CASE STUDY

Preface

Dimac joined the production of sorting machines with the production of spot inspection devices in 2010, when it launched the SPC-LAB, dedicated to vision inspection of metal components (screws and fasteners) with cylindrical geometry. Since then, research and development of inspection solutions at Dimac has never stopped following the company's mission: "to lead metal component manufacturers toward a zero-defect future." The elimination of production defects for Dimac can take the form of a proposed zero-defect factory space and logistics organization. According to this idea, automated sample inspection should directly flank production by providing continuously updated data with the goal of reducing scrap at the sorting stage. Less scrap means less waste, reduced production time, higher earnings, and reduced risk of challenge.

Spot-checking in many cases is an activity still carried out by hand by production line operators: through visual inspection and using gauges or other contact means. The frequency of these inspections is arbitrary, the data collected are often not even transcribed or are on paper reports that companies then do not reprocess. Rarely is this activity integrated with that of metrology departments where, with precision instruments, parts are thoroughly analyzed and measured, with data collected and shared.

Spot-check systems in production such as those developed by Dimac aim to automate and objectify the checks performed by operators, sharing data with production and the quality management system in order to strengthen the interchange of data between departments and their use to increase business efficiency.

Given the variability in terms of size, geometry, and weight of products, the automatic sample control system in production is necessarily designed on the specific needs of the company. At the same time, each company has its own peculiarities in production data management, so interfacing must necessarily be tailored according to the specific context. However, the similarities and synergies between different manufacturers should not be underestimated, both in terms of control and measuring machine hardware and data flow management. We therefore speak of "industrialized customized solutions" to indicate that the core is built on the basis of reliable and cost-optimized modular structures, on which minimal customized elements are introduced to fit seamlessly into the factory environment.

The Dimac SPC-360 case study therefore aims to first tell the story of this approach to the problem, to show how insights of general validity can be drawn from a specific solution.

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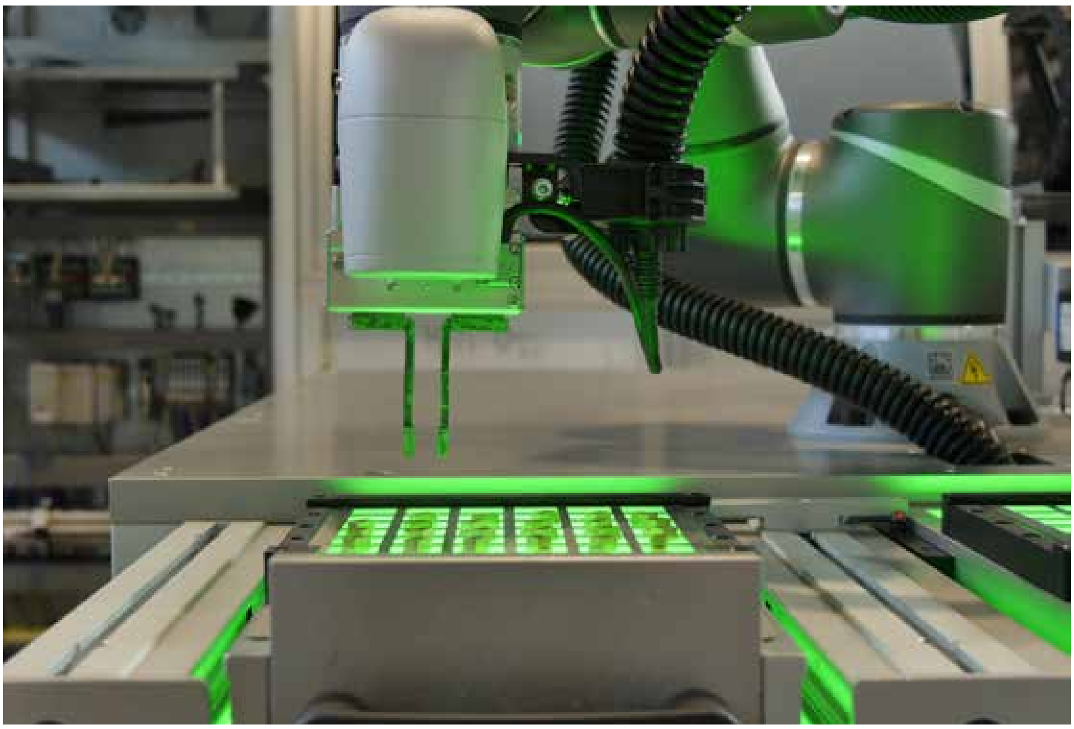
The customer’s request

The customer submitted several dozen of metal components with complex geometry, united by an external shape similar to a parallelepiped with side dimensions ranging from about 3 to 20 mm. In addition to size, the different parts differ in edge conformation, drilling, broaching, material, and threading. For the production process, different parts produced in the factory (about fifty) are required to be checked in rotation. In each inspection cycle, 10 to over 100 identical parts are subjected to measurement.

