

Changing the Engineering Design & Qualification Paradigm in Component Design & Manufacturing (Born Qualified)

FY18 Risk & Impact Review

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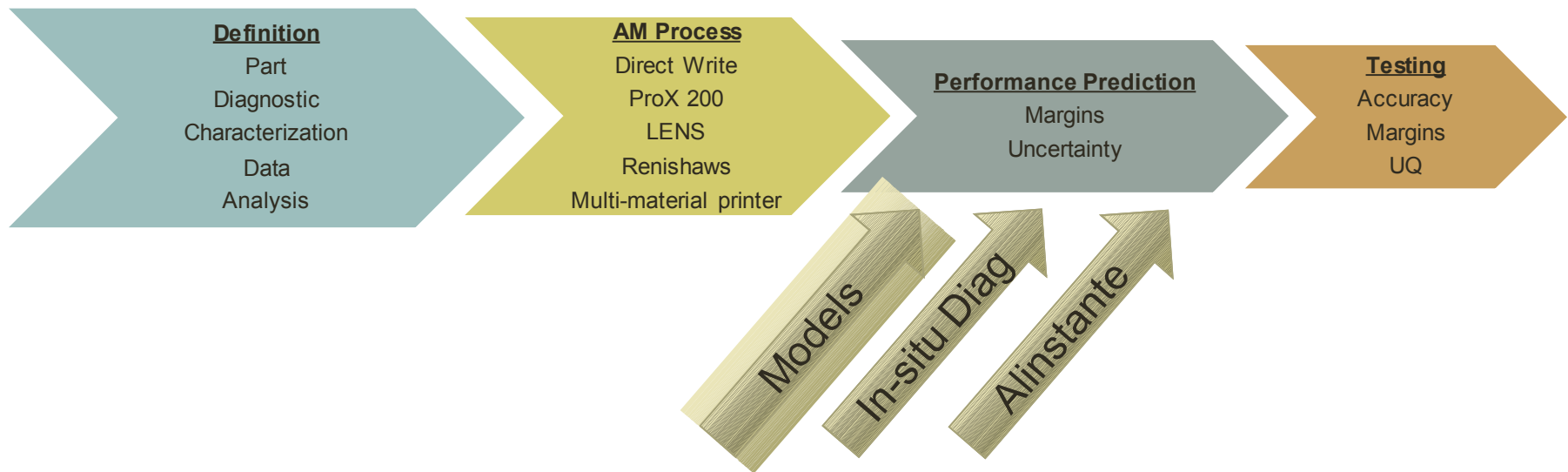
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Development of Risk/Impact Assessment

- Goal - identify critical path efforts in FY18 to support the demonstrators by completing a risk analysis versus execution
- Core assumption is that all current efforts are critical for long-term. With the budget challenges of FY17 and FY18 should some FY18 efforts be reduced while others increased?
- Utilize Risk and Impact variables to generate a Risk*Impact rating
 - A higher Risk*Impact rating means that FY18 budget and effort should be prioritized and a corresponding flow chart with contingency/mitigation plans generated
 - A lower Risk*Impact rating means constant or lower budget depending on FY18 progress and impact

