Non-destructive testing and inspection technologies are advancing very rapidly through the digital revolution, software development and newer imaging capabilities. Often derived from the technological community, both 2D and 3D imaging can solve complex issues in the areas of component life extension, sustainability for service, design optimization, quality control or root-cause failure analysis. High-resolution imaging has become practical, cost-effective and can save critical time when properly applied to real-world applications. However, interpretation of the radiographic images is extremely difficult due to the complex structure involved.

The quality specifications set for turbine blades and stators are very demanding as these blades and vanes are not only used in the aviation sector but also in power plant operations. Turbine blades become increasingly complex due to factors involving optimizing efficiency and weight reduction. In order to maintain high standards and life of turbine blades there should be an accurate method to analyze the blade irregularities such as incompleteness during casting process, wall thickness, controlling the position of cooling holes, hole diameter, roughness etc. These properties can be analyzed with X-ray systems during production and quality control. During maintenance and repairs turbine blades are welded back together and at this instance extensive uses of digital systems are necessary. X-ray systems such as highly dynamic radioscopy, Computed Tomography (CT), automatic defect recognition and micro focus X-ray. CT is a technique which gives the user a three dimensional interface of the inspection item. This allows the user to precisely analyze pores and the wall thickness of the sample, determine geometrical tolerances and to compare the result to the target specifications. It also gives a more accurate analysis of the inspected item than radiography due to the inspection in its three dimensional interface.

In addition, it offers great precision and this technique is also used for quality control of the production process. X-ray slice data is generated using an X-ray source which rotates around the object; X-ray sensors are positioned on opposite sides from the X-ray source and the detectors are in-line detector arrays. This kind of information helps to collect the required data and to speed up the production levels by reducing operative costs and other miscellaneous costs, for instance by reducing the number of rejects by using CT data to enable the process to be corrected on a timely basis. These techniques are widely used now ranging from highly specialized tasks in inline inspection to the universal microelectronics, meteorology and aviation markets.

Over the past 2 years, Highly Dynamic Radioscopy (HDR) has revolutionized inspection via X-rays. Details of thin and thick regions of the sample or specimen become visible when inspecting the specimen in motion and without constant adjustment of the X-ray parameters. This method is faster in detecting defects in the specimens. The term “highly dynamic radioscopy” means that a high level of detector dynamics exists in relation to depth resolution on the one hand, and that a high level of dynamics is present in relation to the image refresh rate on the other.

Inspection of turbine blades has always been a big challenge. Any irregularities in the blade have a huge impact on the gas turbine, so these blades have to be manufactured and inspected in the most sophisticated way possible. The evolution of digital radiographic technology took a leap forward to solve these problems in the industry environment which also enhances production quality and reduce rework.
Radioscopy, or inspection in motion, only works when the image refresh rate is high. Flaws are X-rayed at an optimum projection angle by moving the X-ray beam. This enables better detection. HDR-Inspection makes flaws visible in all thicknesses of the inspected item’s materials right from the start using one setting, and without the inspection operator having to change the parameters. HDR-Inspect is a product that enables the inspection operator to test the entire inspection item with assurance at a glance, even in areas with different densities, by using flat-panel detectors in combination with special software. HDR is a low-noise, fast detector displaying a high level of dynamics in combination with software optimally calibrated. The structural noise that occurs even at high doses can be prevented through multi-gain calibration and a correction of non-linear detector pixels. The complex pixel correction requires very efficient conversion within the software code to be able to be used jerk-free at 30 images per second. In this way most optimum test data can be extracted for a tested specimen. This method can only be followed in a process where one item at a time can be tested for a single run. Mass production testing with this technique is time consuming.

In the due course of time the problem solution for testing nondestructively in combination with mass production emerged in Germany called Automatic Defect Recognition (ADR). It is fully automatic radioscopic inspection system. ADR is designed in such a way that the system does not need any operator involvement as a result of an intelligent software system. All the inspected results can be attained automatically and can be reproduced at any time. The results obtained are highly objective and the decisions put forth to the system can be reproduced at any point of time including all the data specifications and indeed involved in high output rate. It has four levels of accessibility. Level 1 involves in the operating screen and production counters whereas level 2 is accessible to all programming functions which the operator feeds in. In level 3, the system has the capability to terminate the session and in the final level it deletes the cache memory which includes sample data, working directory, program function etc. as ADR is utilized in series production. The software obtains its image data from an X-ray system that is capable of processing very high unit volumes. Inspection decisions are always made according to the same objective criteria due to the ADR software. So there are different software packages depending on the applications. Each of these software packages is coordinated to match the special requirements posed by the inspection task. The only disadvantage is the software cost. Companies have to invest a lot of money compared to HDR or CT techniques. Many companies use image intensifiers either with analog or digital cameras as the image source with amorphous silicon panels with 127 to 400 micron pixel pitch. The toolbar has a progressive layout which makes the system user-friendly. Its unlimited life span and very high magnification makes this technique more usable than any other systems.

To conclude, the techniques used nowadays for the non-destructive testing of samples are diverse. Each company uses its own methodology but these three major principles are followed around the world. Each of the systems has its own advantages and disadvantages. Large scale industries which focus on mass production, implement ADR technology because it is time-efficient, but not all the companies can afford to buy the expensive software. Small scale industries, which act like an original equipment manufacturer (OEM), are choosing HDR technology or CT depending on their usability. With the involvement of modern computer aided manufacturing techniques, CT, ADR and HDR are emerging methods, which are followed from the past 5 years.

References