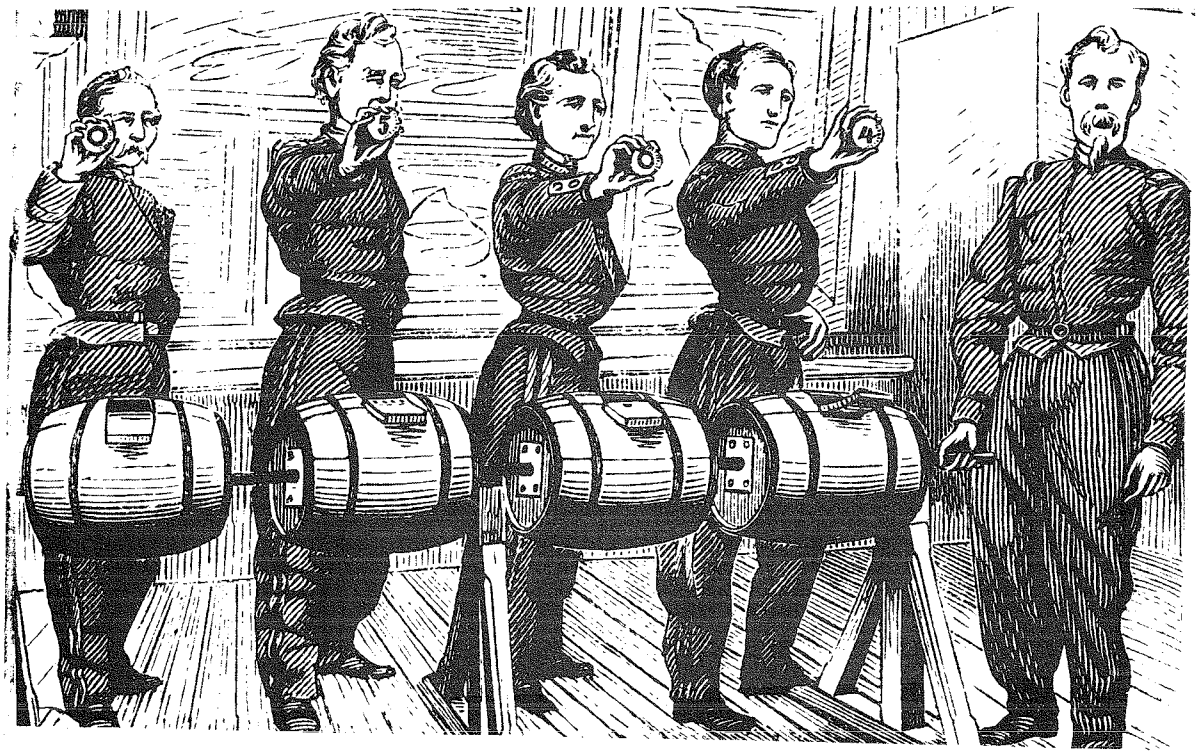

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Abstracts of Papers

I. Virtanen (Turku School of Economics): *Generalized Reliability Characteristics for Systems with States of Reduced Efficiency.*

GENERALIZED RELIABILITY CHARACTERISTICS FOR SYSTEMS WITH STATES OF REDUCED EFFICIENCY

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Abstract

The paper deals with the concepts and characteristics of system reliability, especially in such a case when the system has several possible levels of performance. A situation like this occurs, for example, when the failure of a component or subsystem only reduces the efficiency of the system instead of making it completely inoperable. An example is given by an electrical power system, where a power block can be in operation at a lower level of performance than the maximum: a failure of a smoke ventilator leads to a reduction in available power, but the block is still operating.

When analyzing the reliability of systems with states of reduced efficiency, the traditional characteristics used for two-stage operable or inoperable systems (i.e. when the system is in one of the two states: failure-free and thus capable of full performance or failed and under repair) are unsuitable and inadequate. The reliability of the system remains unresolved (there exist situations when the system is neither fully operable nor fully inoperable, so that reliability cannot be determined at all), or it gets a value which contradicts empirical observation (if operation with reduced efficiency is regarded as normal operation, too high reliability is obtained; if a reduction in efficiency is regarded as total inoperability, too low reliability is obtained).

In order to remove this deficiency, a new definition with an extension in content is given for the concept of reliability. In making the extension, the following requirements are set (to quarantee the teoretical wellfoundness and empirical and logical adequacy):

(a) Failures having a limiting effect on the efficiency of the system are also referred to factors, which decrease the reliability of the system, but their influence is dependent on the seriousness of the consequences of the failure.

(b) When the generalized reliability is applied to general multi-stage systems, we get empirical interpretations analogical to those which re-

sult, when the traditional reliability is applied to ordinary two-stage operable or inoperable systems.

(c) When a two-stage operable or inoperable system is under consideration, the generalized reliability coincides with the traditional concept of reliability.

(d) The mathematical definition of the generalized reliability remains within the limits of the general mathematical definition of reliability (e.g. the definition of Barlow and Proschan or Gnedenko).

(e) The numerical value of the reliability can be determined directly from the behavioural properties of the system, e.g. from the state probabilities of the system.

The quantitative definition of the new, more comprehensive concept of reliability is specified in the form of the following quantitative characteristics. The characteristics are now functions not only of time (as the traditional ones) but also of the level of performance of the system.

Availability of levels of performance, $A_O(c,t)$ is defined as the probability

$$A_O(c,t) = \Pr\{\text{the level of performance of the system at time } t \text{ is } \geq c\}.$$

Mean availability of the capacity, $A_C(t)$ is defined as

$A_C(t)$ = the mean value of the proportional level of performance of the system at time t.

Reliability of levels of performance, $R_O(c,t)$ is defined as the probability

$$R_O(c,t) = \Pr\{\text{the level of performance of the system during the interval } [0,t] \text{ is at least } c\}.$$

Mean operation time of levels of performance, $T_O(c)$ is defined as

$T_O(c)$ = the mean value of that time period after which the level of performance of the system for the first time becomes less than c.

Further, expressions for calculating the generalized characteristics of reliability directly on the basis of the state probabilities are derived in the paper. Remarks on empirical interpretations, properties under steady state and statistical estimation of these characteristics are also given.