Some AI Use Cases and Challenges in Manufacturing

NIST AI for Manufacturing (AI4MFG) Panel

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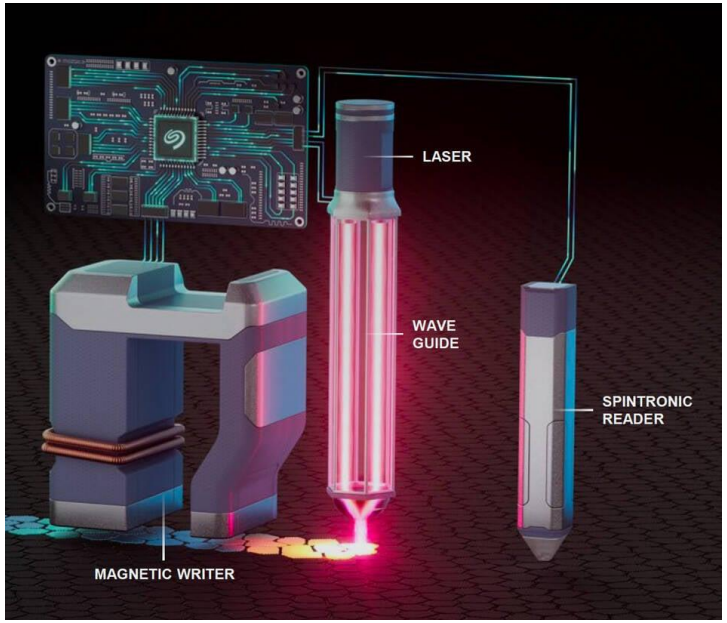
05/27/2026

Seagate

Enabling the World's Data-Driven Economy

- Global manufacturing leader in hard disk drives
- High-volume, high-precision manufacturing operations
- Complex integration of materials science, automation, and quality
- HAMR – Heat Assisted Magnetic Recording – allows for more data to be stored per area

HAMR



Goal: Utilize AI to:

- Improve Product Performance
- Reduce Design & Manufacturing Costs
- Improve Yield

