

The KUKA logo is displayed in a bold, orange, sans-serif font. The background features a light gray, low-poly geometric pattern with several small, white, faceted diamond-like shapes scattered across it.

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Robot Performance Assessment: Current Shortcomings and Proposed Improvements

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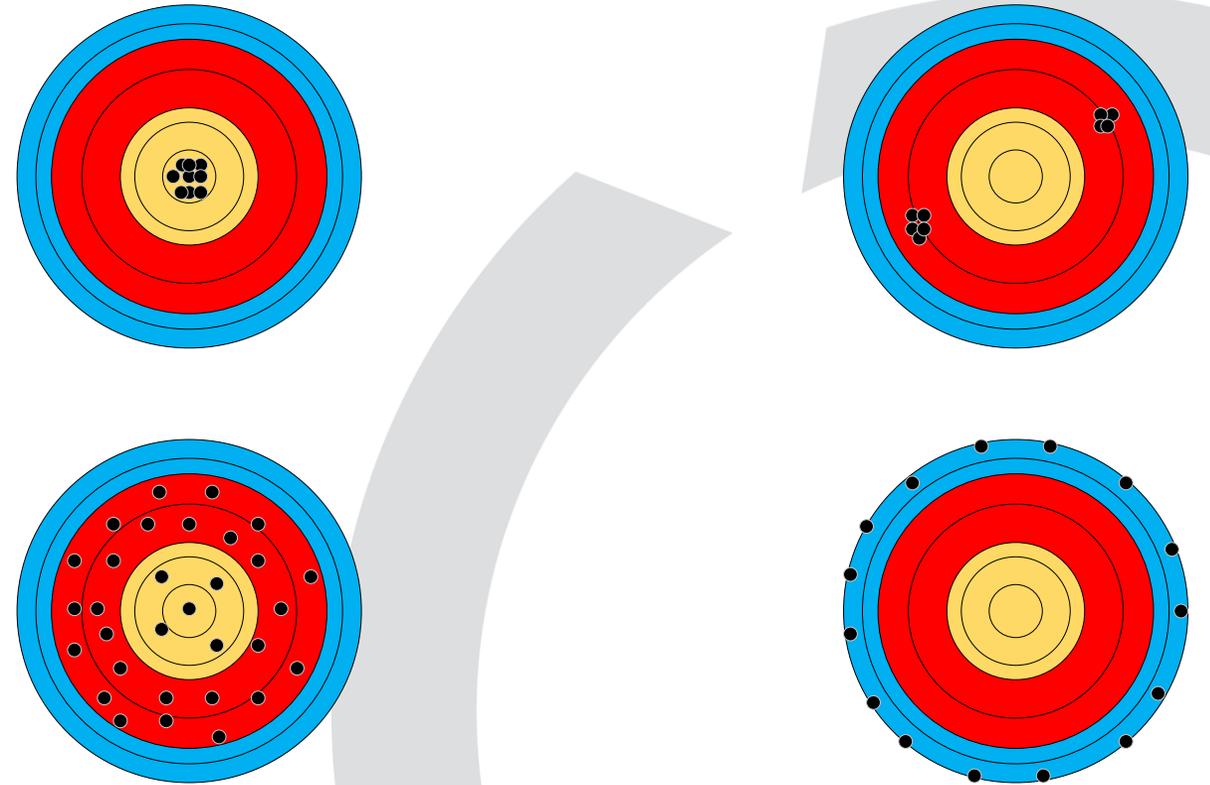
Issues with Current Standards

- No longer suitable for current robot applications
 - Complex paths
 - Highly dynamic motions
 - Performance throughout the robot envelope
 - Varied velocity performance demands (from very low to very high speed)
- Open to interpretation
 - Tests can be setup to produce the best outcome
- No good basis to compare robots
 - Different ISO cubes, different loads, different speeds, etc.
- Definitions and methods lack rigor
- Some items can be left to the manufacturer to define
 - e.g. Limit band for stabilization time

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Issues with Current Standards

The definition of accuracy makes it possible for a robot to be more accurate than repeatable



