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w1.1- Understanding Statistical Process Control (5:29)

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w1.1- Understanding Statistical Process Control (5:29).mp4

Foundations

- Forms data into patterns
- Promotes understanding
- Grounded in statistical principles
- Uncovers special causes of variation
- Inferences based on samples
- Detects product or process performance shifts

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SPC helps us to frame data into understandable patterns.

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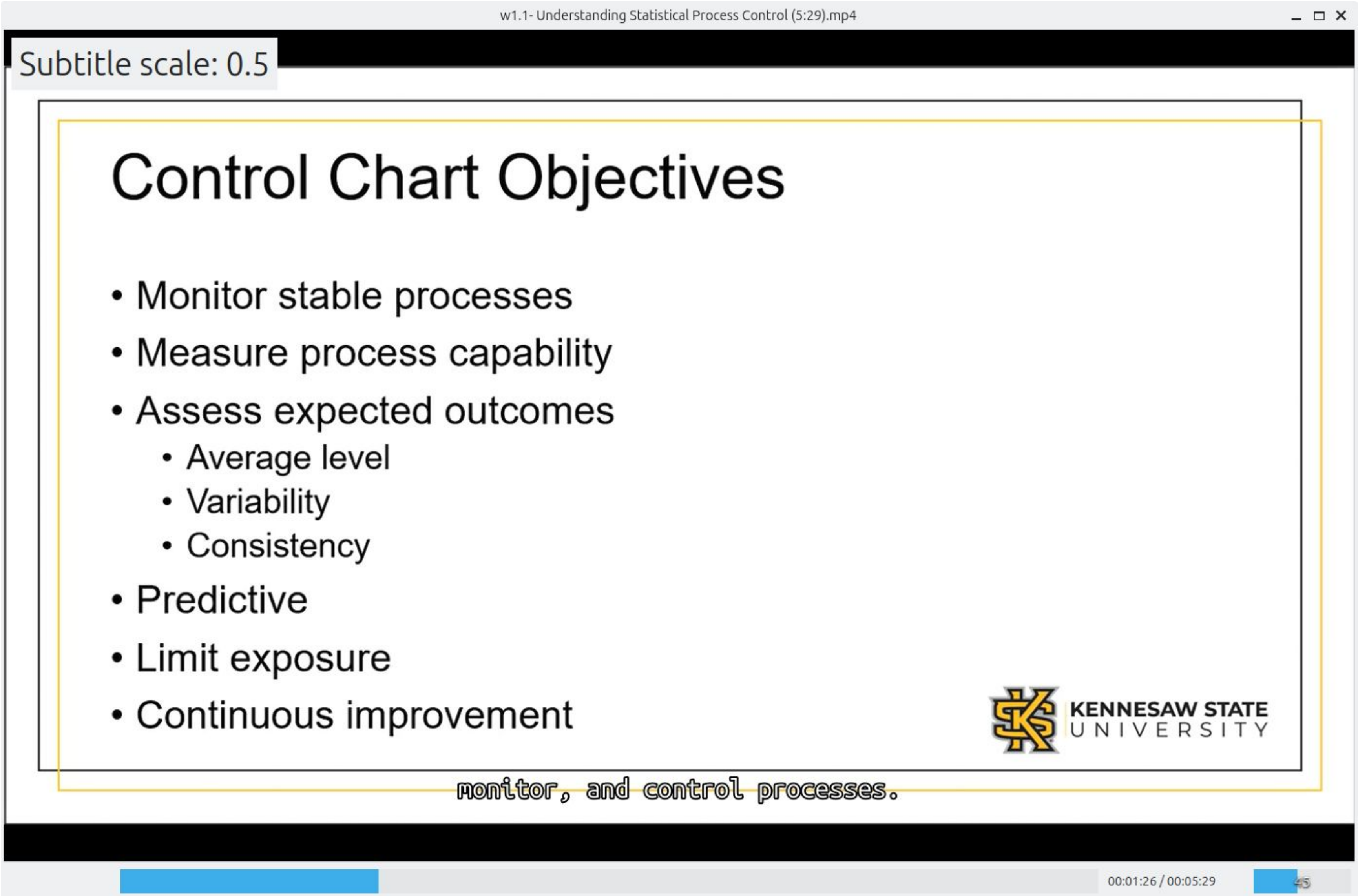