Discovering New Designs

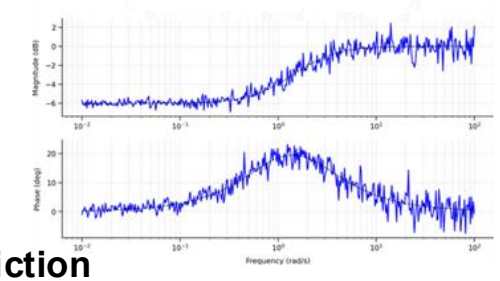
Discovery Loop

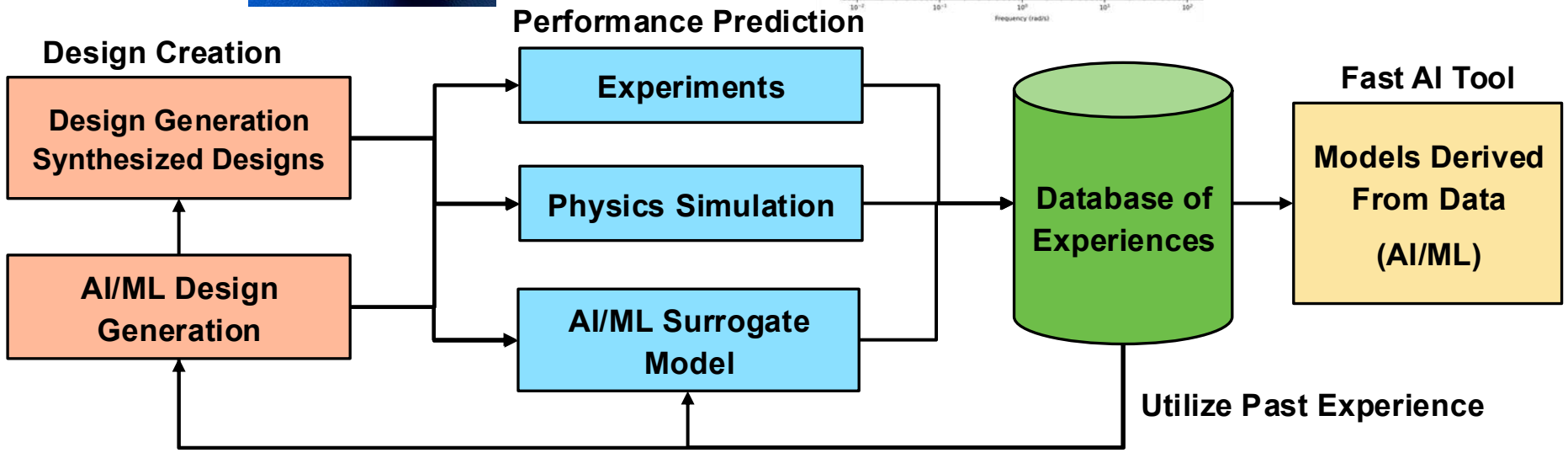
Purpose

- Reduce cost and time to develop new designs

Use Cases

- Materials
- Component Designs
- Controllers
- etc.





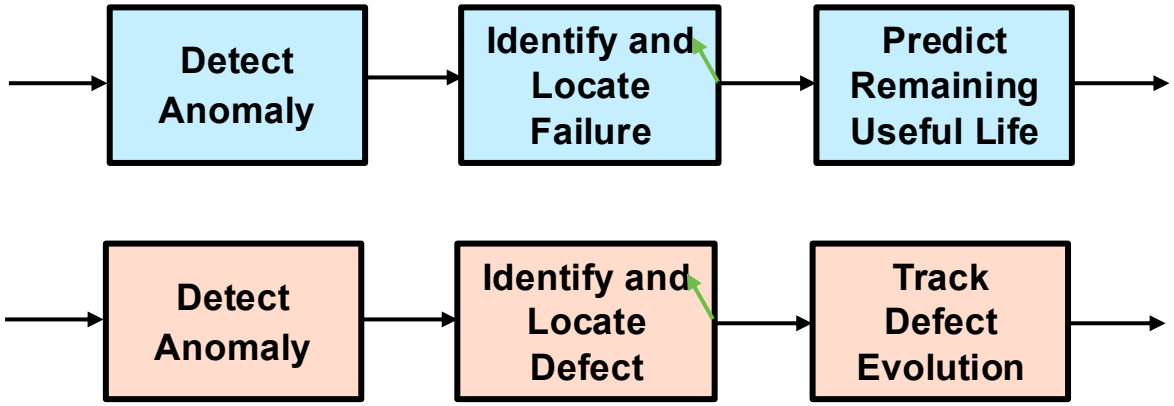
AI/ML Challenges

- **Data** for Training Design Gen, Surrogate Models, Fast AI Tools
- **Surrogate Model:** Generalization → Accuracy → Speed
- **Design Generation:** Control and Diversity

AI for Machine and Product Monitoring

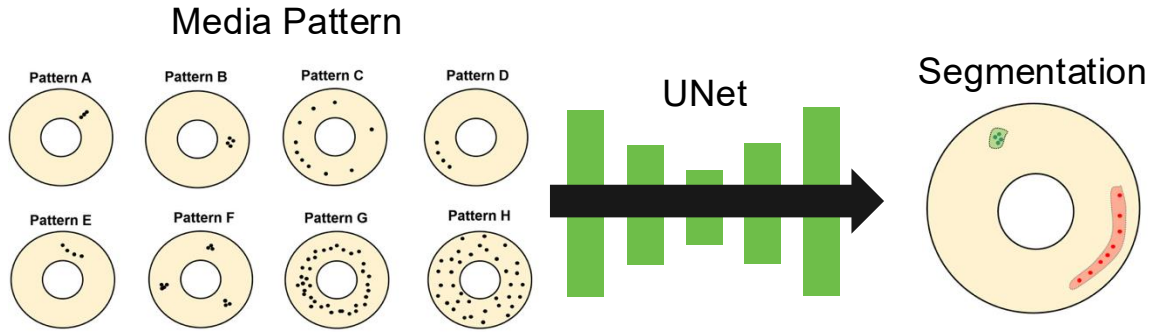
Purpose

- Reduce costs by identifying defects and failures early preventing wasted processing and optimize scheduled maintenance.



