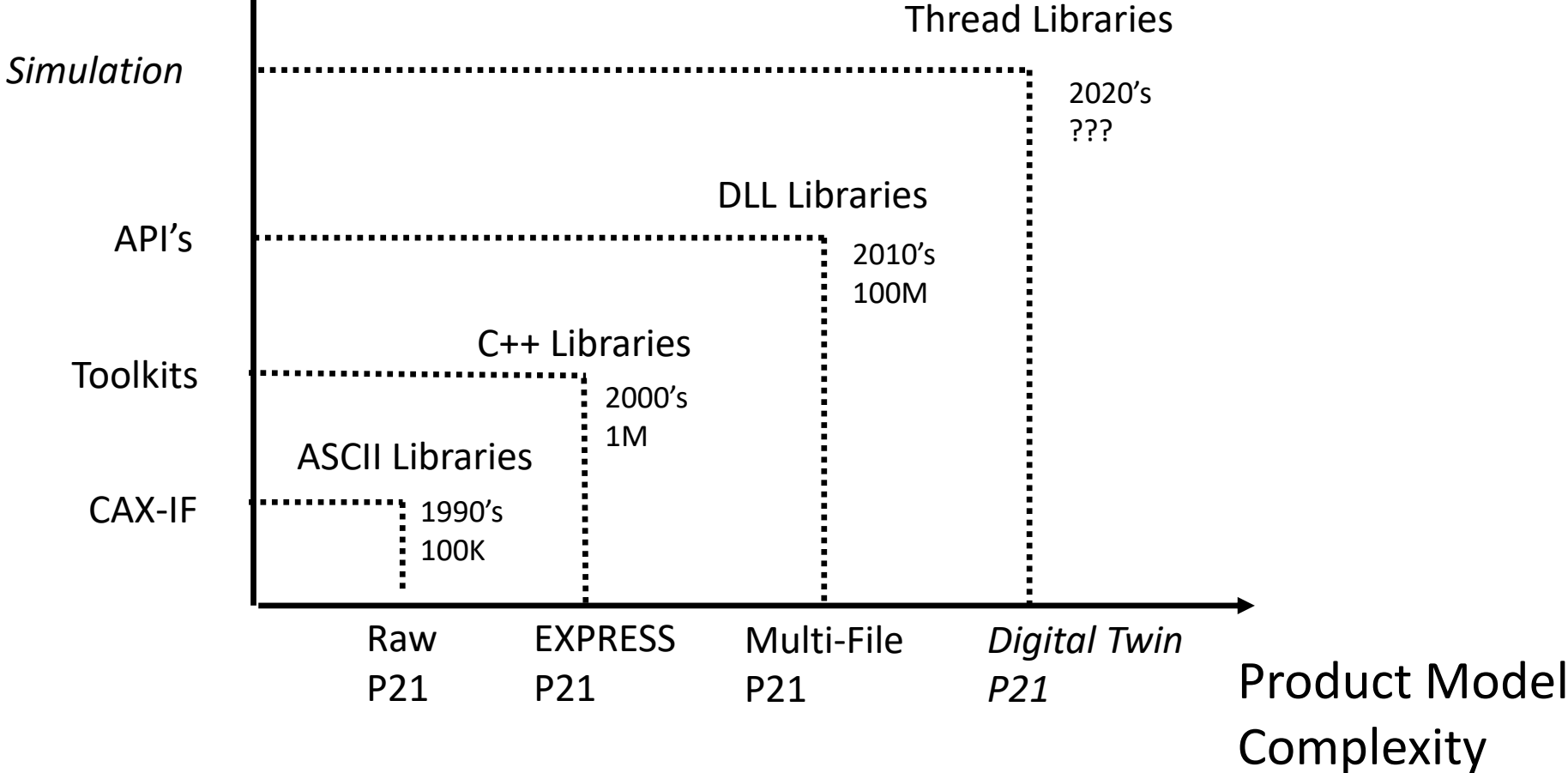# Digital Twin
Part 21

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WG11 & WG15

Background

- Part 21 has been the primary data format for STEP since the 1990's.

- Digital twins will require product models of great complexity.

- We may "break" Part 21 because there will be too many entities for reasonable processing

- For 10 years STEP Tools has been using an informal extension to help it make sense of long complex product models.

- Maybe it is time to make this informal extension a formal one.

Evolution of Part 21

Product Model
Functionality

Raw P21: Read and write using parser
EXPRESS P21: Read and write using compiler
Multi-File P21: Read and write subsets

Simulation

Thread Libraries

2020's
???

