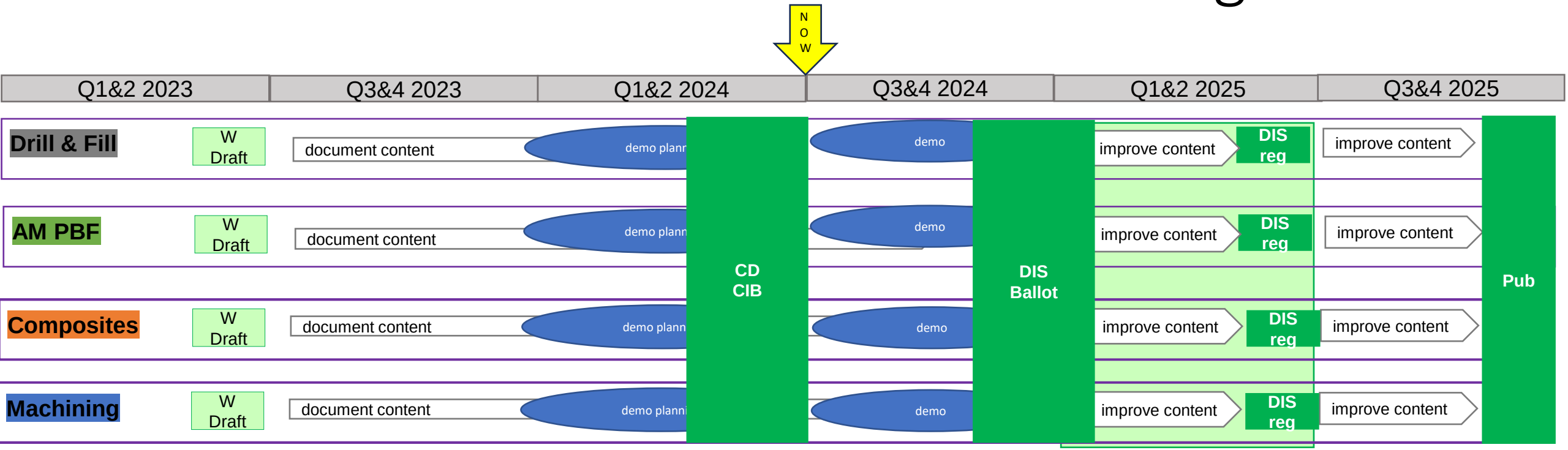
AP238 E4 – Model Based Manufacturing



Drill & Fill Model based assembly for LOTAR

AM PBF Interoperability for reliable manufacturing

Composites Digital Thread for tape layup

