



## TMT RESEARCH PROJECT – 2025/2026

*A.I. Enhanced Machine Vision System for  
Automated Flange Bolting Robot “Boltron” for  
Mining and Minerals Processing Infrastructure*



# tmt

## Who are TMT?

- Established 1999
- Harsh Environment Automation and Equipment
- Local, In-house Design and Manufacturing
- Industrial Equipment and Tooling Systems
- 300 employees across all engineering disciplines



## Australia – Head office

Bibra Lake, W.A. (Two-Storey, 5000m<sup>2</sup>)



## Malaysia

Kuala Lumpur



## United Kingdom

Aberdeen



## Brazil

Rio de Janeiro





# TMT's Origins – Subsea ROV's



NOMAD

2000



NAVIGATOR

2002



TYPHOON MK1

2008



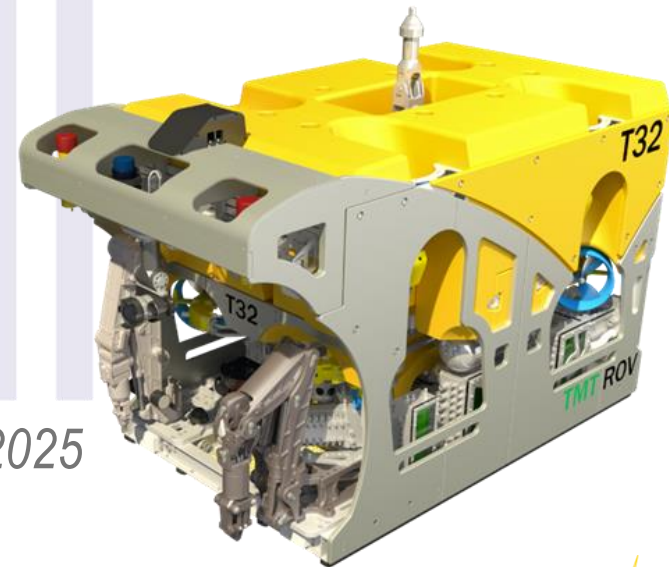
TYPHOON MK2

2011



TYPHOON MK3

2017



TYPHOON MK4

2025

### Applications

- Energy Sector
- Research & Scientific
- Defence

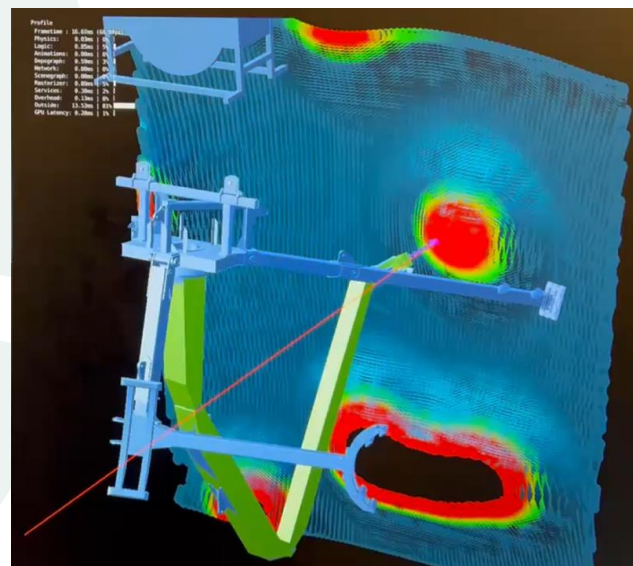
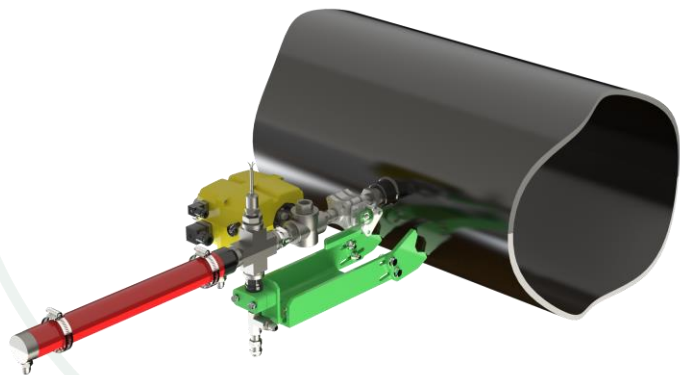
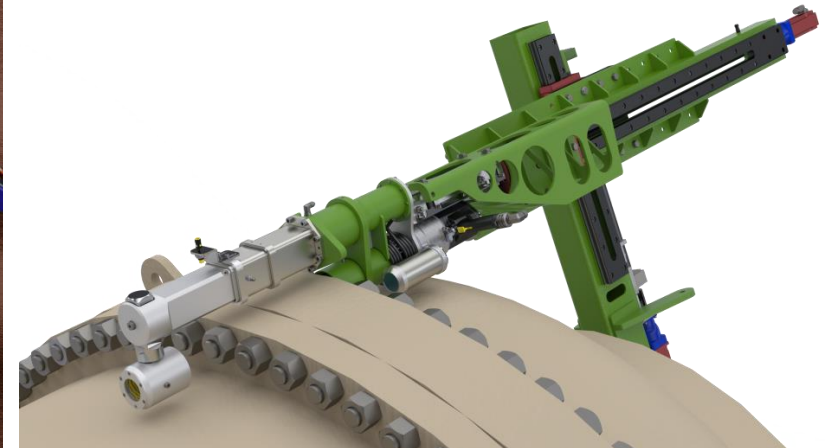
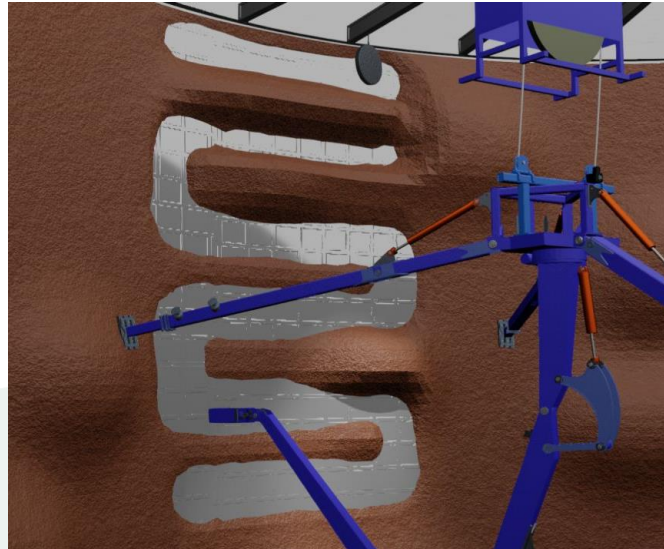
### Available Ratings

- Depth Rating: Up to 7000m
- System Power: Up to 200HP
- Hydraulic and Electrical Tooling Circuits



