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FastCAD – An Innovative Approach to Delivering RCS-informed Survivability Intelligence in Tactically Relevant Timeframes

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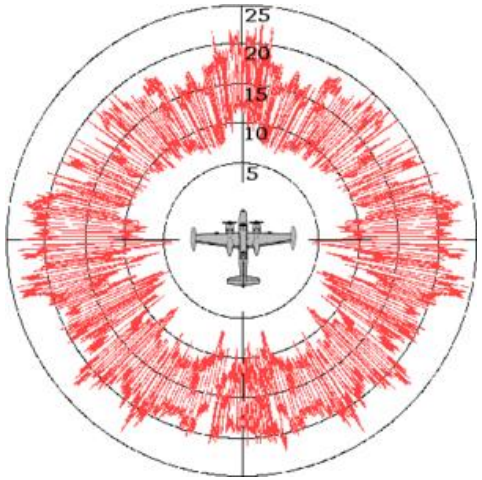
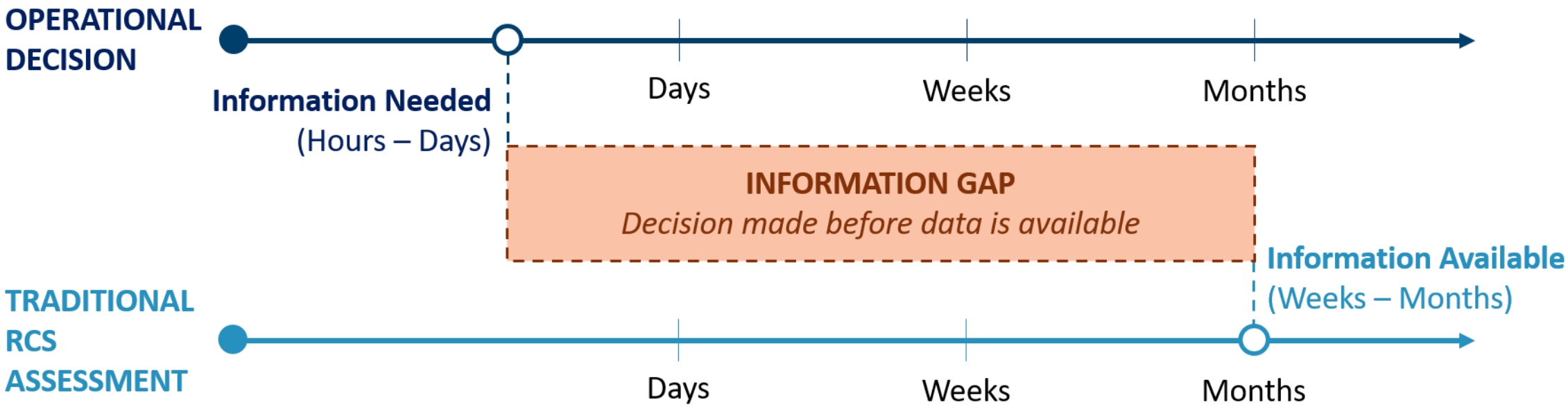
The Mission Problem

- Modern maritime operations **require**:
  - Rapid survivability assessment
  - Current platform signature information
  - Decisions at operational tempo