Machining Reduced tool wear and cycle time

W Draft EXPRESS definition of requirements

CIB Ballot Mapping tables

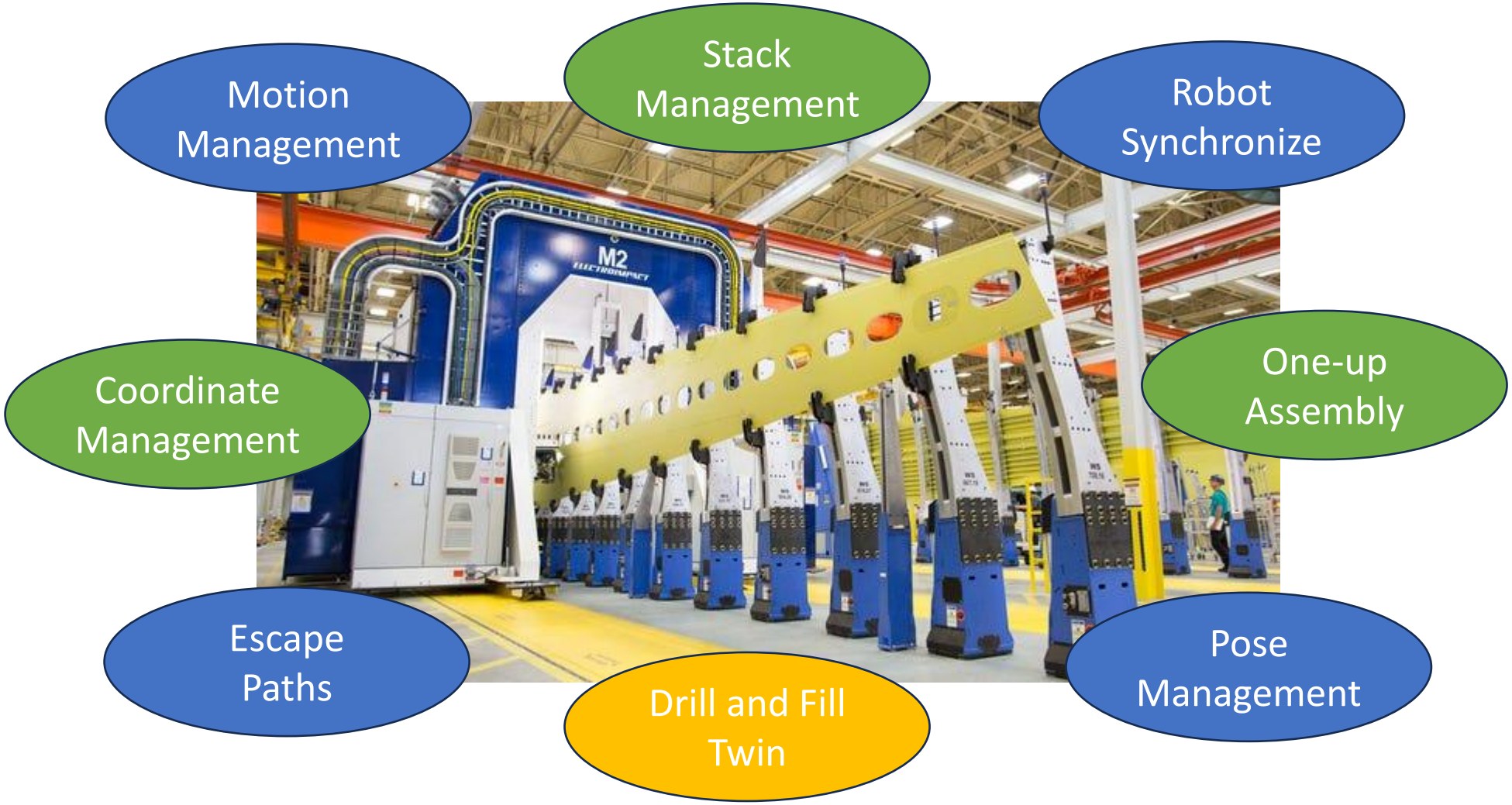
DIS reg English descriptions (final form)

