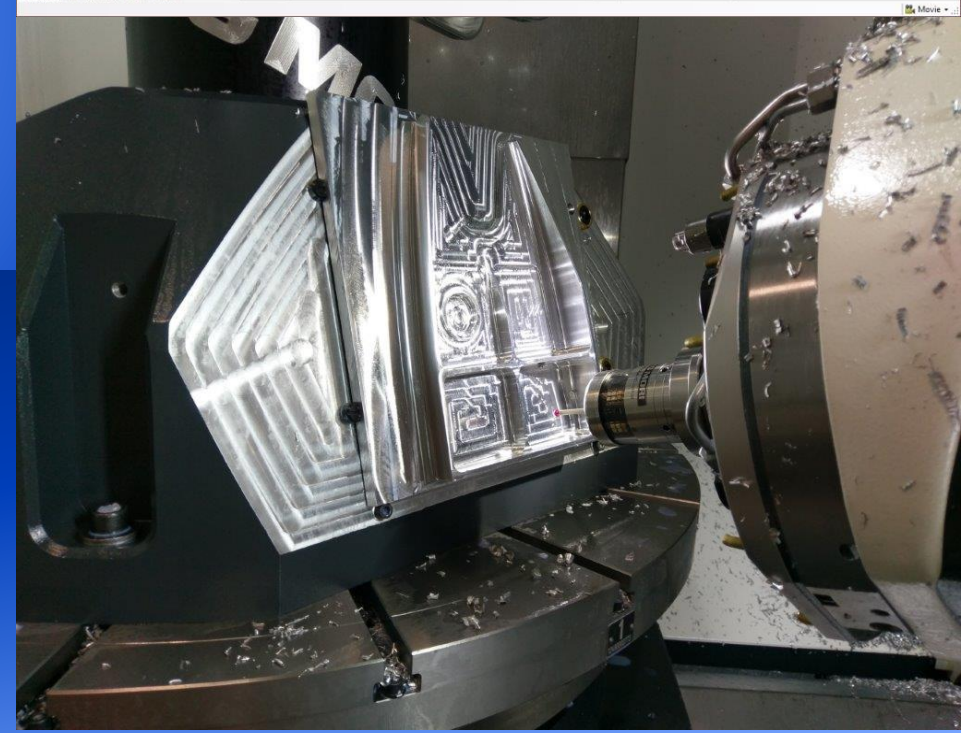
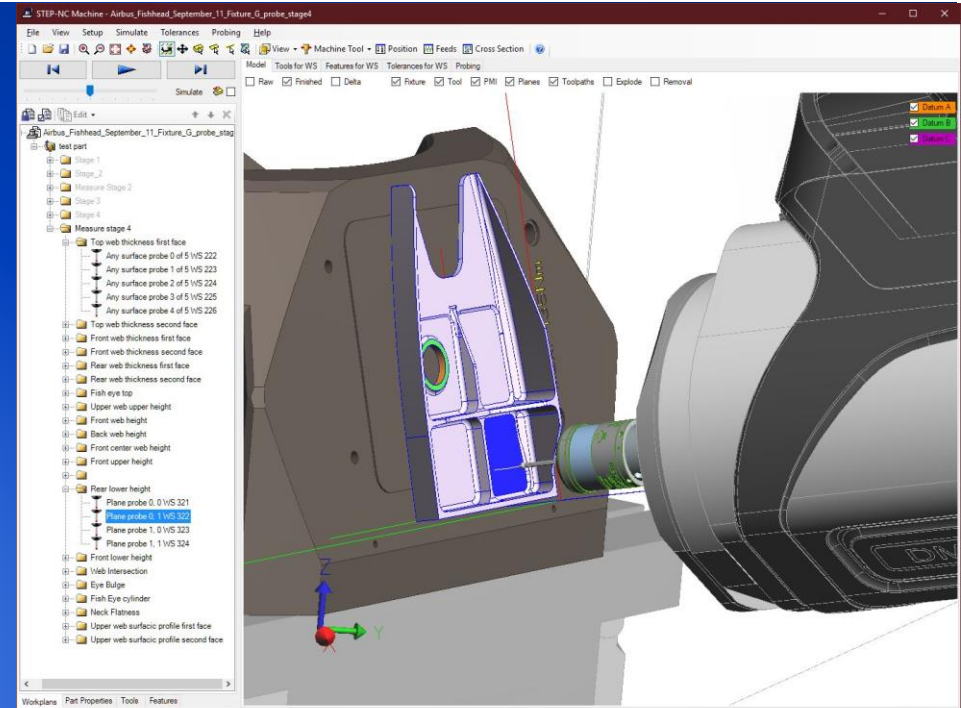