# TMT Advanced Technologies

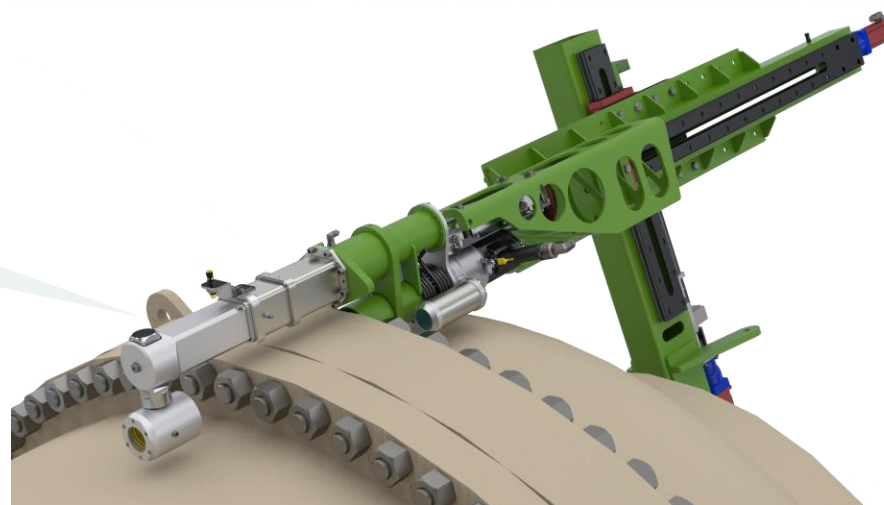
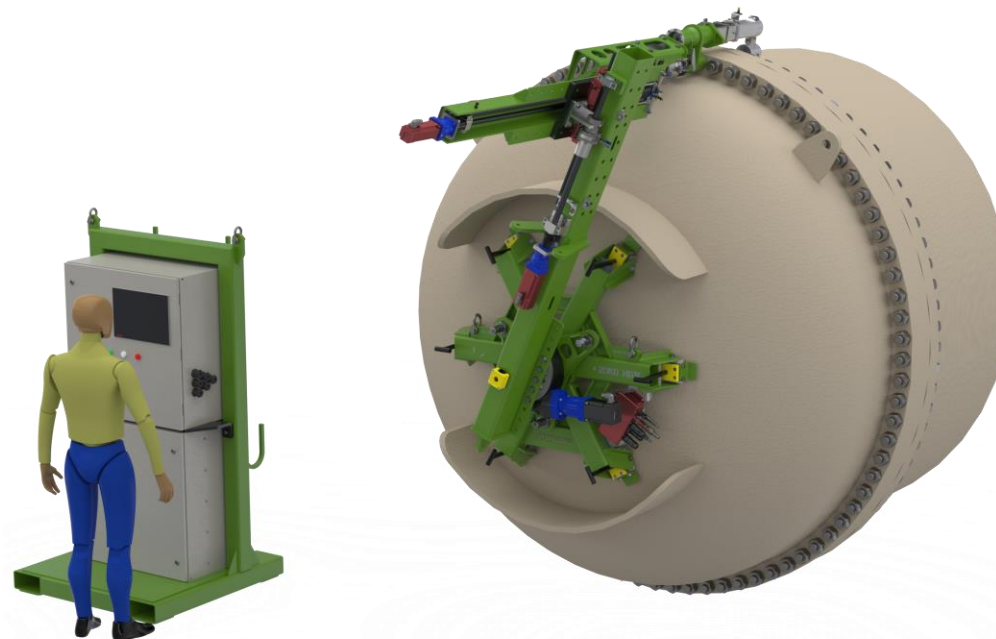
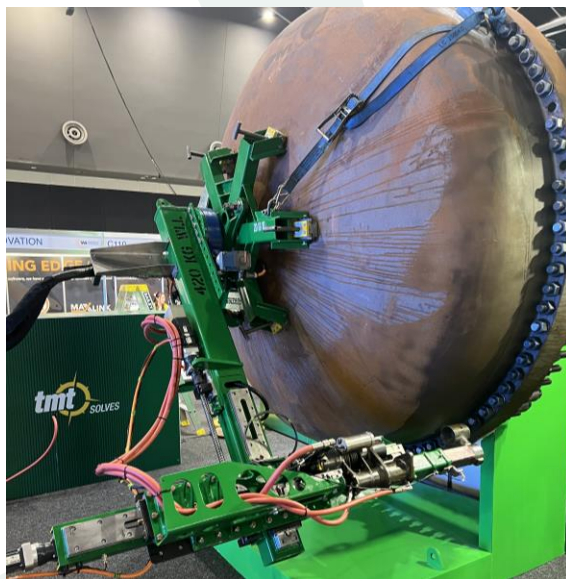
- Real-time Radar Scanning
- Advanced Sensor Integration
- Simulated Environments
- Inverse Kinematic Automated Control
- > Machine Vision (new research)