Drill and Fill Phases

Phase 1 LOTAR

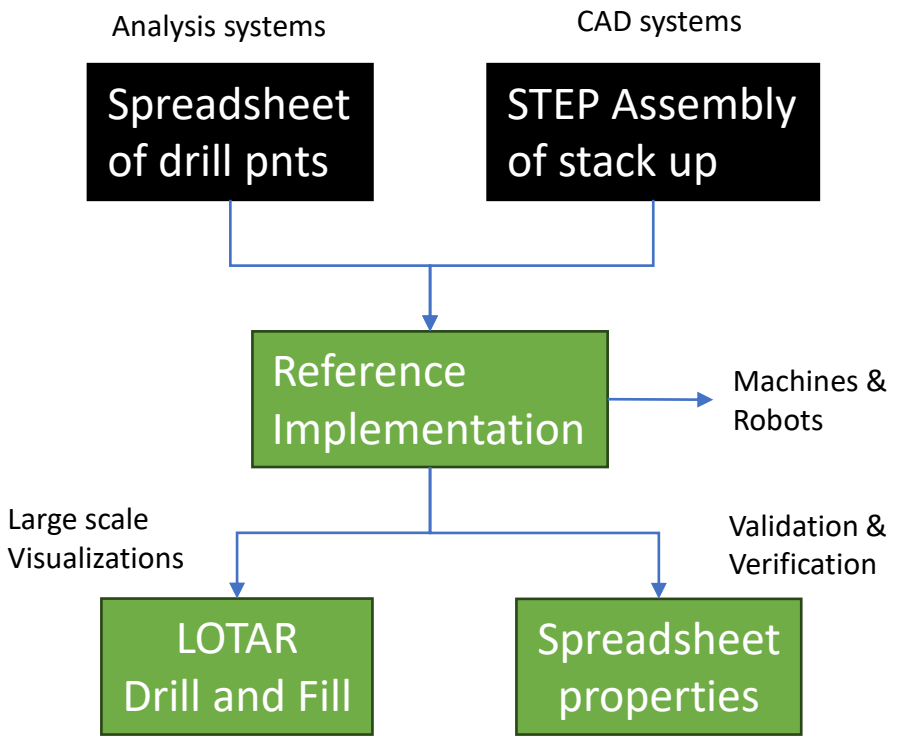
Phase 2 Robot teaming

Phase 3 Weight reduction



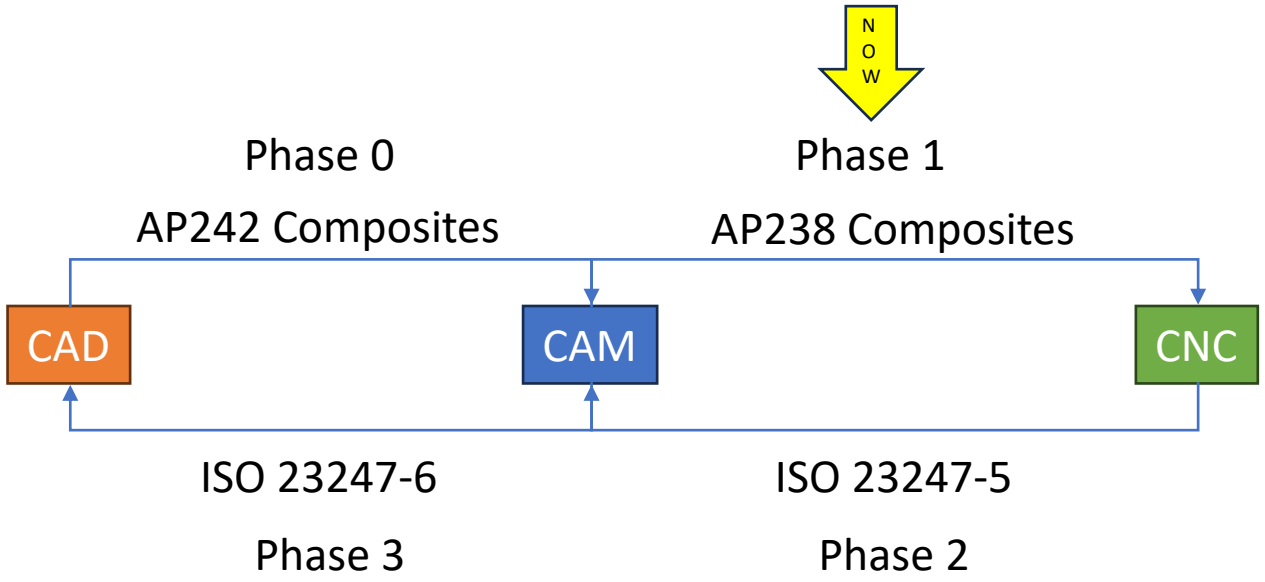
Drill and Fill for LOTAR

- Spreadsheet Input
  - Point and axis definition of stack-up's
  - Oneup classification for sequencing
  - Material for drill and fill, speed and feeds
- Long Term Archiving
  - Machining operation definition
  - Machining sequence definition
  - Machining result verification