Traditional RCS Measurement Systems

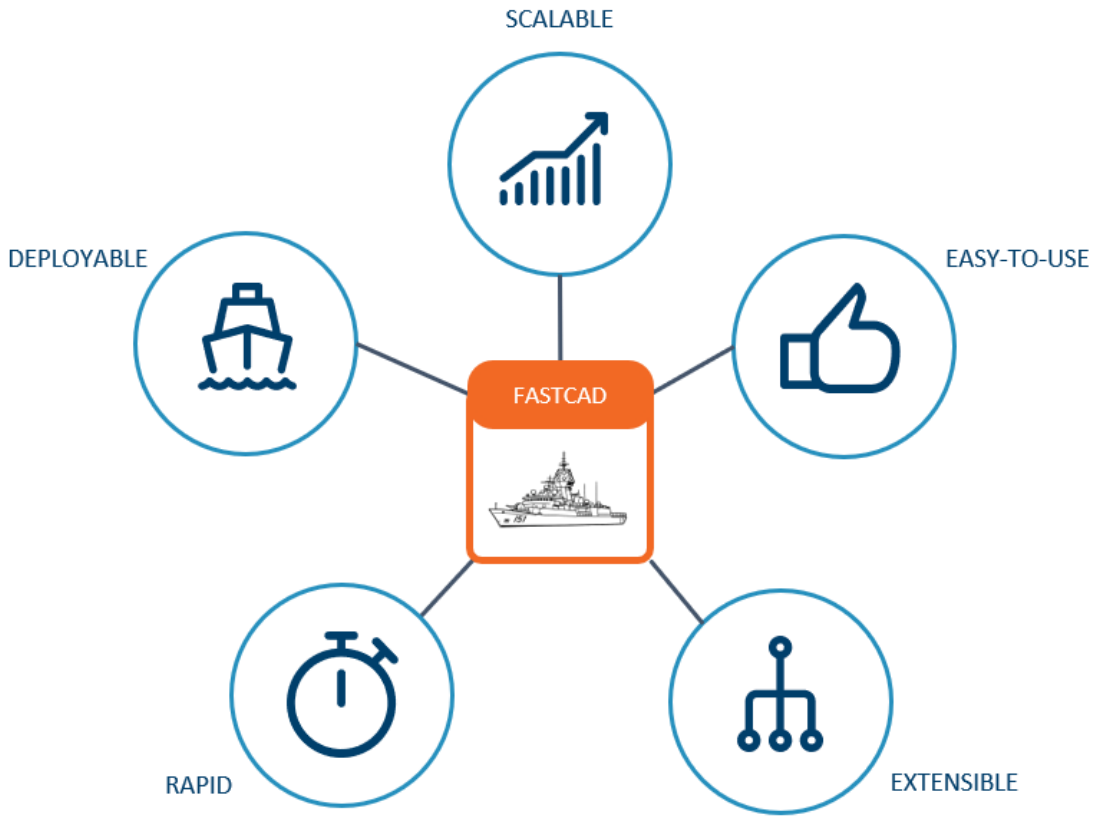
- Current RCS measurement systems:
  - Helicopter-borne radar (ASMS)
  - Shore-based measurement system

- Both systems are:
  - Suitable for high-resolution RCS predictions (directly measure RCS)
  - Expensive to operate
  - Constrained to specific trial environments
  - **Not** optimised for **rapid** assessments or capturing data in an operating environment

