
**Statistical methods in process
management — Capability and
performance —**

**Part 1:
General principles and concepts**

*Méthodes statistiques dans la gestion de processus — Aptitude et
performance —*

Partie 1: Principes et concepts généraux



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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22514-1 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 4, *Applications of statistical methods in process management*.

ISO 22514 consists of the following parts, under the general title *Statistical methods in process management — Capability and performance*:

- *Part 1: General principles and concepts*
- *Part 3: Machine performance studies for measured data on discrete parts*
- *Part 4: Process capability estimates and performance measures* [Technical Report]

The following parts are planned:

- *Part 5: Process capability statistics for attribute characteristics*
- *Part 6: Process capability statistics for characteristics following a multivariate normal distribution*
- *Part 7: Capability of measurement processes*

It is planned to reissue ISO 21747, *Statistical methods — Process performance and capability statistics for measured quality characteristics*, as part 2 of ISO 22514 in the future.

Introduction

0.1 This introduction to capability treats the subjects “capability” and “performance” in a general way. To fully understand the concepts, it would be helpful to consult ISO 22514-3, ISO/TR 22514-4 and ISO 21747. These documents extend this introductory explanation to more specific uses of the procedures.

A process can either be a discrete process or a continuous process. A discrete process generates a sequence of distinguishable items and a continuous process generates a continuous product (e.g. a lane of paper).

The purpose of a process is to manufacture a product or perform a service which satisfies a set of preset specifications. The specifications for a process under investigation are defined for one or more characteristics of the product or service. However, in process performance or capability, only one characteristic is considered at a time. The characteristic can be measurable, countable or a property. The process thus generates either a discrete or a continuous stochastic process.

- The discrete process can be
 - a process of real numbers,
 - a process of natural numbers, or
 - a process telling which event from a set of events has occurred for the individual items.

As an example, the set of events for the individual items could be {colour acceptable; colour not acceptable}.

In general, the notation for a discrete stochastic process is $\{X_i\}$, where X_i is the outcome of element i in the process. In the case where the characteristic is a property X_i , it is a value given to each of the events in the set of events used for characterizing the process. For a discrete process, the index i is normally the number of the item in the generated sequence of items. However, sometimes it may be more convenient to use the time from a fixed point as the index.

- When the process is continuous, a number of possibilities exist for the index, depending on the nature of the product. When the product is e.g. a lane of paper, the index could be the length from a starting point or it could be the time from a fixed point.

It should be noted that normally a serial correlation exists in a stochastic process.

A stochastic process is either stationary or non-stationary. The stringent definition of a stationary stochastic process will not be given here. However, for a stationary process, a distribution exists for X_i which is independent of i .

To obtain a process which satisfies the specifications, the stochastic process should be a stationary process or a well-defined non-stationary process (e.g. a periodic process).

To evaluate a process, a performance study is performed. A performance study should, in fact, start as a theoretical study of all the elements in the process before the process is physically implemented. When the parameters of the various stages in the process have been analysed and redefined, the process is implemented (this may be only as a test process).

Based on sampling from the implemented process, the numerical part of the performance study of the process is started. A number of questions concerning the process must, beyond any reasonable doubt, be answered correctly. The most important question to be answered is whether the process is a stationary process which is

stable or predictable for a reasonable period. For the process, it is then important to identify the probability distribution of the process and to obtain estimates of the distribution parameters within a reasonable small variance. Based on this information, the next stage in the performance study is to map the properties of the characteristics under investigation and decide whether they are acceptable. If the properties cannot be accepted, the parameters of the process itself must be changed in order to obtain a process with acceptable properties.

Consider a well-defined and implemented process that has been accepted using a performance study. The next stage for the process would then be to ensure that the parameters of the process and, thus, of the stochastic process do not change, or change in a predicted way. This is performed by defining a suitable capability study.

Studies of performance and capability indices are used more and more to assess production equipment, a process, or even measurement equipment relative to specification criteria. Different types of studies are used depending on the circumstances.

0.2 The concepts of performance and capability have been subject to large shifts of opinion. The most fundamental shift has been to philosophically separate what is called “capability conditions” in this part of ISO 22514-1 from “performance conditions”, the primary difference being whether statistical stability has been obtained (capability) or not (performance). This naturally leads to the two sets of indices that are to be found in 2.2 and 2.3. It has become necessary to draw a firm distinction between these sets, since it has been observed in industry that companies have been misled about their true capability position due to inappropriate indices being calculated and published.

Statistical methods in process management — Capability and performance —

Part 1: General principles and concepts

1 Scope

This part of ISO 22514 describes the fundamental principles of capability and performance of manufacturing processes. It has been prepared to provide guidance about circumstances where a capability study is requested or is necessary to determine if the output from a manufacturing process or the production equipment (a production machine) is acceptable according to appropriate criteria. Such circumstances are common in quality control when the purpose for the study is part of some kind of production acceptance. These studies may also be used when diagnosis is required concerning a production output or as part of a problem solving effort. The methods are very versatile and have been applied for many situations.

This part of ISO 22514 is applicable to the following:

- organizations seeking confidence that their product characteristics requirements are fulfilled;
- organizations seeking confidence from their suppliers that their product specifications are and will be satisfied;
- those internal or external to the organization who audit it for conformity with the product requirements;
- those internal to the organization who deal with analysing and evaluating the existing production situation to identify areas for process improvement.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1 Basic terms

2.1.1

requirement

need or expectation that is stated, generally implied or obligatory

[ISO 9000:2005, definition 3.1.2]