

What is a semi-repetitive process?

A semi-repetitive process is a production or operational cycle that lies between repetitive (constant work content) and non-repetitive (memoryless) processes. It has a characteristic, recognizable structure (mode) but includes random, partial variations in work content between cycles. Such processes are partially predictable, with variations often caused by changes in "process identity".

Key Usage Examples

- **Medical Procedures:** Open-heart surgeries are semi-repetitive; while they have a common core, the number of bypasses varies between patients.
- **Manufacturing:** Assembly lines that are easily stopped, started, or adjusted for small batches, often termed semi-continuous.
- **Business Operations:** Administrative tasks like order entry, bank reconciliation, and handling customer calls in a call center.
- **Industrial Processes:** Semi-continuous pyrolysis used for bio-oil production, which improves upon batch inconsistencies.
- **Robotics:** Robot pick-and-place tasks where the robot repeats a cycle (collecting a payload, transferring it, returning) until a shutdown command.

Characteristics

- **Variable Duration:** While a "typical" time exists (mode), it is not necessarily the average time.

- **Predictability:** Unlike fully random processes, semi-repetitive processes allow for estimations of time and resources, though these become less reliable as variability increases.
- **Process Repetitiveness Measure (PRM):** A tool to measure how much a process is semi-repetitive based on the distance between the mode and mean, often negatively correlating with the Coefficient of Variation (CV).

Major References

Haim Shore, a prominent researcher in quality and reliability engineering, is the primary source for the modern academic definition and modeling of semi-repetitive processes. His work establishes a framework for analyzing processes that fall between strictly repetitive and completely random (memoryless) states. A key academic reference to his work is the four-part series (published February, 2026):

Part 1: [Engineering Implications of Semi-Repetitive Processes](#)

Part 2: [The Dual-Component Variation of Semi-Repetitive Processes](#)

Part 3: [Measuring Repetitiveness of Semi-Repetitive Processes](#)

Part 4: [Reliability of Process-Time Prediction for Semi-Repetitive Processes](#)

Other Key Academic References

The following works also provide core definitions, mathematical modeling, and engineering implications:

- Shore, H. (2024): "[A novel approach to modeling steady-state process-time with smooth transition from repetitive to semi-repetitive to non-repetitive \(memoryless\) processes](#)" — Published in Quality and

Reliability Engineering International, this is the most comprehensive recent reference. It introduces the Random-identity Paradigm, viewing work-content variation as a change in "process identity".

- Shore, H. "[Layman’s Abstract for Quality and Reliability Engineering International article: A novel approach to modeling steady-state process-time with smooth transition from repetitive to semi-repetitive to non-repetitive \(memoryless\) processes](#)". Published in June, 2023, in Stats & Data Science Views.
- Shore, H. (2021): "[SPC scheme to monitor surgery duration](#)" — Published in Quality and Reliability Engineering International, this work applies semi-repetitive modeling to medical procedures, a classic example of the concept.
- Shore, H. (2021): "[Estimating operating room utilisation rate for differently distributed surgery times](#)" — Found in the International Journal of Production Research, it examines how semi-repetitive variability affects resource planning.
- Shore, H. (2020): "[An explanatory bi-variate model for surgery-duration and its empirical validation](#)" — Published in Communications in Statistics, this provides the empirical foundation for treating surgery as a semi-repetitive process.

Foundational & Supporting Works

While Shore formalized the "semi-repetitive" term, these references provide the broader context of process variability and manufacturing:

- **Manufacturing Classification:** The distinction between repetitive and intermittent (job-shop) systems is traditionally referenced back to De Toni & Panizzolo (1995) in their comparative study of manufacturing characteristics.
- **Statistical Theory:** For the underlying distribution theory (such as why the mode departs from the mean in these processes), Shore cites Stuart & Ord (1987), Kendall's Advanced Theory of Statistics.
- **Automation Context:** Modern references like Hosseini et al. (2015) discuss surgical duration estimation using data mining, which aligns with the need to predict semi-repetitive process outcomes.

Quantifying how "repetitive" a process is - the Process Repetitiveness Measure (PRM)

PRM is a statistical metric developed by Haim Shore to quantify how closely a process adheres to a "typical" repeatable cycle. It serves as a bridge between strictly repetitive systems (where work content is constant) and non-repetitive ones (where there is no discernible typical state).

Conceptual Basis: Mode-Mean Departure

The fundamental logic of PRM is that in a repetitive process, the distribution of completion times is highly concentrated around a single value (the mode). As a process becomes semi-repetitive or non-repetitive, the "typical" time (mode) drifts further away from the average time (mean) due to increasing random variations in work content. Refer to [Why the mode departs from the mean – A short communication.](#)

Metric Definition:

PRM is defined as the standardized distance between the mode and the mean of the process-time distribution.

Mathematical Components: It is typically expressed in terms of the first four statistical moments (mean, variance, skewness, and kurtosis). A practical proxy is the Coefficient of Variation (CV). Shore's research demonstrates that for many practical applications, the Coefficient of Variation (CV)—the ratio of the standard deviation to the mean—is a reliable and simpler alternative to PRM. PRM and 1-CV are often positively linearly correlated. For specific distributions, like the Gamma distribution (commonly used for surgery times), they are mathematically equivalent. Using 1-CV is often preferred because estimating the 3rd and 4th moments, required for a full PRM calculation, involves larger standard errors and requires significantly more data.

Application in Predictability

The PRM is used to determine the predictability threshold of a process.

Predictable: High PRM (low CV) indicates a strong "process identity", where completion times can be accurately forecasted (taking into account random error variation).

Unacceptable: When PRM drops below a certain statistical criterion, the process ceases to be predictable, meaning management can no longer rely on time estimates for scheduling (e.g., in operating room utilization).

The following below summarizes all three process types:

Summary Table of Process Types

Process Type	Work Content	PRM / CV Level	Predictability
Repetitive	Constant	Very High PRM / Low CV	Certain (apart from error)
Semi-Repetitive	Partially Variable	Moderate PRM / CV	Statistical / Probabilistic
Non-Repetitive	Memoryless (no typical work-content)	Low PRM / High CV	Impossible