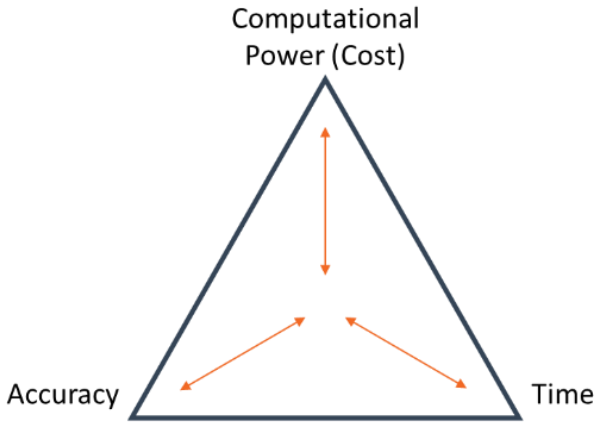
Problem: Timeliness, Location, Cost

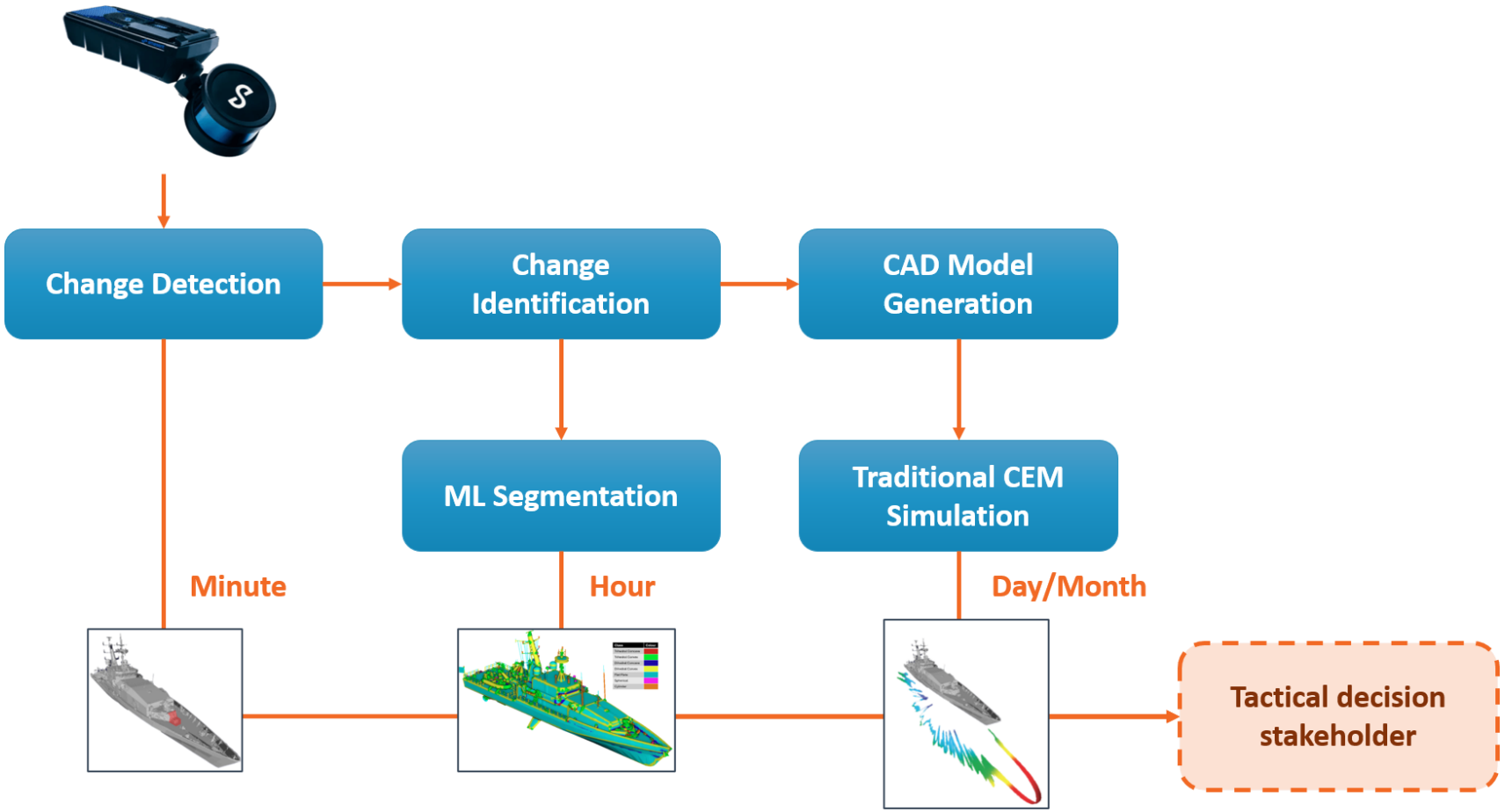
The Mission Scope

- Useful before the decision window closes
- Useable onboard as a portable capability
  - Operate outside of controlled “trial” environments
- Straightforward to operate (*no specialist knowledge*)
- Platform type and operational scenario agnostic