DLL Libraries

API's

2010's
100M

C++ Libraries

Toolkits

2000's
1M

ASCII Libraries

CAX-IF

1990's
100K

Raw
P21

EXPRESS
P21

Multi-File
P21

*Digital Twin
P21*

Product Model
Complexity

Example

- This is the P21 used by STEP Tools

- The catalog data is optional and in comments

- The catalog data is a "Dewey Decimal Classification system" for STEP

- The proposal is to move the catalog out of the comments and into the Part 21 standard

External identifiers

Catalog data

AIM data

```
STEP File Browser - Simple_program_wtih_tool_assembly.stpnc [page 1/34]
File   View   Navigate   Help

ANCHOR;
<1727b5d4-dbe7-4989-8493-68aface34eb8>=#624;   /* line 29 WS 2 TP 1
<12677aa7-7ac2-4dc8-a047-72712798d98c>=#633;   /* line 35 WS 2 TP 2
<32f9c5e3-2b31-427c-a672-f271da5cf82e>=#678;   /* line 115 WS 2 TP 3
<0295d603-ecd3-4648-8e97-c59ed8cd0053>=#690;   /* line 123 WS 2 TP 4
<ae8952bd-c0a3-402c-a835-295b744a1923>=#697;   /* line 127 WS 2 TP 5
<bf45a370-3ce8-4f86-9495-5666399ca765>=#742;   /* line 207 WS 2 TP 6
ENDSEC;

DATA;

/*****************************************************
 * Application object: PROJECT (#10)
 * MAIN_WORKPLAN: #10, #11, #12, #938
 * ITS_WORKPIECES [*]: #10, #13, #265
 * ITS_ID: #10, #14, #15, ['Simple_program_wtih_tool_assembly']
 */
#10=PRODUCT_DEFINITION('','',#14,#16);
#11=PROCESS_PRODUCT_ASSOCIATION('','',#10,#12);
#12=PRODUCT_DEFINITION_PROCESS('machining','',#938,'');
#13=MACHINING_PROJECT_WORKPIECE_RELATIONSHIP('','','',#10,#265);
#14=PRODUCT_DEFINITION_FORMATION('','',#15);
#15=MACHINING_PROJECT('Simple_program_wtih_tool_assembly','',$,#17
#16=PRODUCT_DEFINITION_CONTEXT('CNC Machining',$,'manufacturing');
#17=PRODUCT_CONTEXT('CNC Machining',$,'manufacturing');

/*****************************************************
 * Application object: WORKPIECE (#18)
 * ITS_RELATED_GEOMETRY [*]: #18, #19, #20, #21, #22, #23
 * ITS_CATEGORIES [*]: #18, #24, #25, #26, ['part']
 * ITS_GEOMETRY: #18, #19, #20, #21
 * ITS_STYLED_MODELS [*]: #18, #27, #28, #949
 * ITS_STYLED_MODELS [*]: #18, #29, #30, #950
 * SHAPE_DEFINITION: #18, #19
 * ITS_ID: #18, #24, #25, ['PART1']
 * ITS_CONSTRUCTIVE_MODELS [*]: #18, #19, #20, #21, #31, #1017
 * REVISION_ID: #18, #24, ['']
 */
#18=PRODUCT_DEFINITION('','',#24,#32);
#19=PRODUCT_DEFINITION_SHAPE('','',#18);
#20=SHAPE_DEFINITION_REPRESENTATION(#19,#21);
#21=SHAPE_REPRESENTATION('',(#34,#923),#39);
#22=SHAPE_REPRESENTATION_RELATIONSHIP('','',#21,#23);
#23=ADVANCED_BREP_SHAPE_REPRESENTATION('NONE',(#963),#39);
#24=PRODUCT_DEFINITION_FORMATION_WITH_SPECIFIED_SOURCE('','',#25,
 .NOT_KNOWN.);
#25=PRODUCT('PART1','','',(#264));
#26=PRODUCT_RELATED_PRODUCT_CATEGORY('part',$,(#25));
#27=PROPERTY_DEFINITION('styled model','',#18);
#28=PROPERTY_DEFINITION_REPRESENTATION(#27,#949);
#29=PROPERTY_DEFINITION('styled model','',#18);
#30=PROPERTY_DEFINITION_REPRESENTATION(#29,#950);
#31=CONSTRUCTIVE_GEOMETRY_REPRESENTATION_RELATIONSHIP(
'supplemental geometry','',#21,#1017);
#32=PRODUCT_DEFINITION_CONTEXT('part definition',#33,'');
#33=APPLICATION_CONTEXT(
'configuration controlled 3D design of mechanical parts and assembl
#34=AXIS2_PLACEMENT_3D('',#35,$,$);
#35=CARTESIAN_POINT('',(0.,0.,0.));
#36=CARTESIAN_POINT('',(0.,0.,0.));
#37=DIRECTION('',(0.,0.,1.));
#38=DIRECTION('X direction',(1.,0.,0.));
```

Some Requirements

- Make STEP data easier to understand and debug
  - To enable more complex digital twins
- Support multiple classification systems
  - Built from mapping tables, EXPRESS-X, SysML and other languages
- Seamless upgrade from current P21
  - So catalogs can be added to existing data
- Enable lightweight access
  - So simple applications can be written at lower cost
- Support multiple data formats
  - So QIF results can explain STEP measurements

Issues to think about

- How to encourage participation in the testing and development
- Should this be a 10303 standard or a 23247 standard
- What should be the timeline