STRONGER TOGETHER

Advancing 200mm wafer fabs: The Automation & Autonomy maturity framework

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Agenda

- Introduction
- Why investing in 200mm fabs
- The industry challenges
- The solution is to increase automation and autonomy
- Proposed Automation and Autonomy framework
- From assessment to implementation/strategy
- Examples and use cases

Introduction

The Purpose

- Create a practical maturity framework for 200mm fabs
- Standard definitions, staged roadmap, ROI guidance

The Scope:

- Now: Front-end 200mm fabs, US & Europe
- In the future: Backend (Assembly, Packaging & Test)

Expected outcomes

- Maturity model (M0–M4)
- Playbooks for upgrading domains
- Industry benchmarking dataset
- White paper (2026)

Who is involved

- Flexciton - project lead
- SEMI Smart Manufacturing US Chapter
- Active members: AMAT, Fabmatics, PeerGroup, Nexperia, Diodes, Staubil, Flexciton
- Industrial experts

Why Investing in 200mm Fabs

1. Large ongoing investments

Ministers welcome £115million investment by Seagate Technology

Date published: 11 September 2025

The First Minister and deputy First Minister have welcomed a major investment by Seagate Technology Holdings at its plant in Derry/Londonderry.

MILPITAS, Calif. — January 7, 2025 — The semiconductor industry is expected to start 18 new fab construction projects in 2025*, according to SEMI's latest quarterly World Fab Forecast report. The new projects include three 200mm and fifteen 300mm facilities, the majority of which are expected to begin operations from 2026 to 2027.

2. Key for GaN, SiC, specialty & legacy nodes.

- **ST to build high-volume 200 mm SiC campus (Catania)**
- **onsemi moving Bucheon line to 200 mm SiC in 2025**
- **Nexperia: $200 M for 200 mm GaN/SiC & silicon at Hamburg**

3. Critical for automotive, IoT, power electronics.

The Solution: Strategic Investment in Automation and Autonomy

200mm Fabs Face Many Challenges

- **Operational Complexity:** Every fab is different, limited standardization
- **Market Pressures:** Managing volatile demand cycles while maintaining operational efficiency
- **Talent Shortage:** Critical labor shortages in skilled technicians and engineers
- **Business Continuity:** Ensuring resilient operations in an uncertain global environment
- **Technology Gap:** Limited methodology for strategic technology investments

The Result: Ad-hoc projects, reactive firefighting, and missed opportunities for systematic improvement

The Path Forward: Automation and Autonomy

Automation

This system follows a predefined set of if-then rules

Autonomy

This system is free to make its own decisions using AI

The Path Forward: Automation and Autonomy

Automation

Defines HOW to execute task to achieve outcome

Execution of predefined tasks and control logic by machines and software

- **Physical movement:** handlers, OHT/AGV/AMR moves, robot load/unload
- **Tool & workflow automation**: recipe download and selection, step sequencing.
- **Local decision rules:** fixed dispatch rules, control loops at unit operations

Autonomy

Defines WHAT is desired outcome and the system decides HOW

Ability to **formulate and modify plans to achieve high-level goals under constraints**

- Executing plans, adapting to unexpected events, and coordinating with minimal human intervention.
- It layers learning, perception, and goal-seeking optimization on top of automation

What Holds Fabs Back from Greater Automation and Autonomy

- Older legacy tool sets → Lack SECS/GEM or piecemeal implementation
- Classic SECS/GEM not built for data streams → rolling out SEMI EDA difficult
- AMHS retrofit in legacy bays → Complicate OHS/OHT installs
- High mix speciality flows (power, RF, MEMS) → Need deep tool connectivity
- Brownfield automation needs niche skills → slower, limited upgrades
- ***Lack of ROI clarity → harder to justify, prioritise investments***

Laying the Foundation for an Automation & Autonomy Framework

The **Principles**

- **Domain-specific** based on the input from fabs
- **Practical**: straightforward to use and actionable
- **Agile**: can be modified as we progress
- Helps plan your next maturity steps with **ROI**
- Driven by **fab KPIs** - that can change over time