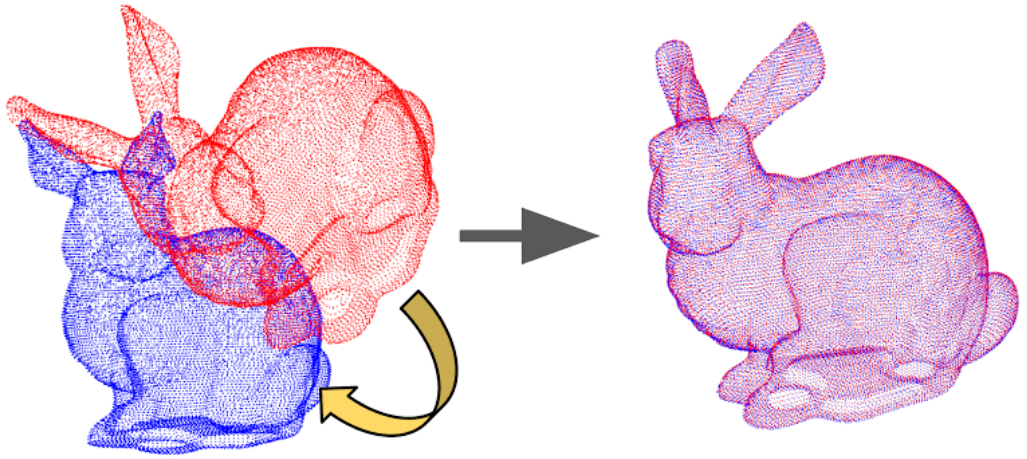
FastCAD Multi-Approach Overview

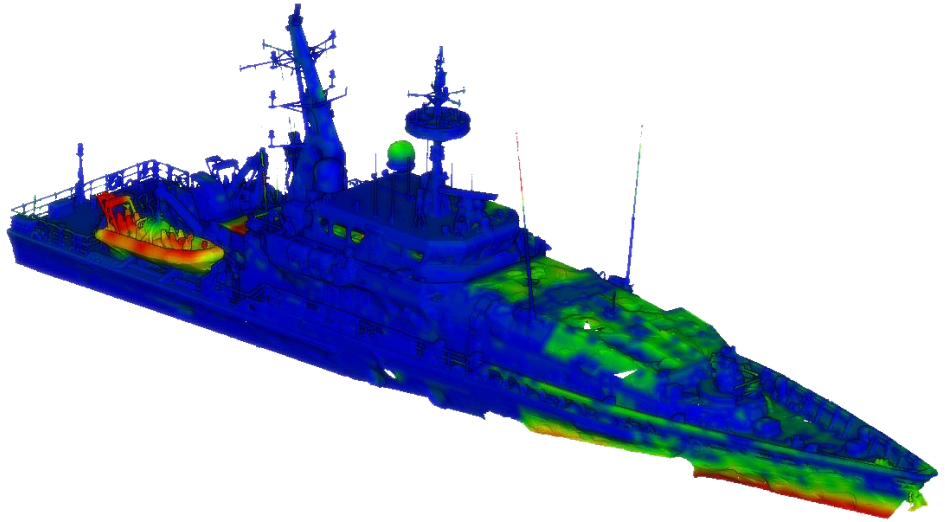




Change Detection

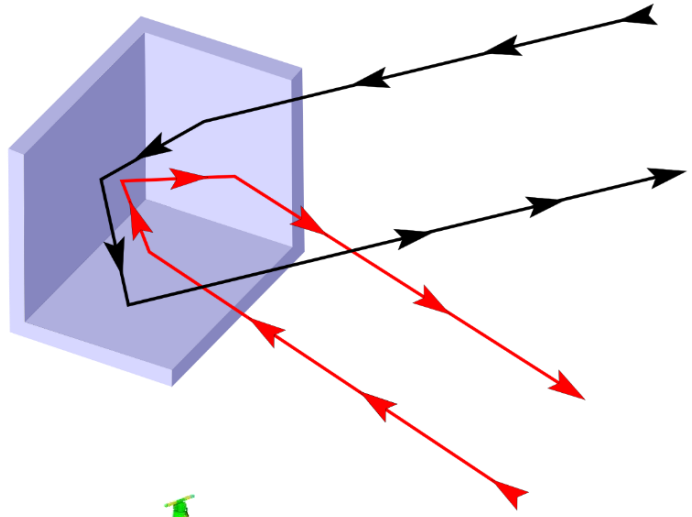
- Two key stages:
  - **Registration**: Align point clouds into a common frame
  - **Comparison**: Measure differences between datasets
- **Iterative Closest Point** (ICP) for efficient point cloud registration
- **KDTree** for fast nearest-neighbour searches
- Change quantified using the **median distance** to the nearest n points
- Results visualised as a colour-coded change map

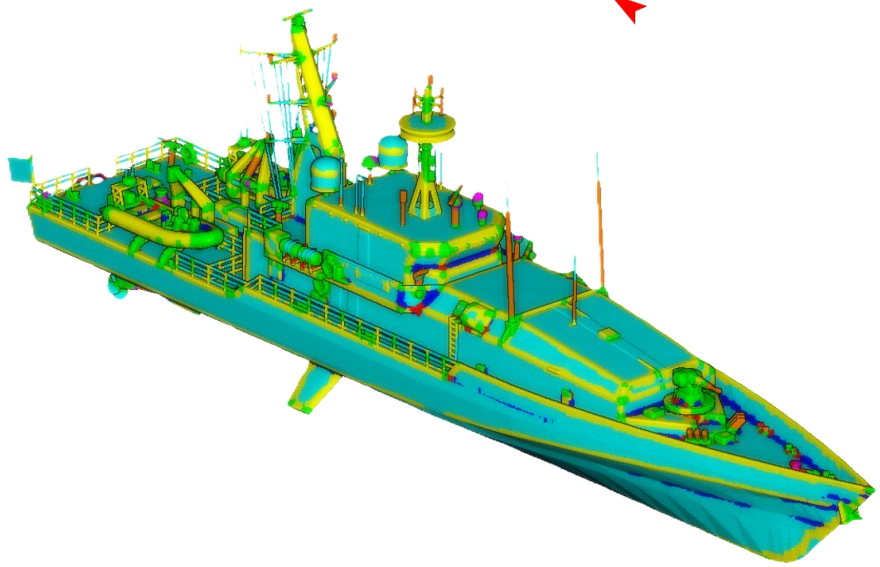




ML Feature Segmentation

- Identification of geometry that is likely to have significant impact on a platform's RCS
- Sought and highlighted geometry that:
  - May significantly impact RCS signature (e.g. corner reflectors)
- In future the intention is to provide indications about what bearings of the vessel are affected