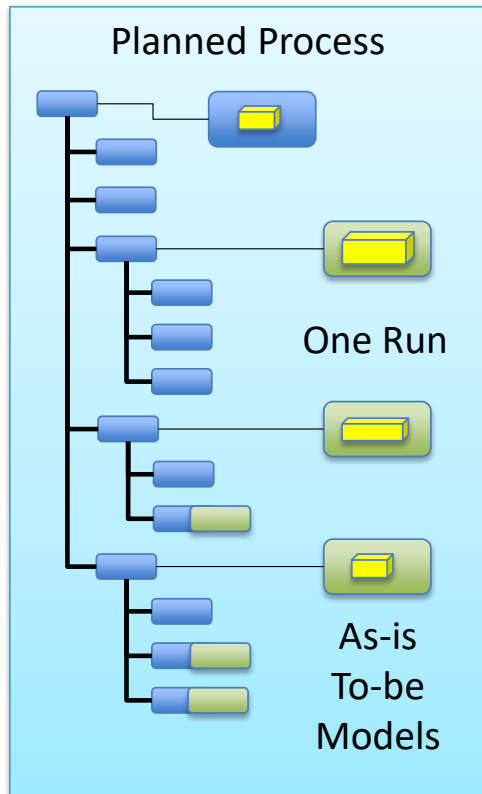
Twin Modeling in AP238 Edition 2



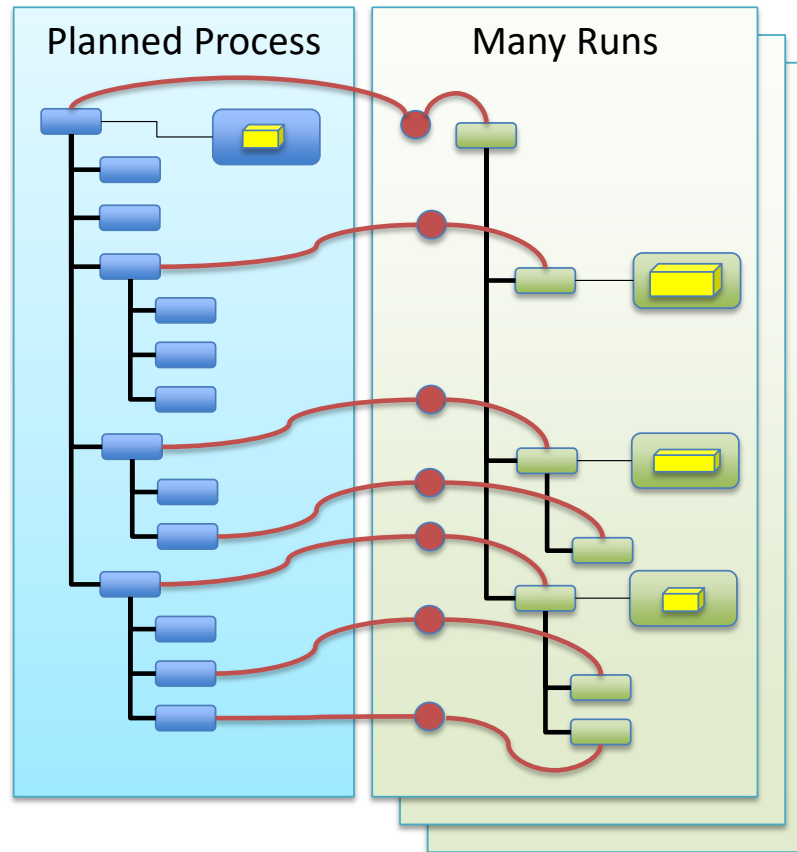
Dr. Martin Hardwick
Convener ISO Digital Manufacturing