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Issues with Current Standards

Inconsistent definitions

$$CR = \max CR_j \quad j = 1, 2, 3$$

$$CR_j = \min \sqrt{(x_i - x_e)^2 + (y_i - y_e)^2 + (z_i - z_e)^2} \quad i = 1 \dots m$$

$$CO = \max CO_j \quad j = 1, 2, 3$$

$$CO_j = \max \sqrt{(x_i - x_{ci})^2 + (y_i - y_{ci})^2} \quad i = 1 \dots m$$

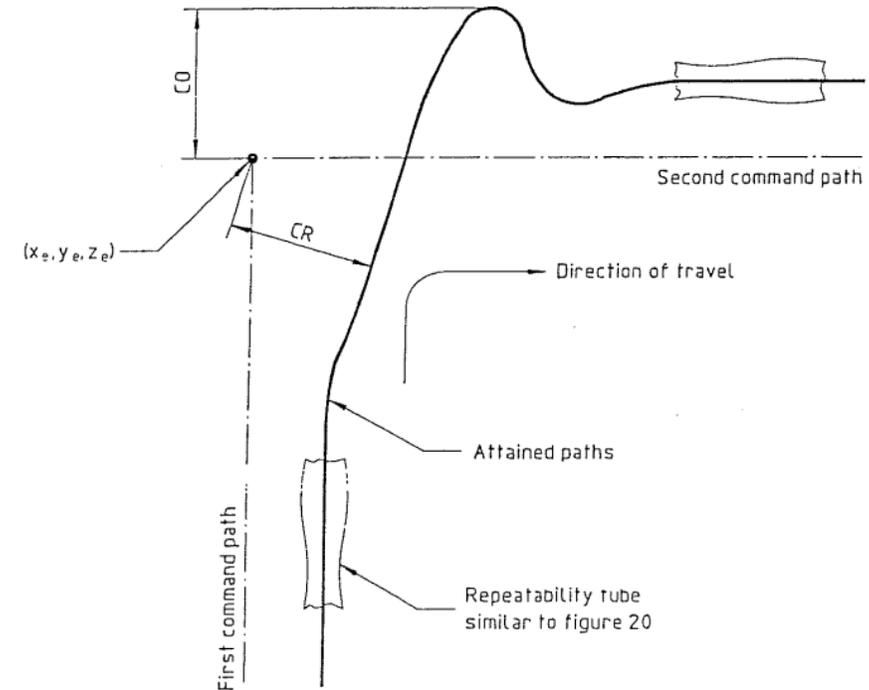


Figure 22 - Cornering overshoot and cornering round-off error at a sharp corner



Proposed Improvements

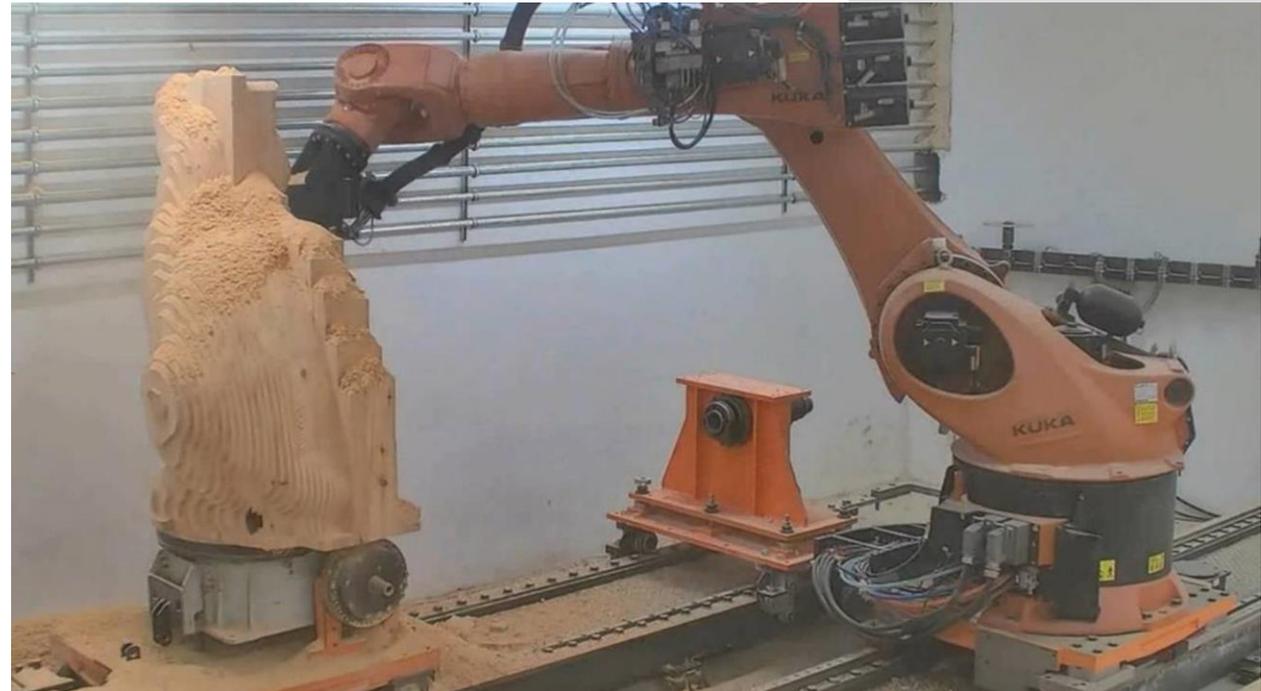
Application-based standards

- Specific trajectories and criteria
 - Tailored to robot reach and DOFs
- Complements standard performance criteria

Proposed Improvements

Application-based standards – Milling-Type

- 6D Accuracy
 - Full range of orientation
- Wide robot motion range
 - Parts require robot to stretch out and tuck in
- Cornering
- Velocity accuracy
- Applications:
 - Milling
 - Additive manufacturing