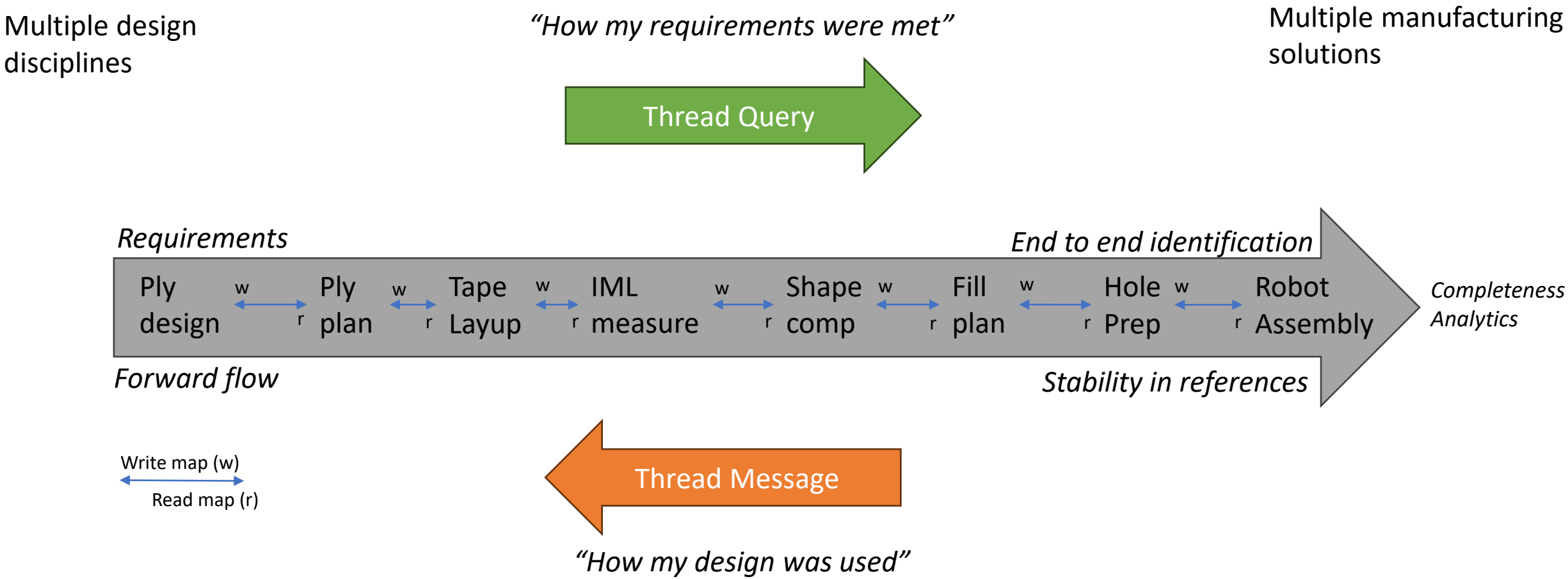
Operation sequence is late bound

Digital Thread for Composite Tape Layup



Phase	Input	Output
0	Composite Assembly Table design	Nominal courses in STEP-NC
1	Manufacturing courses in STEP-NC	Manufacturing codes for tape layup
2	Manufacturing placements	As-laid courses
3	As-laid tapes	As-built composite ply assembly