AI Use Cases

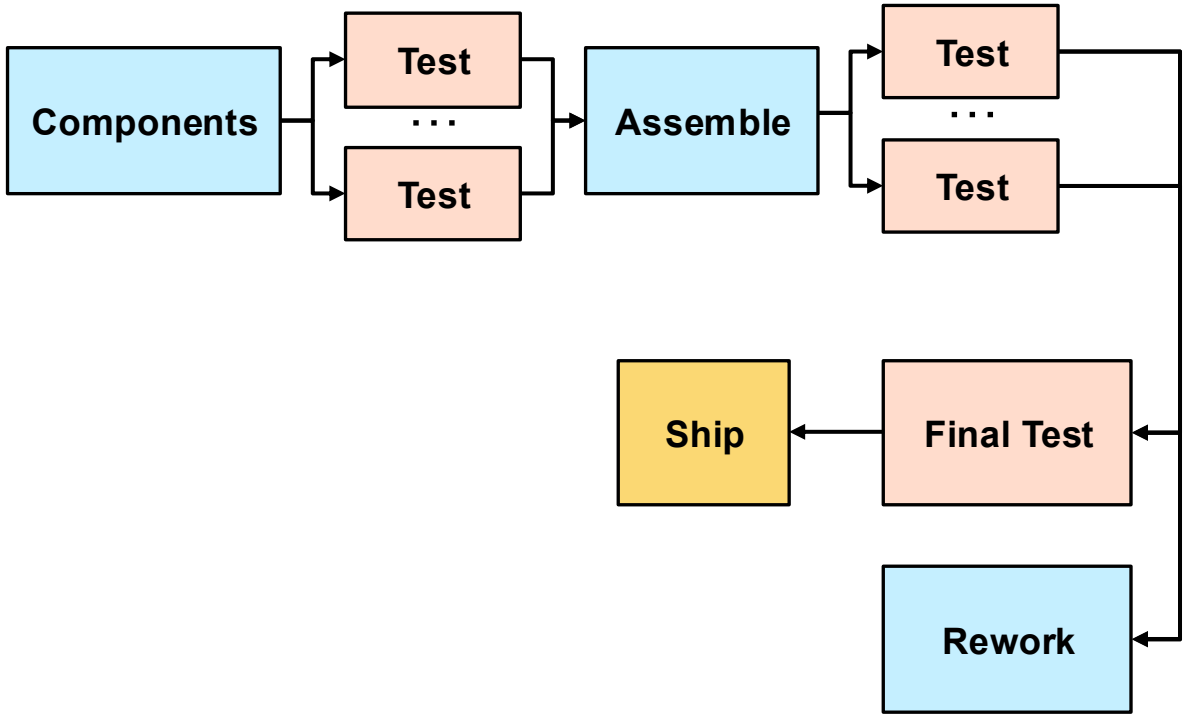
- Anomaly Detection
- Diagnostics (Failure/Defect Detect, ID, & Localize)
- Prognostics (Remaining Useful Life Prediction, Track Defects)



AI/ML Challenges

- Limited diversity in data
- Definition of Anomaly and/or Failures/Defects
- Integration of Domain Knowledge and ML (Synthetic Data, Features, Structure, Loss, etc.)

Test Time Optimization



Purpose

- Reduce test time while preserving yield

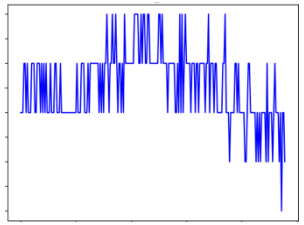
Use Cases

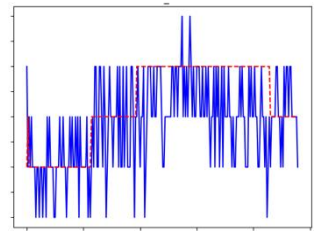
- Statistical Sampling Instead of Full Inspection
- Eliminate Redundancy
- Parallelization / Faster Test Algorithms & Equipment
- Optimize Test Sequences / Adaptive Testing
- Use Models to skip low-risk Tests

AI/ML Challenges

- Rare failures
- Large feature spaces (lots of measurements)
- Model drift (robustness), Model speed
- Equipment for AI/ML