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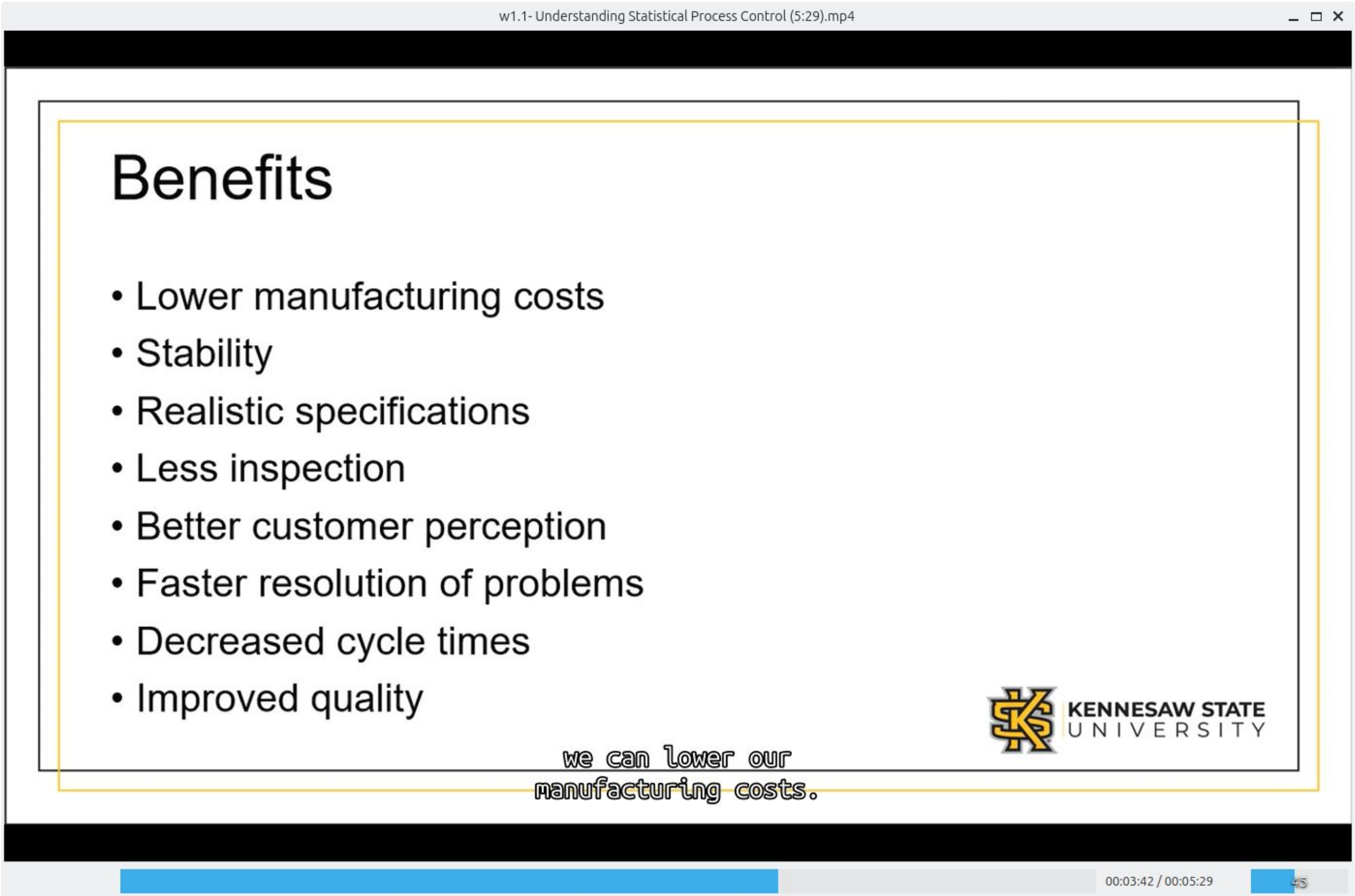

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SPC Costs

- Determining what will monitored
- Data collection
- Control charts
- Training
- Oversight
- Corrective action