The Maturity Framework

Maturity Levels M0 - M4

Goal-seeking optimization Self-correcting	**M4 Autonomous**
Cross-system feedback Predictive decisions	**M3 Adaptive**
Analytics boost decisions	**M2 Augmented**
M1.1 Partly Automated M1.2 Fully Automated	**M1 Automated**
Manual decisions Spreadsheets	**M0 Manual**

The Maturity Framework

Assessment Disciplines

Maturity Levels M0 - M4	Data & Sensing	Equipment & Data Integration	Material Handling	WIP Flow Management	Quality & Yield	Maintenance & Reliability	People & Workflow	Test & Qualification
M4 Autonomous — Goal-seeking optimization, Self-correcting								
M3 Adaptive — Cross-system feedback, Predictive decisions								
M2 Augmented — Analytics boost decisions								
M1 Automated — M1.1 Partly Automated, M1.2 Fully Automated								
M0 Manual — Manual decisions, Spreadsheets								

The Maturity Framework

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Maturity Levels M0 - M4

- Goal-seeking optimization
  Self-correcting
- Cross-system feedback
  Predictive decisions
- Analytics boost decisions
- M1.1 Partly Automated
  M1.2 Fully Automated
- Manual decisions
  Spreadsheets

M4	Autonomous
M3	Adaptive
M2	Augmented
M1	Automated
M0	Manual

M1.2 criteria

- MES with core functions
- Data mostly from tools & WIP (>80%)
- Basic data model & ontology

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Manual decisions Spreadsheets — **M0 Manual**								

M3 criteria

- Predictive routing & collision avoidance
- Transport cost optimisation
- WIP flow & operational constraints

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M2 criteria

- Analytics for IE system configuration
- Analytics wrapper for dispatching/ scheduling

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Manual decisions Spreadsheets — **M0 Manual**								

M0 criteria

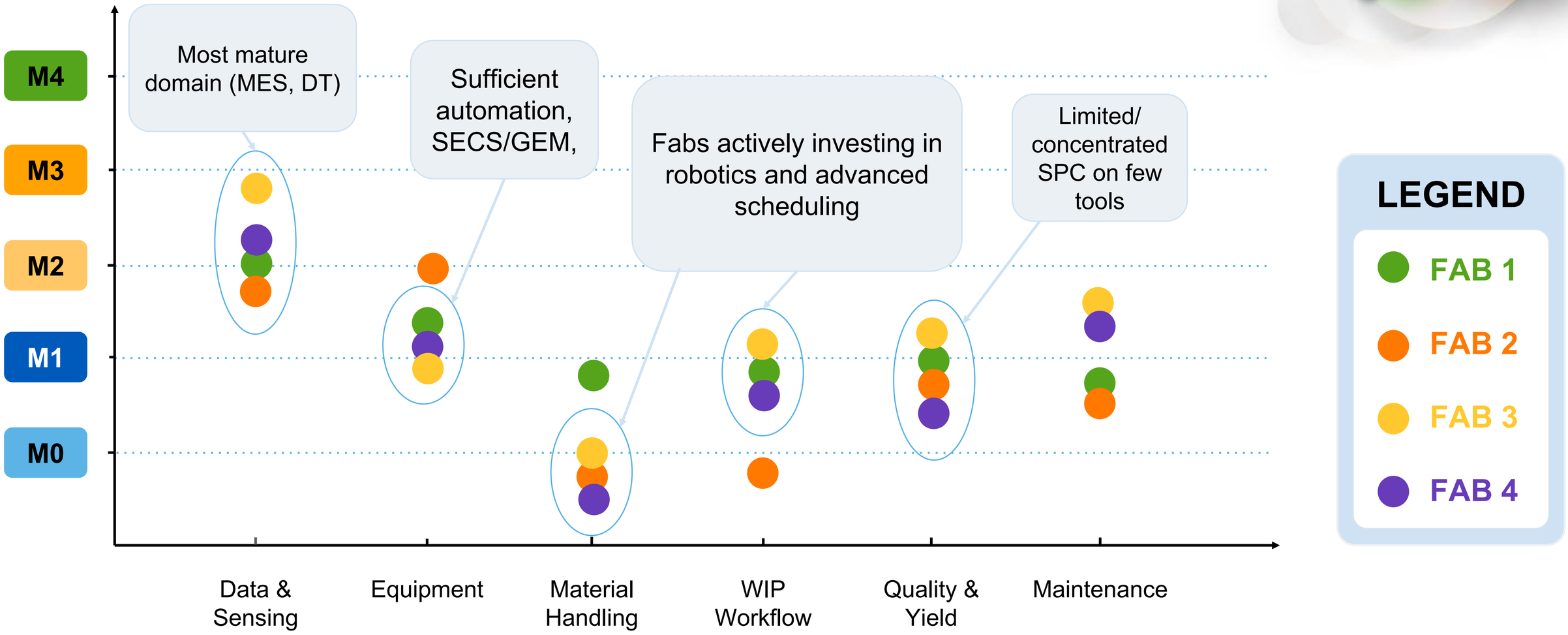
- Run-to-failure;
- Calendar PMs;
- Downtime logged manually