Benefits

- Quicker processing speed, providing crew feedback in hours
- Crew can understand the impact of changes or even do something about it immediately (rearrange or modify)

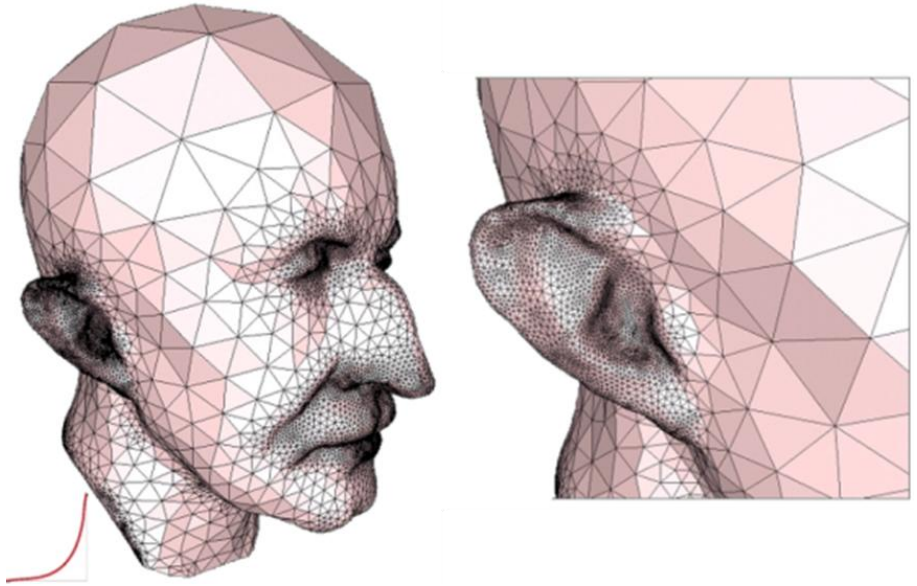
CAD Model Generation

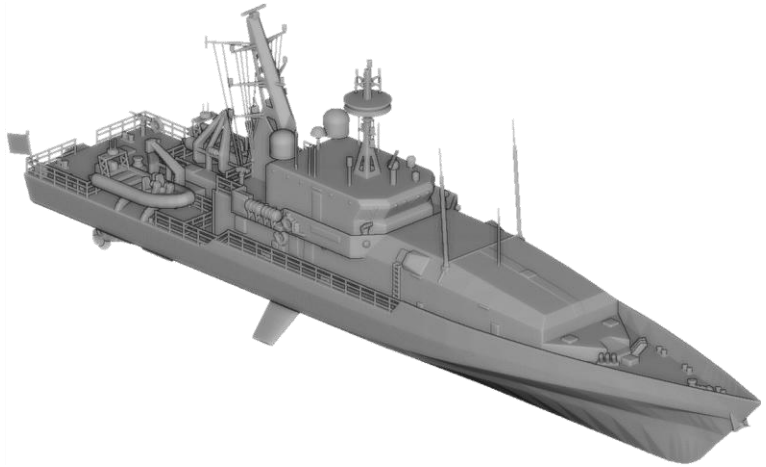
Memory-Efficient Processing

- Large point clouds create significant memory challenges for matrix-based algorithms ($n \times n$)
- Batch processing to divide large problems into manageable chunks
  - m^2 of $\frac{n}{m} \times \frac{n}{m}$
- GPU parallelisation to maintain performance while reducing memory requirements

Dynamic Decimation

- Many platform surfaces have low geometric complexity
- Uniform high-resolution meshes are inefficient and increase RCS simulation costs
- Used eigenanalysis to estimate local geometric complexity
- Applied complexity-driven decimation:
  - Reduce mesh density in simple regions
  - Preserve detail in complex areas





Closing

- Future work
  - Articulate operational application
  - Improve system to meet operational application
    - **Change Detection:** work toward a real-time capability
    - **ML Feature Segmentation**: introduce a feedback loop with signature results
    - **CAD Model Generation**: introduce ML feature segmentation for targeted / repetitive reconstruction
  - Conduct operational trials

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