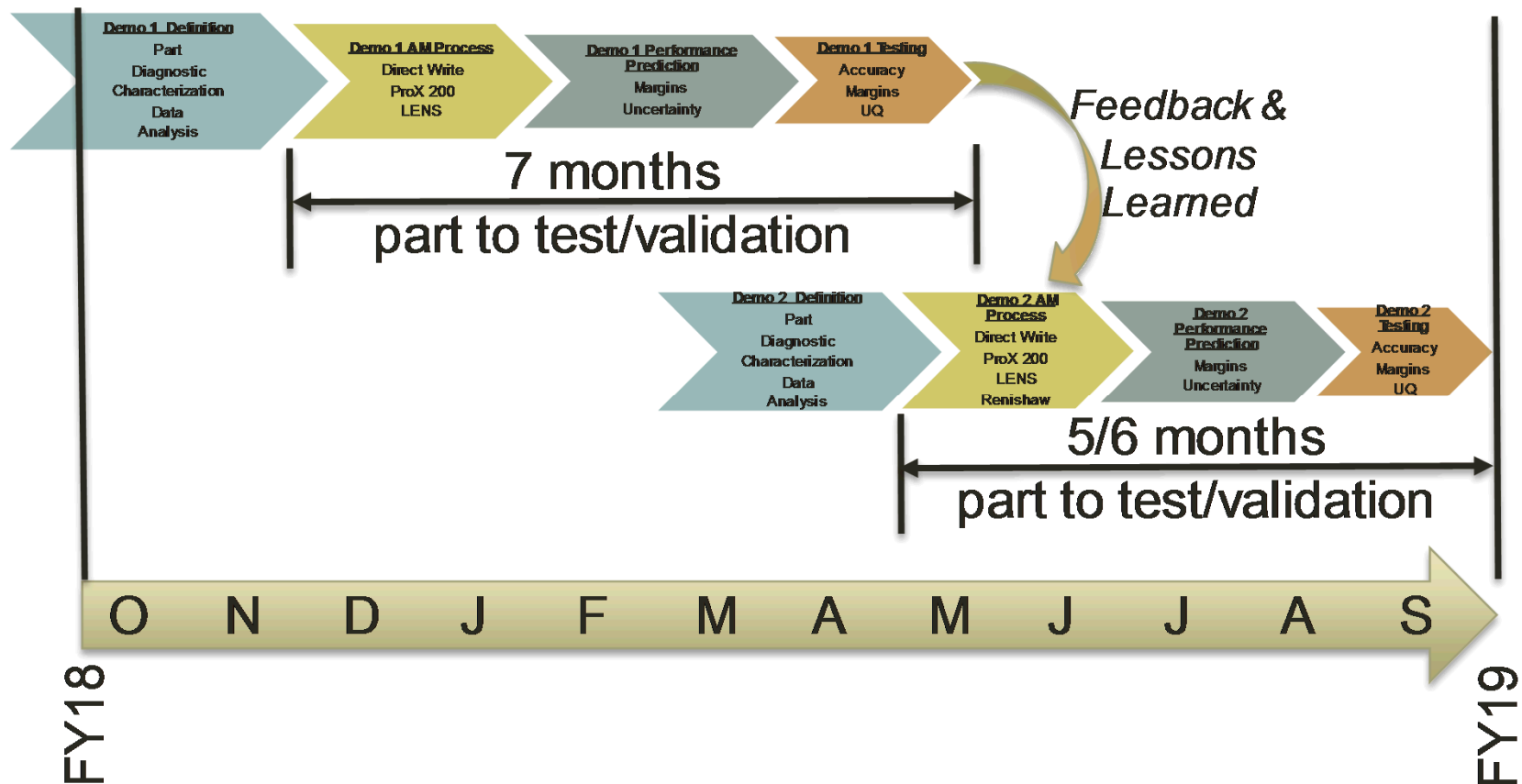
FY18 Integration

- Years 1 and 2 focused on development, evaluation and down-selection of capabilities to predict exemplar performance
- As we plan for Year 3 we are finalizing integration plan to drive the performance predictions using Demonstrators
- Key aspects of Demonstrators by Project Areas in flow-chart



FY18 Integration, Cadence, & Exemplars

- Assuming 2 Demonstrators starting in September, need plan finalized by August
- Focus will be on generation of database for predictions of GTS Valve Housing and IR Exemplars performance
- Assumed ability to accelerate timing with each demonstrator



Risk-Readiness/Impact

AM Process for Demonstrator 1 (Oct-May)	FY18 Risk (Readiness) 1-Low Risk (Ready) 5-High Risk (Not Ready)	FY18 Impact 1-Low 10-High	FY18 Priority Rating (R/R*I)	Notes
Direct Write	1	10	10	
ProX 200	2	10	20	Schedule issues
LENS	1	10	10	
Renishaws	4	10	40	Not available for 1 st Demonstrator, Facility readiness is highest risk
Multi-Material	3	8	24	Exemplar 3?

Actions:

1. Renishaw availability is not in BQ's scope but will continue to influence & support
2. Multi-material printer is also not in BQ's scope but will continue to influence & support
3. ProX 200 schedule issues will decrease once Renishaws are operational

Risk-Readiness/Impact

AM Process for Demonstrator 2 (Mar-Sep)	FY18 Risk (Readiness) 1-Low Risk (Ready) 5-High Risk (Not Ready)	FY18 Impact 1-Low 10-High	FY18 Priority Rating (R/R*I)	Notes
Direct Write	1	10	10	
ProX 200	1	10	10	
LENS	1	10	10	
Renishaws	3	10	30	Assume ready Apr, Facility readiness is highest risk
Multi-Material	2	8	16	Exemplar 3?

Actions:

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2. Multi-material printer is also not in BQ's scope but will continue to influence & support
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Risk-Readiness/Impact

Performance Predictions for Demonstrator 1 (Oct-May)	FY18 Risk (Readiness) 1-Low Risk (Ready) 5-High Risk (Not Ready)	FY18 Impact 1-Low 10-High	FY18 Priority Rating (R/R*I)	Notes
mm-Wave in-situ Diagnostics	3	5	15	Lacking validated IR is long term risk
Spectroscopy and surface in-situ	4	5	20	Capabilities address long term risk
Alinstantiate Testing	2	10	20	Scanner, tester, LIBS sufficient for BQ Exemplars
Alinstantiate Robot	2	5	10	Robot is focused on long term risk

Actions:

1. Focus on long term plans for Robot and Spectroscopy

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Process models	2	7	14	Needed models exist for FY18?
Material models	3	10	30	
Exemplar model	1	10	10	
Optimization	3	10	30	
UQ	5	10	50	

Actions:

1. Continue to prioritize UQ
2. Work with process models to finalize runs needed for predictions
3. Work with LENS models to downselect methods and assumptions for short and long term needs

Risk-Readiness/Impact

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Material models	3	10	30	
Exemplar model	1	10	10	
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UQ	4	10	40	

Actions:

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- Highest Risk/Impact Ratings:
 - UQ
 - Renishaw printers
 - Optimization
 - Material Models
- Contingency Plans
 - UQ – Need complete data set, materials characterization of defects/damage
 - Options - KCNSC data set, tensile bar data, Fracture Challenge 3, NIST AM bench
 - Use and pursue new NDE options internally and externally
 - Renishaw – Need powder bed printing option
 - Options – use KCNSC data set as Renishaw part evaluation for possible future Demonstrator 2 build at KC
 - Continue to influence Renishaw facility availability

Primary 3-Year Deliverables

Project Area	FY16-18 Focus	FY16-18 Primary Deliverable (1 of n)
AM Process	material stock & process capabilities	3 exemplars, process parameters
In-situ Diagnostics	process measurements	validated IR
Alinstantiate	rapid characterization	geometric measurements/distortion, defects
Process models	T, geometry	thermal fields
Material models	microstructure, properties/defects	process & microstructure
Exemplar models	structural performance	residual stress, demonstrate damage tolerance paradigm
Optimization & UQ	capabilities for optimization under uncertainty	risk-averse optimization, bridge microstructure to macroscale UQ