Assessment phase and next steps

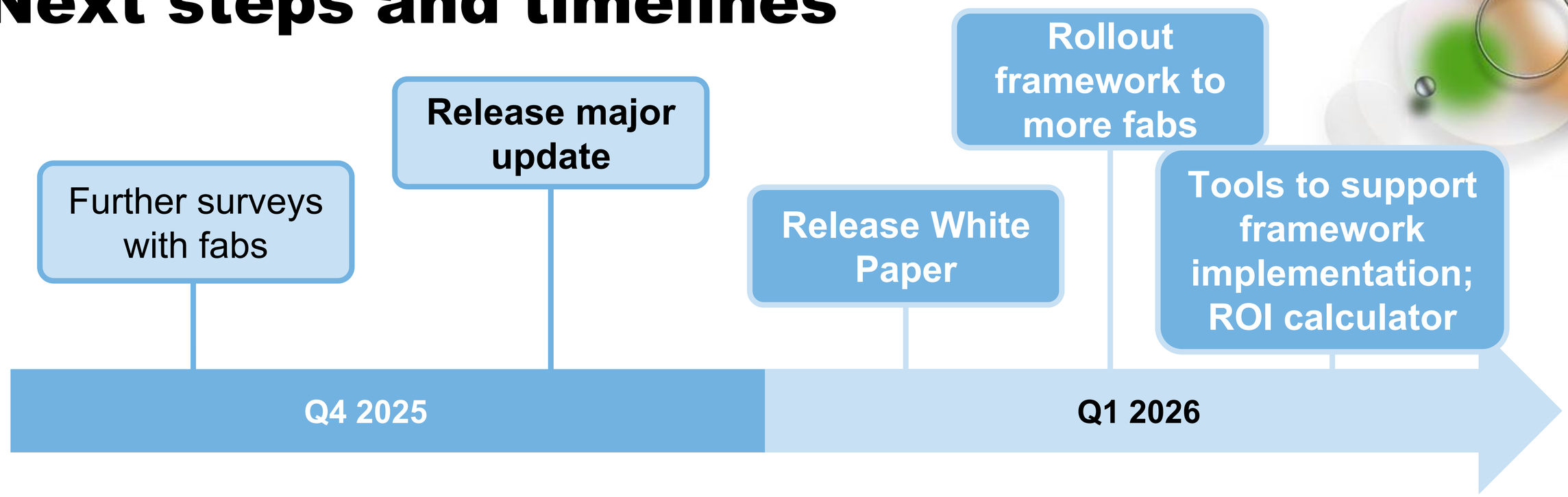
Process:

- Contact & interview 200mm fabs, esp. fabs in transition
- Survey & interview operational team (***confidentiality & data anonymity assured***)
- Collate & analyze data of individual/all fabs
- Identify & share individual automation opportunities & benefits (capacity & ROI)
- Develop & share benchmarking report

Initial survey results



Next steps and timelines



Reach out to us!

If you work in fab management or are an semiconductor industry expert, get in touch with us at dennis.xenos@flexciton.com and abahadur@semi.org

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Thank You

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