Reduce two lengthy tests into one using prediction





Agentic AI in Manufacturing

Purpose

- Reduce costs through closed-loop optimization of yield, test, and process

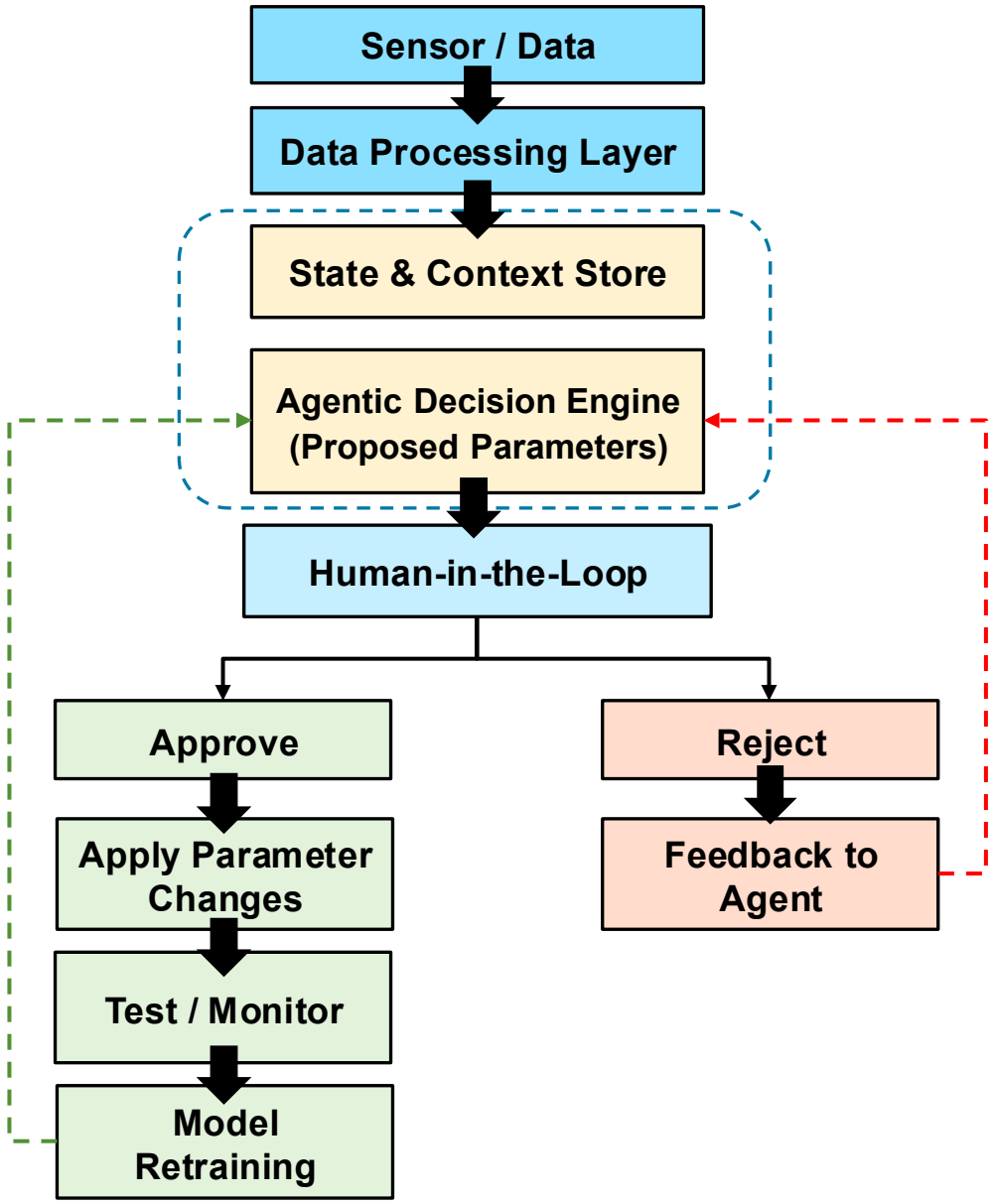
Use Cases

- Data gathering / explaining
- Feature pipelines
- Anomaly detection
- Diagnose issues/failures
- Adjust parameters (safely)

AI/ML Challenges

- Fragmented data
- Model drift & validation
- Real-time decision constraints
- Trust + governance: Human-in-the-Loop

Example Product Parameter Agent Pipeline



Key Takeaways

- Data coverage over data amounts
- Design discovery surrogate models require generalization
- Synthetic data generation (design creation) must be controllable and diverse
- Model drift can be an issue, model robustness must be addressed
- Agentic AI systems should have Human-in-the-Loop
- Key to AI/ML model acceptance is improving confidence (testing, interpretable, correctable)

- **Bonus: Data Challenge Contests**
  - Have Training, Test and Validation datasets
  - Validation dataset not seen by contestants, only evaluated at end of contest
  - Nice to have a website where contestants can upload results and get scores
  - Check that scoring measure cannot be “gamed” (e.g. all zero answer gives best score)

Backup Slides