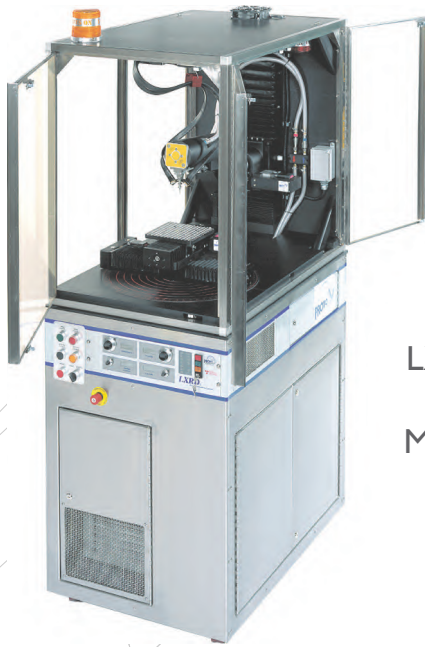
RESIDUAL STRESS MAP INSIDE A TRUNION



RESIDUAL STRESS MAP ON A C-141 FRAME

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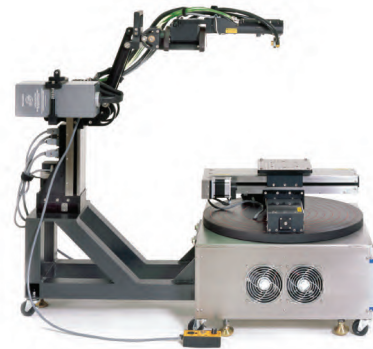
AUTOMATED X-RAY DIFFRACTION RESIDUAL STRESS MEASUREMENT SYSTEMS AND SERVICES



LXRD - LABORATORY
RESIDUAL STRESS
MEASUREMENT SYSTEM



iXRD - PORTABLE AND
INLINE RESIDUAL STRESS
MEASUREMENT SYSTEM



Modular Residual Stress Mapping



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