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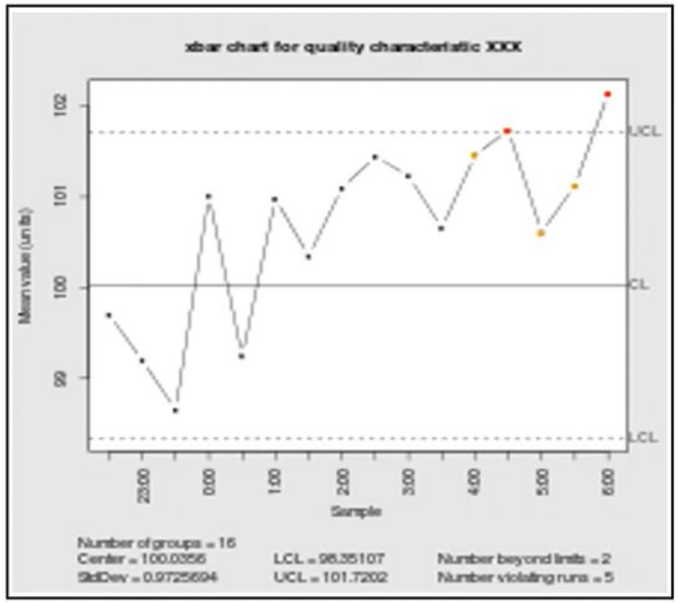
w1.1- Understanding Statistical Process Control (5:29).mp4

Structure of a Control Chart



https://en.wikipedia.org/wiki/Control_chart

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Statistical Process Control (SPC) uses statistical tools to visualize, analyze, and control processes consistently, favoring a proactive approach to maintain output quality.

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Core Objectives and Implementation

- **Upstream Control**: In Six Sigma, the focus shifts from monitoring final outputs to controlling "vital Xs" (input variables) to maintain consistent results.
- **Targeted Deployment**: SPC is an involved process that should only be deployed where it is critical to business aims.
- **Implementation Needs**: Successful execution requires selecting appropriate variables, setting up data collection methods, providing training, and dedicating resources for investigation and corrective actions.

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The Role of Control Charts

Control charts, also known as Shewhart charts, are the primary feature of SPC.

- **Components:** These charts display measured statistics (mean, range, or proportion) against a center line (CL) and calculated upper and lower control limits (UCL and LCL).
- **Stability and Variation:** They help distinguish between random variation and "special cause" variation, allowing operators to detect performance shifts.
- **Capability Assessment:** Black Belts use these charts to determine if a process is operating as expected by comparing its functional range to specified tolerances.
- **Problem Localization:** Control charts signal issues instantly, allowing examinations to be localized to only the material produced since the last check, thereby reducing scrap.

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Key Benefits

- **Cost and Quality**: Proactive SPC lowers manufacturing and inspection costs while improving stability, quality, and customer relationships.
- **Operational Efficiency**: Implementation often leads to decreased cycle times and faster problem resolution.
- **Continuous Improvement:** These tools provide a reliable method to measure parameters both before and after process changes to monitor improvement efforts.

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w1.2- Rational Subgrouping (5:46)

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In Six Sigma, **rational subgrouping** is the practice of organizing data into groups that allow you to distinguish between two types of variation: variation occurring within a process at a specific point in time, and variation occurring over time.

The goal is to collect data in a way that makes it easy to see if your process is "in control" or if there are outside factors causing "special cause" shifts.

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The Two Dimensions of Variation

Rational subgrouping works by isolating variation into two distinct buckets:

Type of Variation	Definition	Goal in Subgrouping
Within-Subgroup	Variation between items produced under the same conditions (same operator, same batch, same machine).	This should represent the "natural" or **common cause** noise of the process.
Between-Subgroup	Variation that occurs over time or across different shifts, batches, or locations.	This should reveal **special causes** or trends that need fixing.