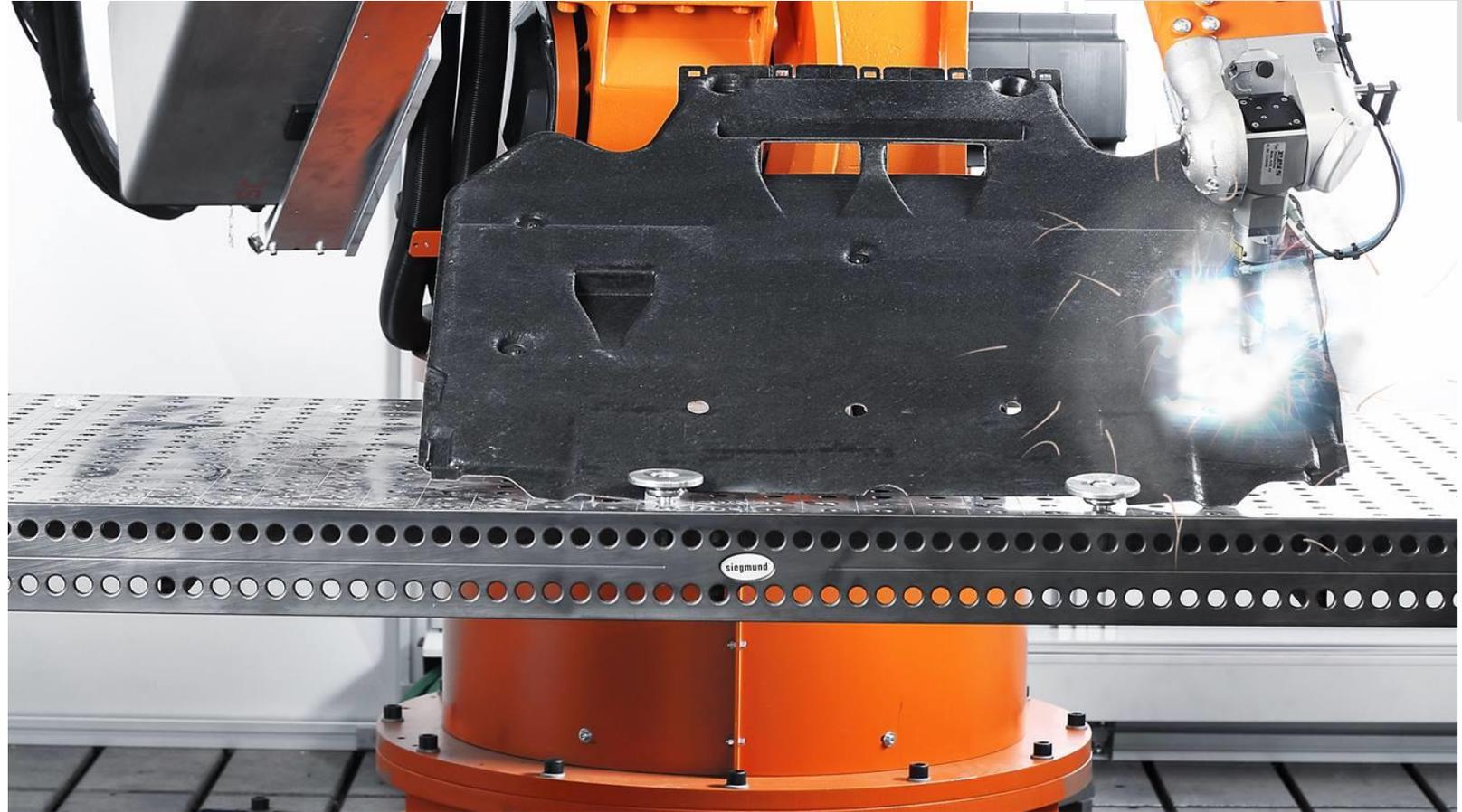


Proposed Improvements

Application-based standards – Cutting/Separating