Digital Thread continued

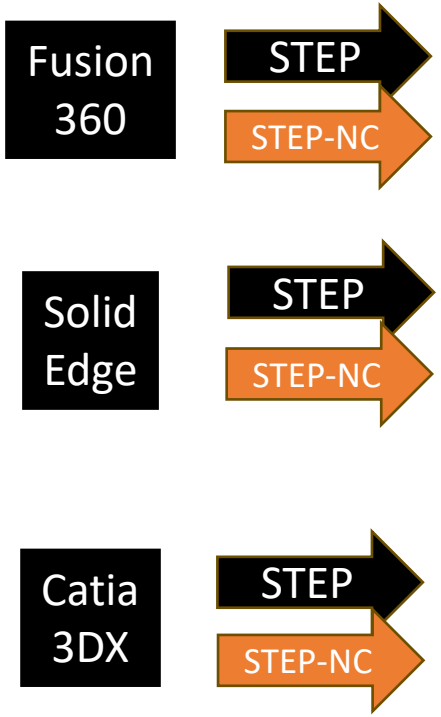


777X wing

PBF data exchange

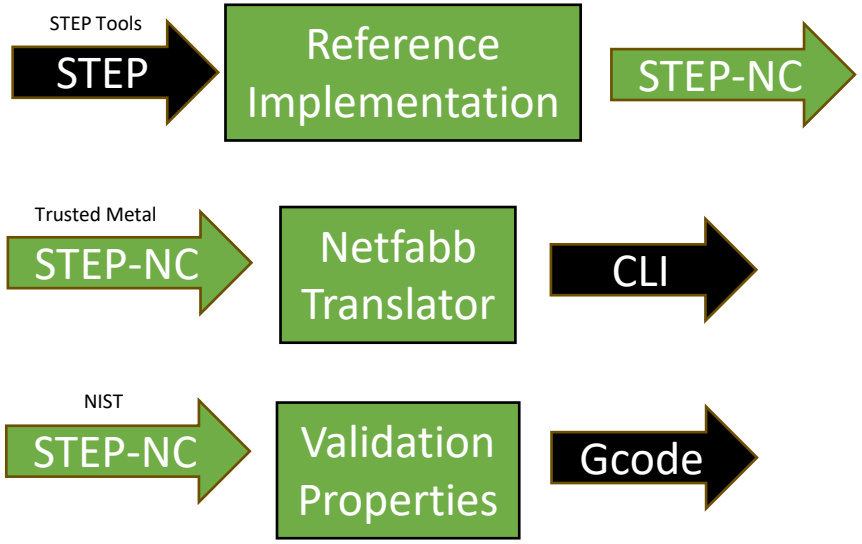
Phase 3
Update CAD to write STEP-NC

CAD Systems
With STEP



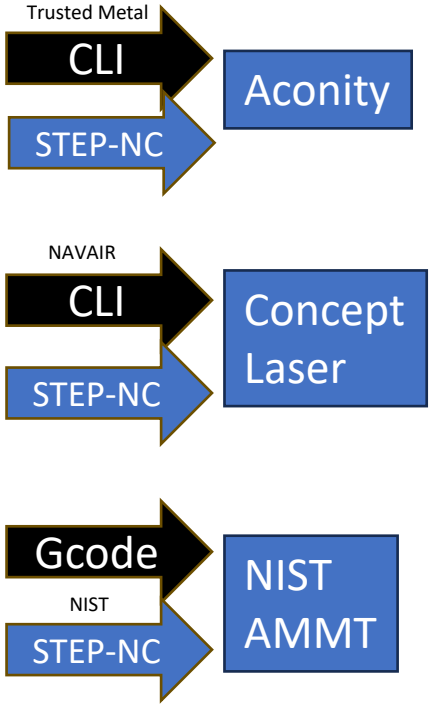
Phase 1 (3D, 2D, 1D)
Build Reference systems