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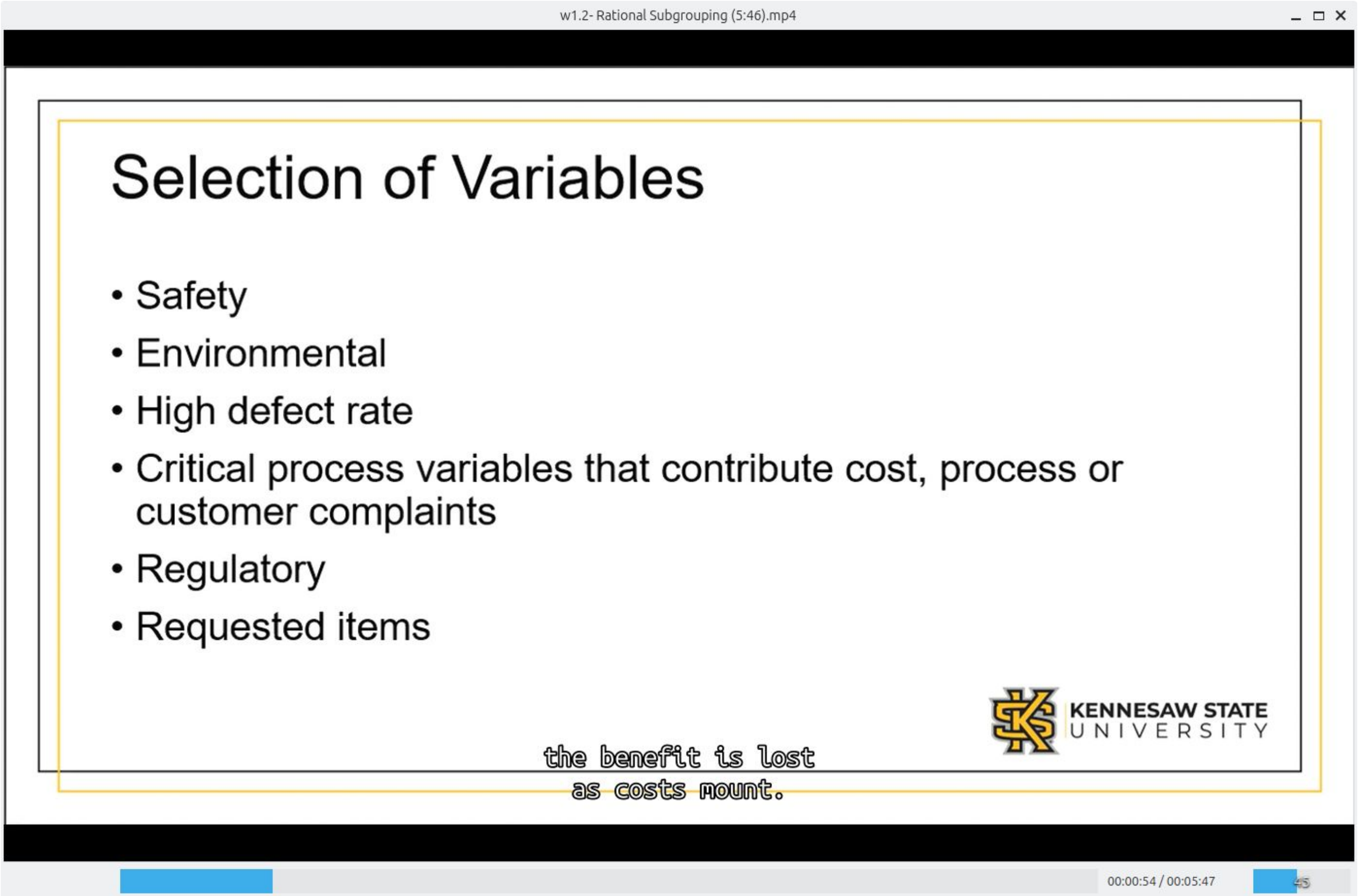

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Rational Subgrouping

- Selection
  - Homogenous
  - Maximum variation
  - Process knowledge
- Types
  - Time based
  - Representative state

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Principles for Subgrouping

- Standard sampling
- Never subgroup unlike things
- Minimize variation within subgroup
- Maximize variation between subgroups
- Average across noise

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Control Limits and Subgroup Size

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This transcript details the strategic implementation of Control Charts and the critical role of rational subgrouping. The core message is that monitoring must be purposeful; over-monitoring creates a burden that can make a process "clouded and ineffective."