AP238 e2 EXPRESS for digital twins

<https://stepmfg.github.io/ap238e2/data/clause5.htm#fig-twinmodel>



Model process state using new attributes



Link runs using Part 21 Edition 3

ENTITY executable

```
[ ... other attributes omitted ... ]  
twin_state: OPTIONAL twin_state_enum;  
as_planned: OPTIONAL executable;  
state_start : OPTIONAL Date_time;  
state_end   : OPTIONAL Date_time;  
state_error : OPTIONAL reason_string;  
END_ENTITY;
```

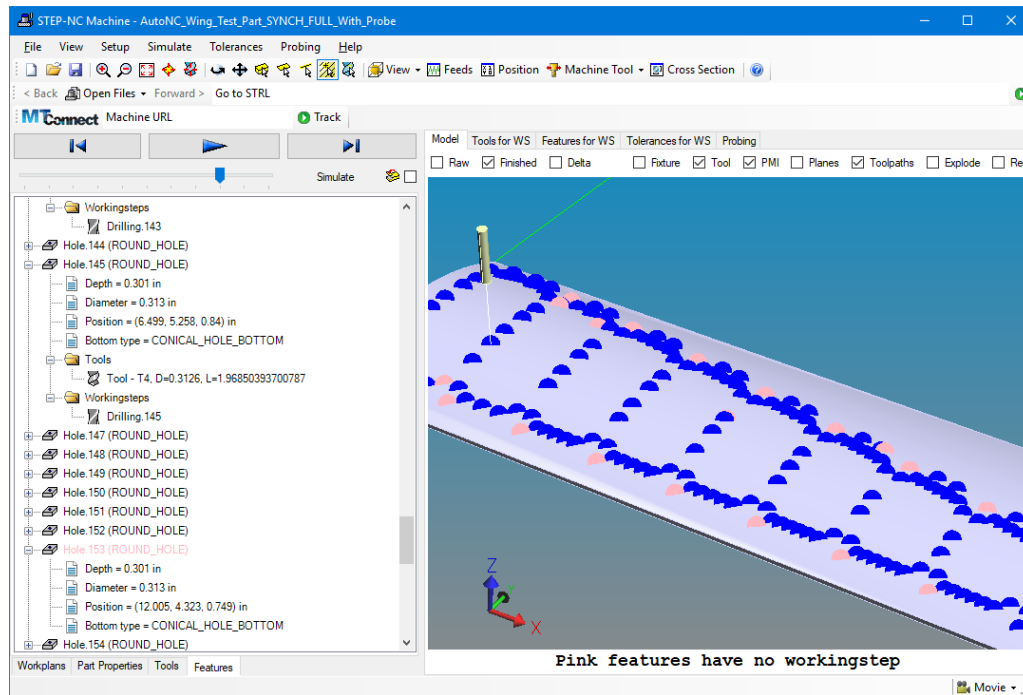
```
TYPE twin_state_enum = ENUMERATION OF  
(simulated, machined); END_TYPE;
```

Executable is supertype of all processes.

Definition above shows its new attributes for Edition 2

Digital Twins for robot drill and fill

- Multi-robot STEP-NC program for wing assembly
 - Model current state of each process in the digital twin
 - Complete, in-progress, disabled, cancelled, etc.