STEP-NC Systems



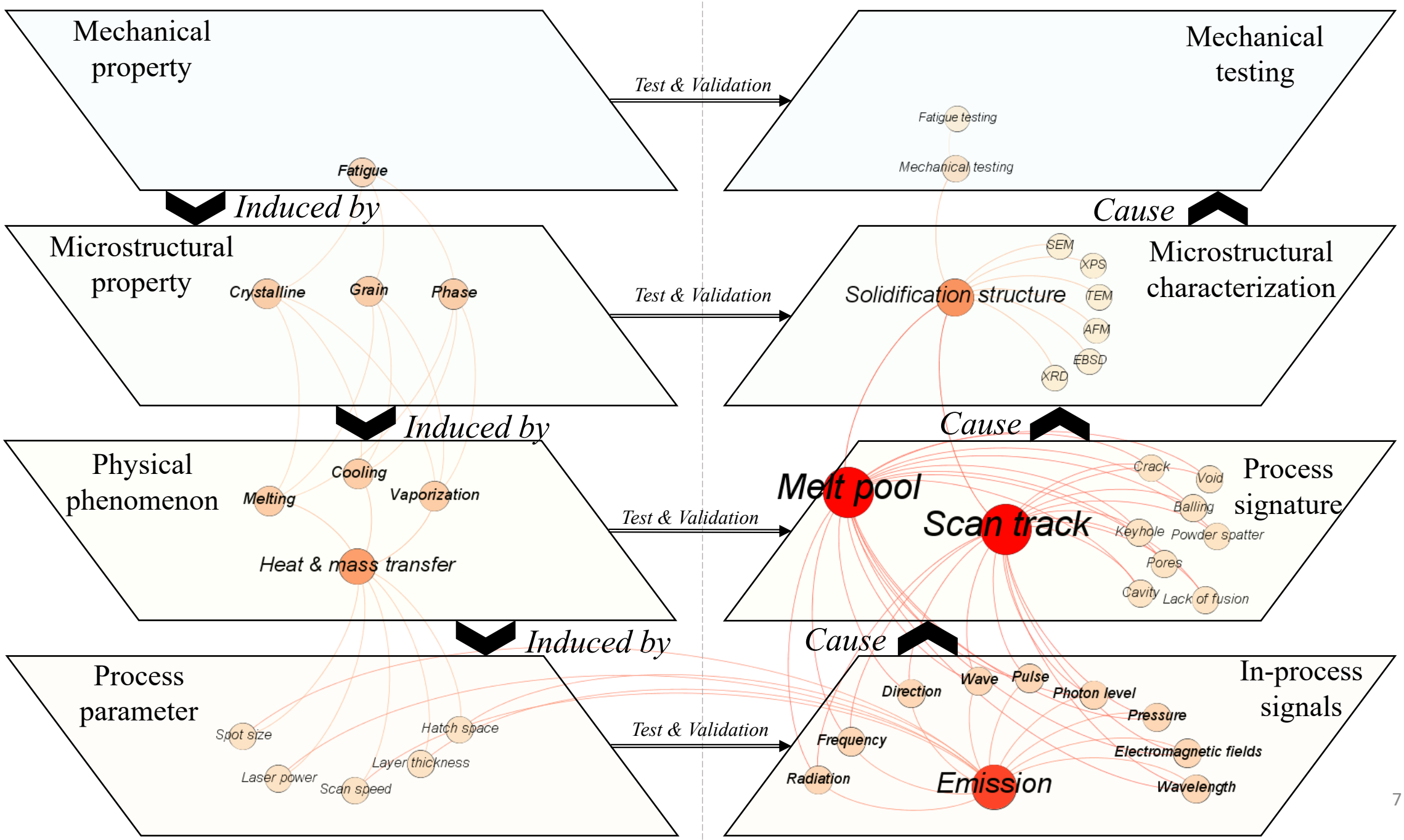
Phase 2 (0D)
Update controls to read STEP-NC

Open Control
Powder Bed Fusion



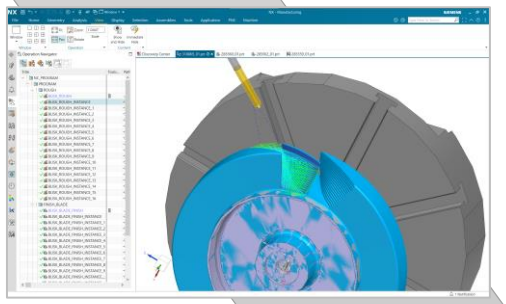
1. **Make a part model**
2. **Convert to STEP-NC using reference algorithm**
3. **Same part on different machines more reliably**

PBF Fatigue modeling (Phase 3)



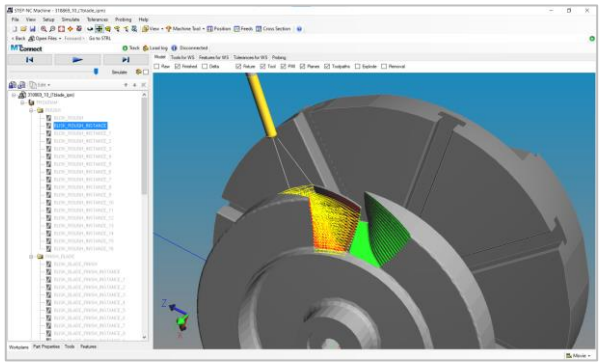
Cutting Based Collaboration

Machining system constraints
(torque, power, accelerations, jerk, stiffness, stability etc.)