Here is a summary of the key concepts discussed:

1. Selecting What to Monitor

You shouldn't monitor everything. Focus on the "vital few" variables that impact the entire process. Selection criteria include:

- **Safety and Regulatory requirements.**
- **High defect rates** or customer complaints.
- **Critical Process Variables:** Identifying the one variable that others depend upon.
- **Tools for selection:** Use Pareto charts, ANOVA, or Design of Experiments (DOE) to find these priorities.

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2. The Mechanics of Rational Subgrouping

Subgrouping is how we organize data to see the difference between "noise" (common cause) and "signals" (assignable cause).

- **The Golden Rule:** Minimize variation *within* a subgroup (keep it homogeneous) and maximize the potential for variation *between* subgroups.
- **Time-Based Subgrouping:** Items are collected in the order of production. This is the best way to catch shifts in the process average.
- **Representative Subgrouping:** Used for product acceptance; a random sample is taken from all products made since the last check.
- **Size Matters:** Smaller, frequent subgroups (e.g., 5 groups of 5) are much more informative than one large group (e.g., 1 group of 25). Larger groups are more likely to hide a process shift within the average.

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3. Error Types and Control Limits

The transcript explains the balancing act required when setting control limits, typically at $\pm 3\sigma$.

Error Type	Definition	Result of Wide Limits	Result of Narrow Limits
Type 1	Treating random noise as a problem (False Alarm).	**Decreases** (fewer false alarms).	**Increases** (too many false alarms).
Type 2	Missing a real process shift (Failed Detection).	**Increases** (limits are too "loose").	**Decreases** (more sensitive to change).

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Key Recommendation

For most processes, aim for a **subgroup size of 2 to 6.** This range provides enough sensitivity to detect shifts (reducing Type 2 errors) without becoming overly sensitive to natural variation (Type 1 errors).

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w1.3- Sources of Variation (3:37)

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w1.3- Sources of Variation (3:37).mp4

Special Cause Variation

- Unexpected
- Unpredictable
- Infrequent
- Examples
  - Machine malfunction
  - Operator issues
  - Faulty adjustment
  - Defective material
  - Training

eliminate special cause variation.

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w1.3- Sources of Variation (3:37).mp4

Common Cause Variation

- Due to random chance
- Noise
- Healthy

- Examples
  - Inadequate procedures
  - Poor design
  - Poor maintenance
  - Poor working conditions
  - Inadequate material
  - Measurement error
  - Normal Wear