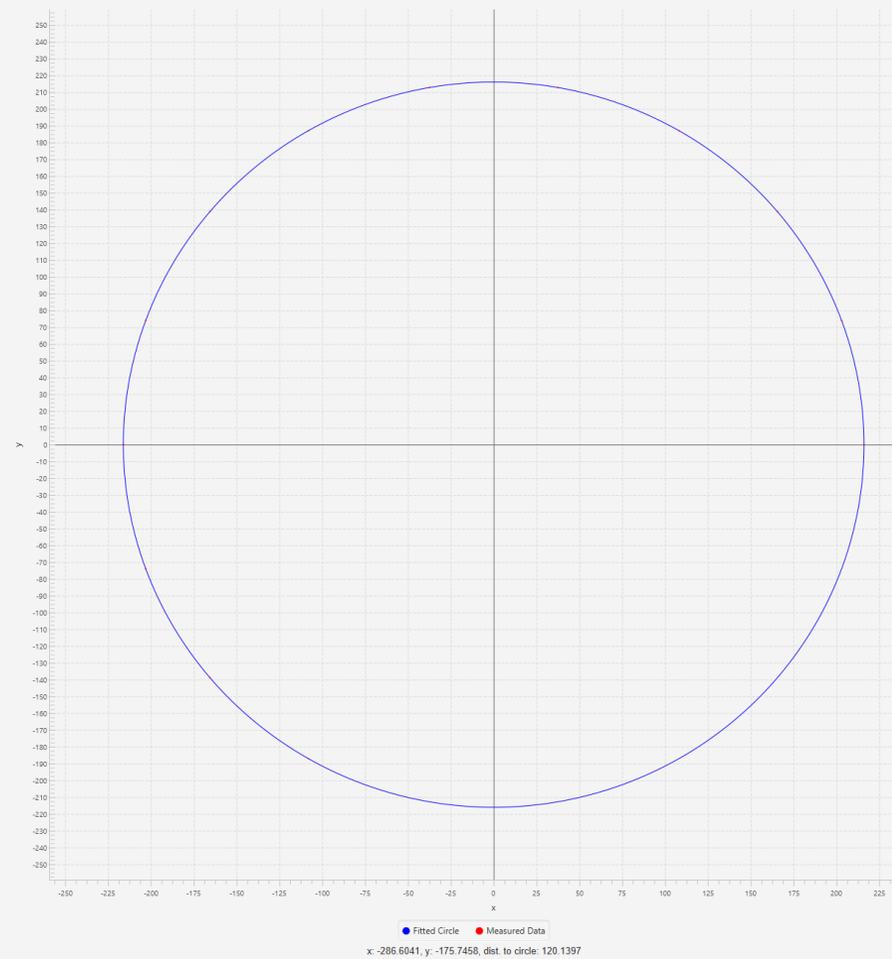
- “Planar” accuracy
- Cornering
- Velocity accuracy
- Very low speed