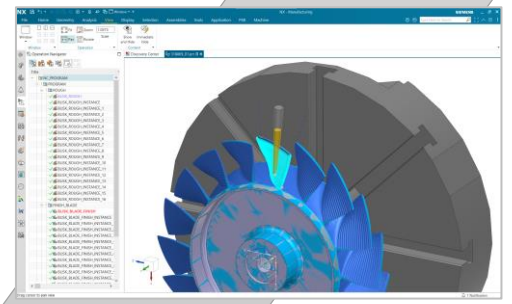


Workpiece material commercial name
Machineability classification
Specific cutting force coefficient (K_c)

GKN AEROSPACE



SANDVIK coromant

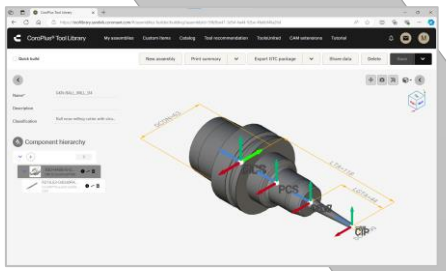


Adoption and comparison
Implementation
Validation of solution

Solution request
- Predicable tool wear
- Reduced cycle time

Solution proposal
- Cutting tool
- Cutting data

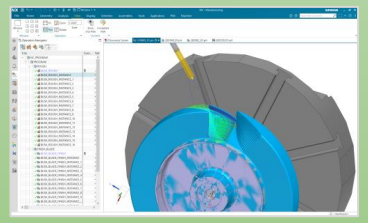
Chip thickness
Equivalent cross section area
Single tool and multi tool



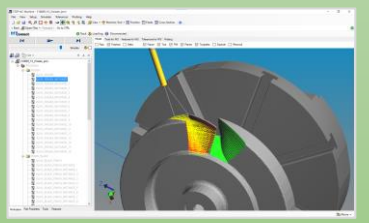
Cutting based data exchange

Process planning

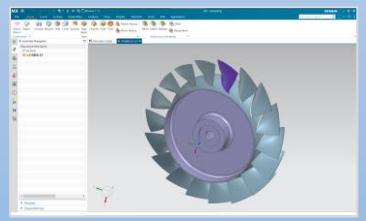
Solution provider



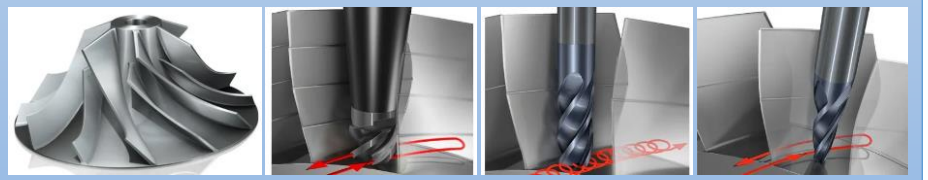
3. Develop solution in collaboration



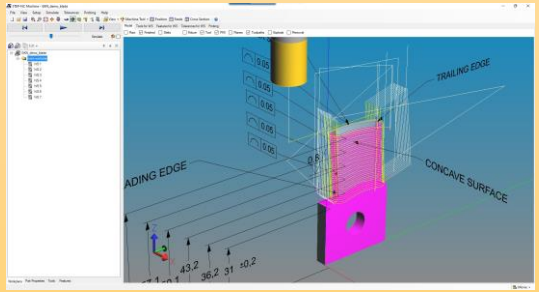
-cutting process detailing
-same shape
-working steps, cross section, CAM strategy