The basic requirement is the quick and accurate measurement in the inspection plan (as many as 50 different measurements for each item), which can be performed by a vision system. This involves inspecting the 6 outer faces and, in many items, also the inner faces at the broaching. Some these measurements can be obtained from profile projection (black-and-white images with backlighting), others require direct light (gray-tone images). The company’s internal procedures require that every quality control tool be subjected to MSA audits.

The customer also requested to take care of the reliability of the acquired data, not only in terms of quality of the measurement but also by thinking about any possible external interference that could lead to incorrect evaluations. Foremost among them is the issue of alignment between the control plan on the machine and the latest version of the control plan produced by the quality department. Again, the issue of subjecting acquired data to validation before it is deposited on corporate databases arises, in order to concentrate data governance operations in the acquisition stages and not progressively foul the databases with poor quality information.

Finally, attention was paid to the acceptance path of the new quality control process by the plant’s operational staff. The changing management required a dedicated project path, with specific attention to both the ergonomics of the newly introduced operations and the involvement of people in the development and start-up phase of the project.



CASE STUDY

The hardware

The study first focused on the different geometries and manufacturing tolerances of the parts, to design the hardware needed to manipulate, frame, illuminate, and photograph the wide range of items, without losing sight of the production context of insertion (oily environment, dust, vibrations) and the ergonomics of the process.

The operator places the parts to be subjected to inspection on one of two sliding drawers. Each drawer is equipped with 36 backlit slots, where the operator jave to place the parts with the only care of using the same support face. A cobot equipped with a camera on the head picks up, one at a time, the workpieces always in the same orientation and places them on the first measuring station, where images of the bottom face are acquired with either backlighting or direct illumination. The part is then moved to the main inspection station via a linear axis. This station is equipped with a horizontal camera, an upper camera and a diagonal camera; it is also equipped with an encoder rotary table: the upper face, the different side faces and the inner faces of the broaching are then acquired in sequence. A second linear axis takes the part to the exit chutes: if it is within tolerance it is unloaded into the OK box, but if it has one or more anomalies it is unloaded onto the NOK chute and made available to the operator for possible subsequent verification.

Behind the complexity of the hardware is a data management process that always places reliability at the center, starting with input verification and ending with the deposit into the customer's repository database. Some elements characterize this process and deserve to be told.

Synchronization between machine recipes and enterprise management system

SPC-360 operates according to a “recipe” that implements a control plan for a set of parts prepared by the company.

To be sure that the part is controlled according to the most up-to-date control plan, **the SPC-360 interfaces with the company’s management system before the control program starts and verifies the correct alignment.**

Recipes programmed for one SPC-360 can be transferred to other SPC-360s, and all can be synchronized over the network with the company’s computer system..

The spc controls and the interface with the enterprise production system

Companies produce many different parts, often very similar to each other.

Choosing a control plan may not be easy when items have nonspeaking or similar names: the operator must be assisted in identifying the correct item he has put into the machine.

SPC-360 interfaces with the production work plan: the operator selects on the screen the production machine from which the parts came and is offered the list of the last items produced, in order of execution in production. It is also possible to load recipes via bar-code reader or by entering the name directly on the monitor.

MSA testing and measurement accuracy

MSA tests are devoted to quality control of measuring instruments, and SPC-360, falling fully into the category of automatic instruments, is subject to MSA1 and MSA3 procedures. **Special features are provided within the software to simplify data acquisition for these two specific tests.** Dimac can then take care of the data processing and delivery of the test report.

With the SPC-360, for measurements obtained from black-and-white images by profile projection, the standard deviation settles at values of less than a micron (even for heights referred to the support plane), about twice for measurements obtained from gray-tone images.

Measurement quality and measurement problems in the production environment

One of the most onerous challenges of measuring in production is to distinguish the disturbance (caused by dust, oils, temperature, chips and filings, dirt...) from the actual contour and surface of the part.

The conditions of the production environment, where the operator performs a cursory cleaning of the part with rags or paper, are in fact very different from those in the laboratory where workpieces can be thoroughly cleaned. **Within the image processing system, specific software filters have been introduced that drastically reduce the influence of dirt on the measurement.** Since it is not always possible to discriminate dirt, manual validation of out-of-tolerance measurements was introduced, so that the operator still has the opportunity to better clean the dirty parts and repeat the measurement on the machine without having to redo the work entirely even on clean parts.