- Applications:
 - WaterJet cutting
 - Laser cutting



Proposed Improvements

Application-based standards – Cutting/Separating



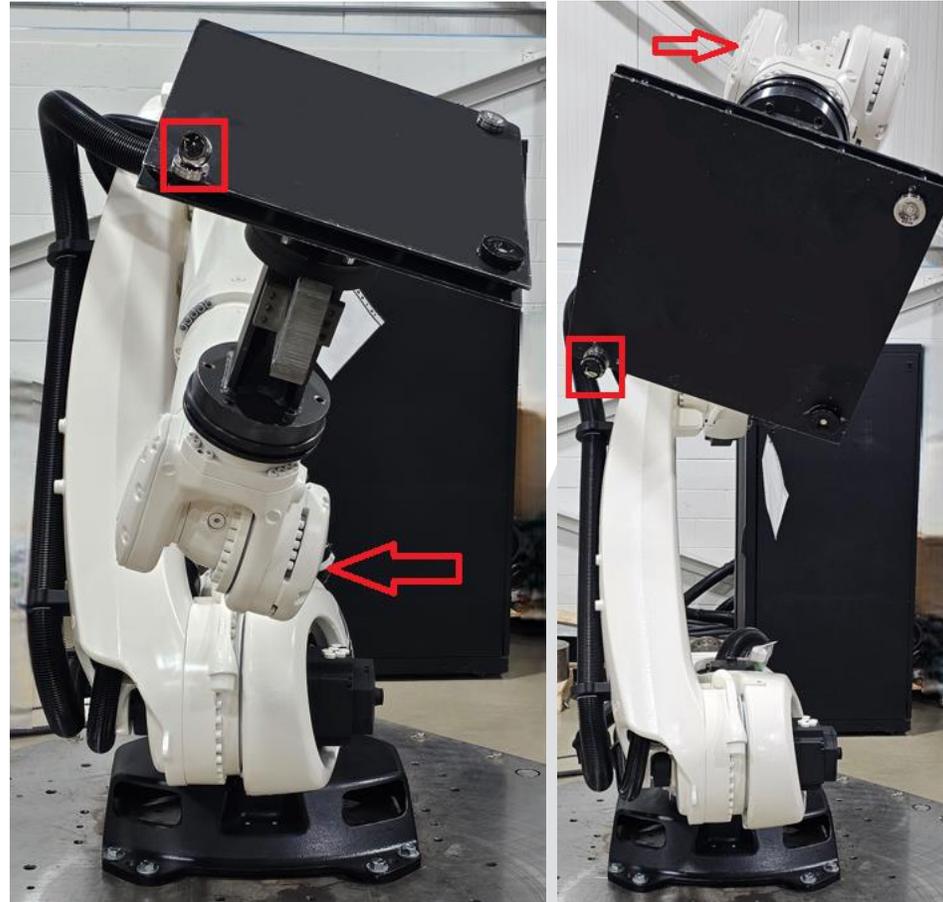
Proposed Improvements

- Fixed-TCP accuracy
- Performance at the edges
- Stopping times and distances
- Drift due to joint re-mastering (re-calibration)
- Low speed performance
- Small circle performance
- Component exchangeability
- Pose drift due to high ducty cycles

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Proposed Improvements

Fixed-TCP



Proposed Improvements

Absolute Accuracy Calibration

- Process severely handicapped by measurement systems
 - Accuracy
 - Range
 - Line of sight
- Need for better tools



THANK YOU!