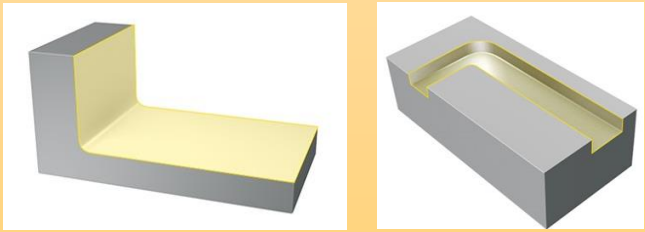
2. Initiate collaboration



-concept detailing
-similar shapes



1. Find collaboration



evaluate equivalence
and opportunities

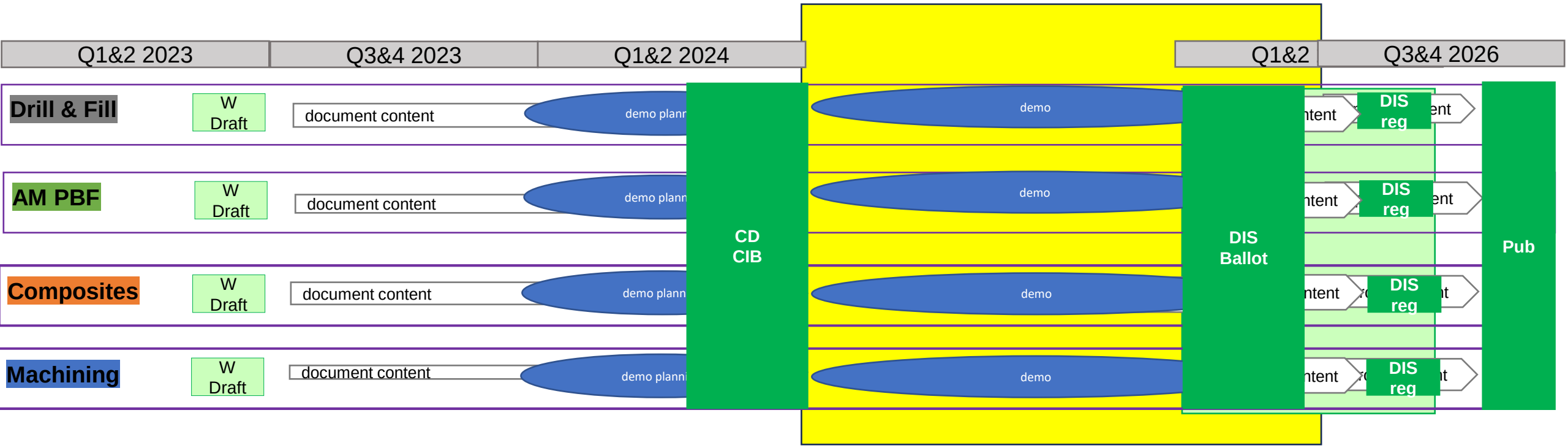
Phases

1.

2.

3.

Conclusion – time budget – one year



Drill & Fill	Model based assembly for LOTAR	W Draft	EXPRESS definition of requirements
AM PBF	Interoperability for reliable manufacturing	CIB Ballot	Mapping tables
Composites	Digital Thread for tape layup	DIS reg	English descriptions (final form)
Machining	Reduced tool wear and cycle time	TBD	Time extension for Inter-laboratory testing

New dates

Updated project-plan

	Current	Proposed
CD	2024-04-09	2024-04-09
DIS	2024-12-31	2025-12-31
IS	2025-12-31	2026-12-31

Justification – points to make

- Hugely expensive to fix things on manufacturing floor so standard needs to be right
  - Systems are locked down
  - Change is expensive and hard to justify
  - Make it right so it will not have to be corrected
- Need for integration with ISO 23247-5 & 6 which is not yet at CD
  - Need 23247 for manufacturing digital twin
  - CD will be published in September
- The complex high precision algorithms required for high quality manufacturing take time to develop
  - Relatively few experts
  - Testing on expensive, high demand machines
  - Errors have an undesirable impact on production