# A refresher - Boltron Automated Bolting Robot

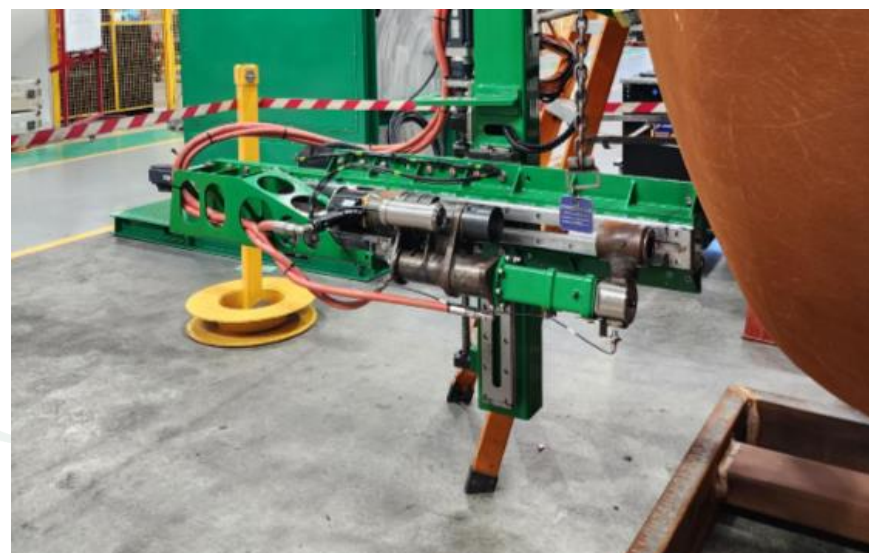
- Automated bolting operations
- Adjustable frames for different flanges
- Rear nut holders, nut ejection and offset tooling
- Dust and chemical proof
- Nil (or reduced) requirement for scaffolding





# Why Investigate Machine Vision?

- *Improved bolting capability*
- *Improved setup and calibration time*
- *Maintenance data collection*
  - *Assess bolt condition*
  - *Boltron positioning accuracy trends*
- *Minimal hardware changes required*
- *Low risk*
  - *Features are additive*
- *Active area of research*
  - *Rapidly developing*



# Challenges

- *Outdoor lighting conditions*
- *Limited training data*
- *Noise*
  - *Scratches/wear*
  - *Wear patterns*
  - *Colour variation*
- *Parallax error*
  - *Concentric circular/hexagonal features becomes difficult*





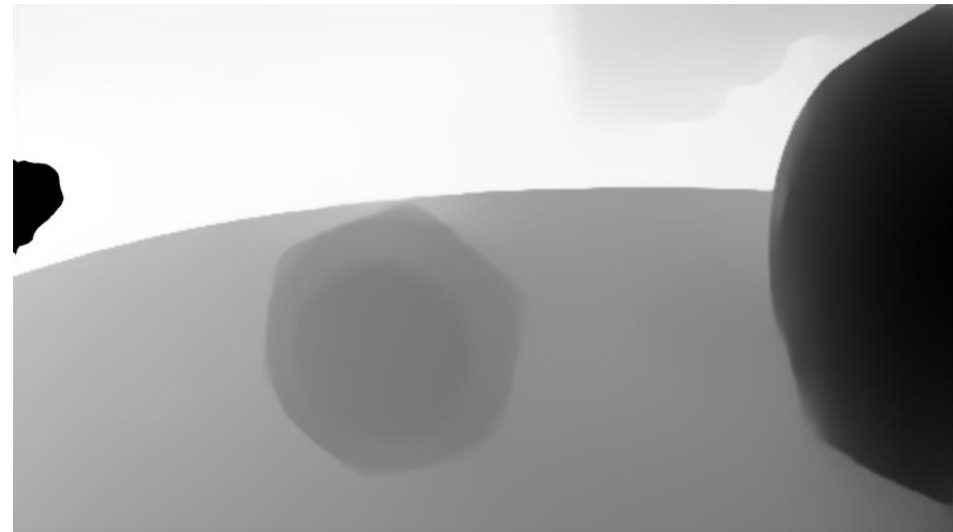
What if we remove all the texture and lighting variation, and just operate on the geometry... ?