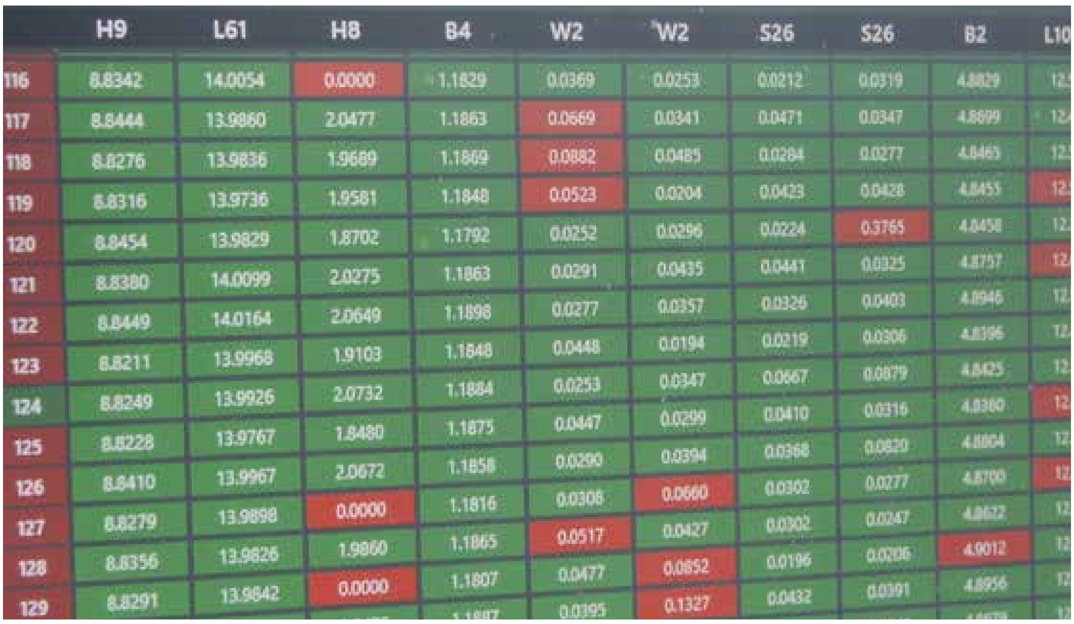
Data validation process

Within a batch of parts subject to inspection, there may be the presence of out-of-tolerance parts, but also that by chance some measurements turn out to be out of tolerance without being so (e.g., due to the presence of dirt that cannot be filtered at the software level). Since each control cycle can last several minutes and provide 5-10 thousand data, the problem arises of repeating only the unreliable measurements and validating the acquired data efficiently.

At the end of each work cycle, SPC-360 proposes a summary table of all acquired measurements in which all anomalies are highlighted. All parts with an anomaly are discarded in NOK chute so that they are immediately distinguishable from the parts that instead passed the check the first time.

The operator can intervene in several ways at this point: he can individually view the images from which the anomalies emerged to check for dirt problems, he can repeat the automatic acquisition of only the anomalous parts, he can correct the anomalies manually by typing in a manual measurement or acquiring it with a USB gauge connected to the machine, or he can accept the anomalies and close the job. All manually corrected measurements and the ID of the operator who made the correction remain tracked in the database.

Once the job is completed, the acquired data are immediately uploaded into the company's information system and are no longer manageable on the machine. At the operator's option, all or some of the acquired images can also be uploaded, such as all images of defects.



	H9	L61	H8	B4	W2	W2	S26	S26	B2	L10
116	8.8342	14.0054	0.0000	1.1829	0.0369	0.0253	0.0212	0.0319	4.8829	12.
117	8.8444	13.9860	2.0477	1.1863	0.0669	0.0341	0.0471	0.0347	4.8699	12.
118	8.8276	13.9836	1.9689	1.1869	0.0882	0.0485	0.0284	0.0277	4.8465	12.
119	8.8316	13.9736	1.9581	1.1848	0.0523	0.0204	0.0423	0.0428	4.8455	12.
120	8.8454	13.9829	1.8702	1.1792	0.0252	0.0296	0.0224	0.3765	4.8458	12.
121	8.8380	14.0099	2.0275	1.1863	0.0291	0.0435	0.0441	0.0325	4.8757	12.
122	8.8449	14.0164	2.0649	1.1898	0.0277	0.0357	0.0326	0.0403	4.8946	12.
123	8.8211	13.9968	1.9103	1.1848	0.0448	0.0194	0.0219	0.0306	4.8396	12.
124	8.8249	13.9926	2.0732	1.1884	0.0253	0.0347	0.0667	0.0879	4.8425	12.
125	8.8228	13.9767	1.8480	1.1875	0.0447	0.0299	0.0410	0.0316	4.8360	12.
126	8.8410	13.9967	2.0672	1.1858	0.0290	0.0394	0.0368	0.0820	4.8804	12.
127	8.8279	13.9898	0.0000	1.1816	0.0308	0.0660	0.0302	0.0277	4.8700	12.
128	8.8356	13.9826	1.9860	1.1865	0.0517	0.0427	0.0302	0.0247	4.8622	12.
129	8.8291	13.9842	0.0000	1.1807	0.0477	0.0852	0.0196	0.0206	4.9012	12.
				1.1887	0.0395	0.1327	0.0432	0.0391	4.8956	12.