



Understanding Type I and Type II Errors in Precision Machining

The impact of statistical decisions on quality.

In the realm of statistics and quality control, the concepts of Type I and Type II errors are key to understanding how decisions are made and the potential consequences of those decisions. While these terms are often discussed in the context of hypothesis testing, their significance extends far beyond theoretical statistics. Understanding the practical implications in precision machining is important when mistakes are not acceptable in the no-fail industries we serve.

Defining Type I and Type II Errors

A Type I error, also known as a “false positive,” occurs when a test incorrectly rejects a true null hypothesis. In simpler terms, it means detecting a problem or defect when none exists.

A Type II error, or “false negative,” happens when a test fails to reject a false null hypothesis, or when a test fails to identify a real problem or defect.

In manufacturing and particularly in the precision machining industry — where accuracy and tight tolerances are critical, the distinction between these two types of errors can mean the difference between success and failure.

Type I Errors in Precision Machining

Imagine a quality control inspection where every part is measured to ensure it meets strict specifications. If the

inspection system commits a Type I error, a part that meets all requirements is incorrectly deemed defective and rejected. While no faulty part reaches the customer, it also means waste. In our shops we strive to eliminate waste — wasted material, wasted operator time, wasted machine time — which all increase production costs. Reducing the number of Type I errors in our shops helps us preserve the value that our performers create.

Type II Errors in Precision Machining

A Type II error, on the other hand, occurs when a defective part passes inspection. This is the worst possible scenario in our shops. Parts that have been 100% inspected but defective parts still make it to the customer. In no-fail industries,

this can be especially dangerous. A defect might lead to mechanical failure, safety hazards or even death.

Consider a scenario where a faulty gage allows undersized parts to make it to a medical device manufacturer making heart valves. The repercussions could be disastrous. If a Type II error occurs when the valve is tested at the customer, it could lead to it being installed in a patient.

One answer to this problem is tightening our acceptance criteria; however, this would increase Type I errors and result in more parts that meet customer specifications being rejected. Although I would much rather have parts that meet spec be rejected than the non-conforming parts making

Actual	Predicted		
		Negative	Positive
	Negative	True Negative	False Positive
	Positive	False Negative	True Positive

it to the customer, there must be balance. The goal is zero percent Type II errors and as few as possible Type I errors.

Understanding and managing these errors is essential for our shops to eliminate mistakes.

In practice, achieving the goal of zero Type II errors means that we can never achieve zero Type I errors. The challenge is to create

systems that reduce variation. Statistical process control is the best solution in our toolbox to provide scientific actionable data to reduce variation

Conclusion

Type I and Type II errors are not just abstract statistical terms. They are concrete realities that affect operational efficiency, product quality and profitability. Understanding and managing these errors is essential for our shops to work to eliminate mistakes. Continuous improvement involves educating ourselves on the potential for problems and eliminating them before they happen. When we understand how we can fail, poka-yokes (mistake-proofing) can be added to the process reducing our potential for failure. **P**

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