# Hybrid AI Model: Depth Estimation

- *Trained on diverse data sets*
- *Estimates relative depth*
- *Allows us to extract geometry*
- *Use fast shape recognition algorithms*

## **Caveats:**

- *Not effective under certain lighting conditions*
- *Parallax caused inaccurate center prediction*





# What is the 'center'?

- *Bolt thread depth varies*
- *Washer may be off-centre*
- *Need to align with nut's hex face*

## How to detect it?

- *Parallax makes face vs. sides hard to distinguish*
- *Answer: Segmentation!*



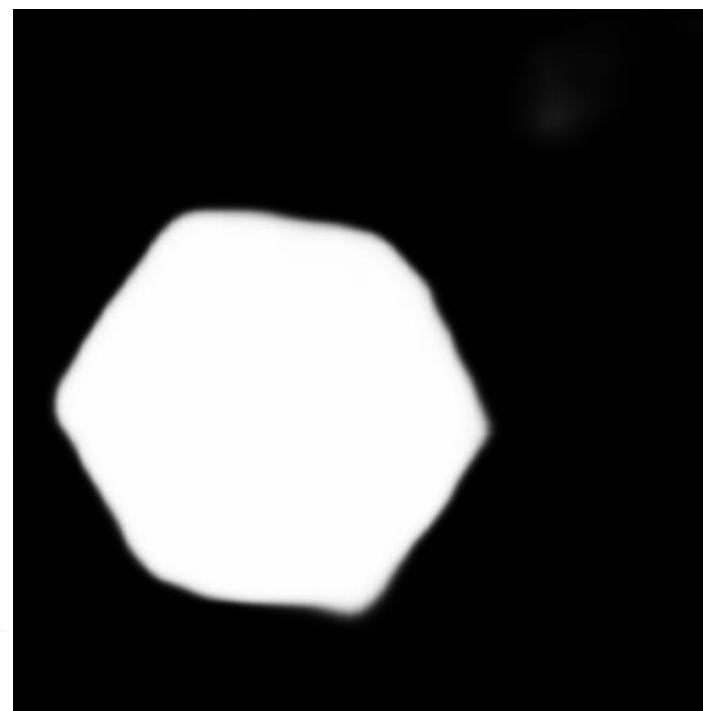
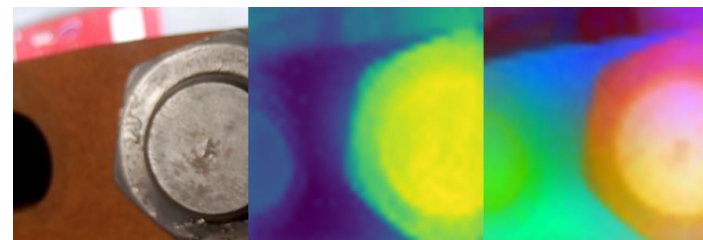


# Machine Learning: Segmentation

- *Typically requires large, diverse, hand-labelled datasets*
- *Limited data → poor performance*

## DINOv3

- *General-purpose model*
- *Trained on millions of images*
- *Encodes rich visual information*
- *Works well with smaller datasets*





# Machine Learning: Segmentation

- *Direct center regression needs broad training data*
- *Failures are hard to interpret*
- *Segmentation makes errors visible*
- *Enables clearer diagnosis of model confusion*





# Benefits to WA

Improving the financial viability of Mining, Minerals and Refinery operations in WA,

- HSEQ outcomes that improves the lives of WA workers,
- Integration of automated activities to remote-control centers (control, monitoring and data management),
- Local development and support of automated systems,
- Reduced burden on manpower in remote areas,
- Significant WA export opportunities, both in respect to mining and minerals products, but also equipment sales,



# Companies Under Engagement





# Thank you

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