Digital Wing



Physical Robots

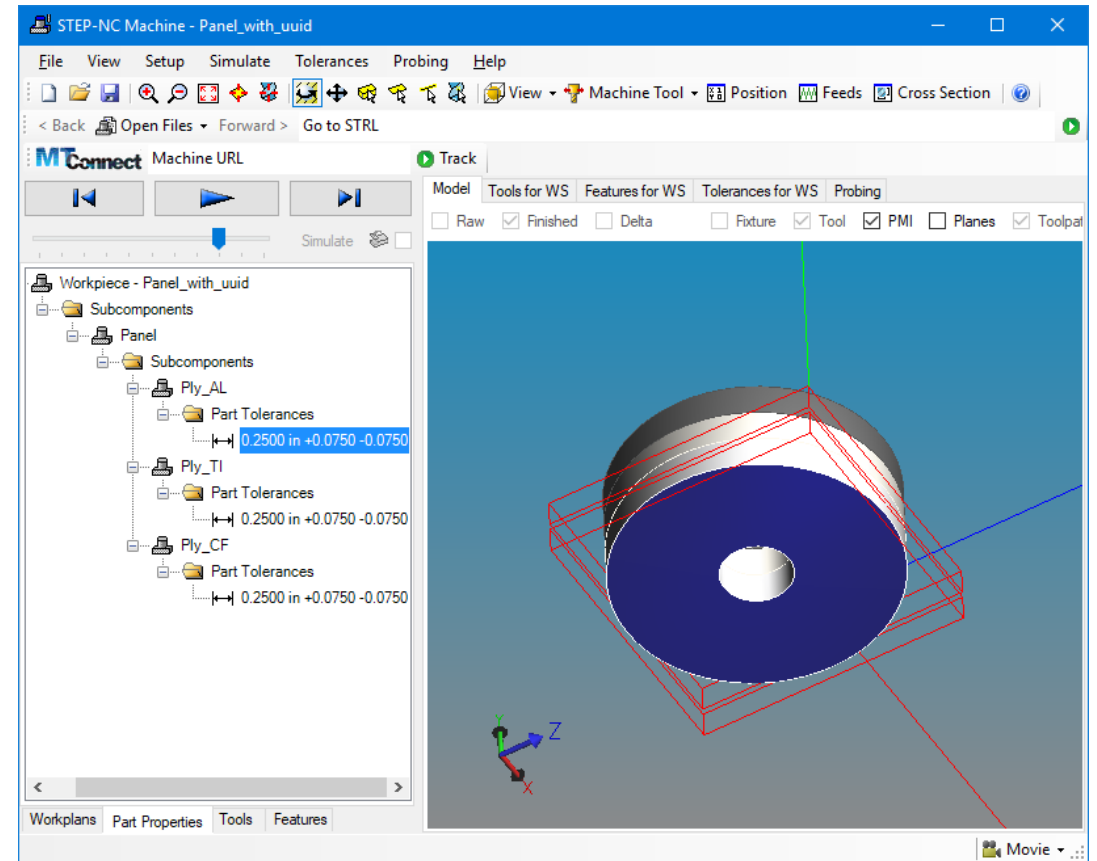
Digital Twins for wings

- States shown as
 - Colored discs on the geometry (to be in right side of wing on slide 3)
- Explained as
 - Process status data in the feature tree (to be in left side of wing on slide 3)

	State	State Start	State End	State Error
	Ready	Null	Null	Null
	Complete	Not Null	Not Null	Null
	Process Error	Not Null	Not Null	Not Null
	Process interrupted	Not Null	Null	Not Null
	In-process	Not Null	Null	Null
	Disabled	Null	Null	Not Null
	Unnecessary	Null	Not Null	Not Null

Digital Twins for fasteners (for discussion)

- **Model stack up depth**
- **Show status on wing**
 - Above nominal
 - Below nominal
 - Out of tolerance
 - Completed
 - Scheduled



Digital Twins for cutters (for discussion)

- **Model current dimensions**
- **Show wear trends**
 - Above average
 - Below average
 - Ready
 - In-process