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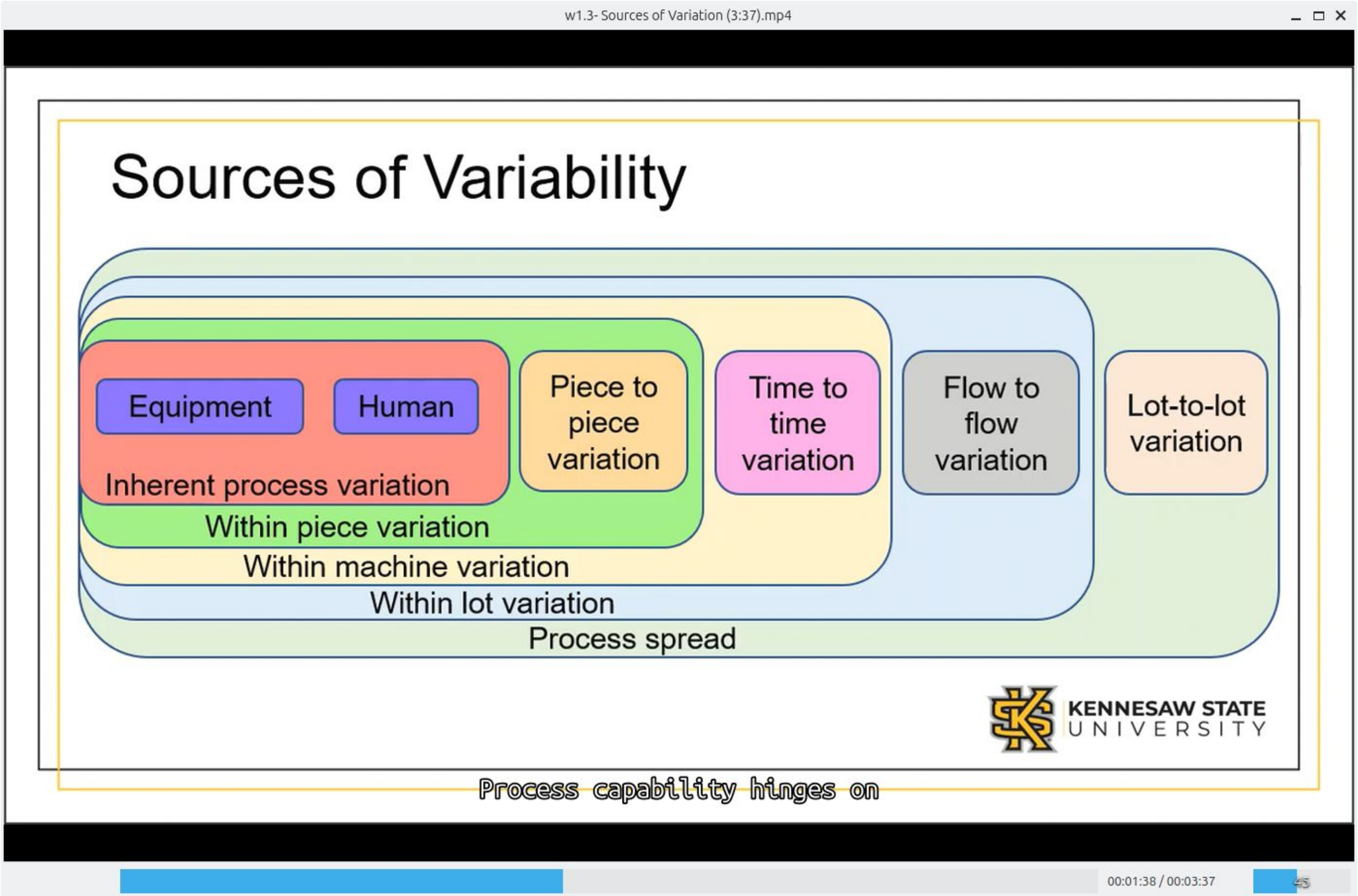

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Understanding the different types and sources of variation is critical for effectively managing a manufacturing process. In SPC, the primary goal is to distinguish between variation that can be fixed and variation that is inherent to the system.

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1. Special Cause vs. Common Cause Variation

The first step in analyzing a process is identifying the nature of the "noise" or changes observed.

- **Special Cause (Assignable Cause) Variation**: This is variation that can be traced to unexpected and unpredictable behaviors.
  - **Goal**: Find and eliminate these specific issues.
  - **Examples**: Machine malfunctions, incorrect equipment settings, defective materials, or a lack of operator training.

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- **Common Cause (Chance Cause) Variation:** This is considered "healthy" variation or inherent noise within the system.
  - **Warning**: Mistaking common cause for special cause can lead to increased variation due to unnecessary adjustments.
  - **Examples**: Inadequate procedures, normal equipment wear, and standard measurement error.

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2. Peeling Back the Sources of Variability

You can think of long-term process variation like an onion; you must "peel away" specific layers to reveal the inherent process capability.

Variation Layer	Description
Lot-to-Lot	Changes in the process average as you move between different batches.
Within-Lot	The dispersion of measurements inside a single batch or lot.
Machine-to-Machine	Variation based on the flow of products across different pieces of equipment.
Time-to-Time	Isolating changes that occur purely due to the passage of time.
Piece-to-Piece	Differences found when inspecting individual products sequentially.

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3. Measurement Error and Inherent Capability

Even after accounting for the layers above, human and mechanical factors still contribute to the total variation.

- **Measurement Error:** This results from how a part is handled, the choice of measurement location, and the instrument used. It is often a mix of human factors and equipment condition.
- **Interactions:** Significant variation can come from the interaction between the human operator and the instrument or equipment.
- **Inherent Process Capability:** This is what remains after all other sources are isolated. It represents the purest state of reproducibility under ideal operating conditions.