STEP-NC
Status

Martin Hardwick
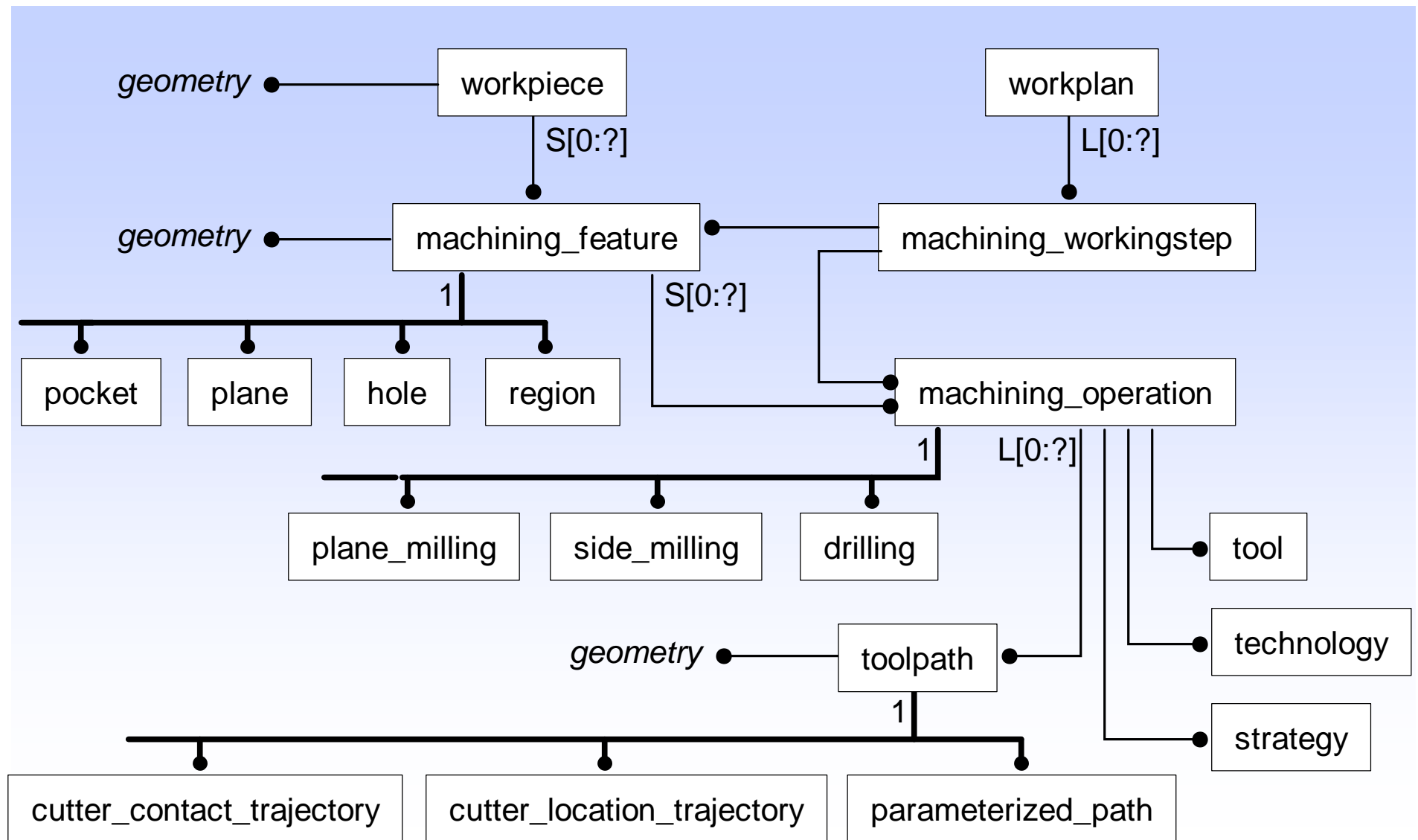**David Loffredo**
info@steptools.com

STEP-NC Manufacturing Center
Watervliet Arsenal, Building 20
Metal Processing Manufacturing Division
Watervliet, New York 12189
(518) 266-6212 / (518) 266-6211 fax
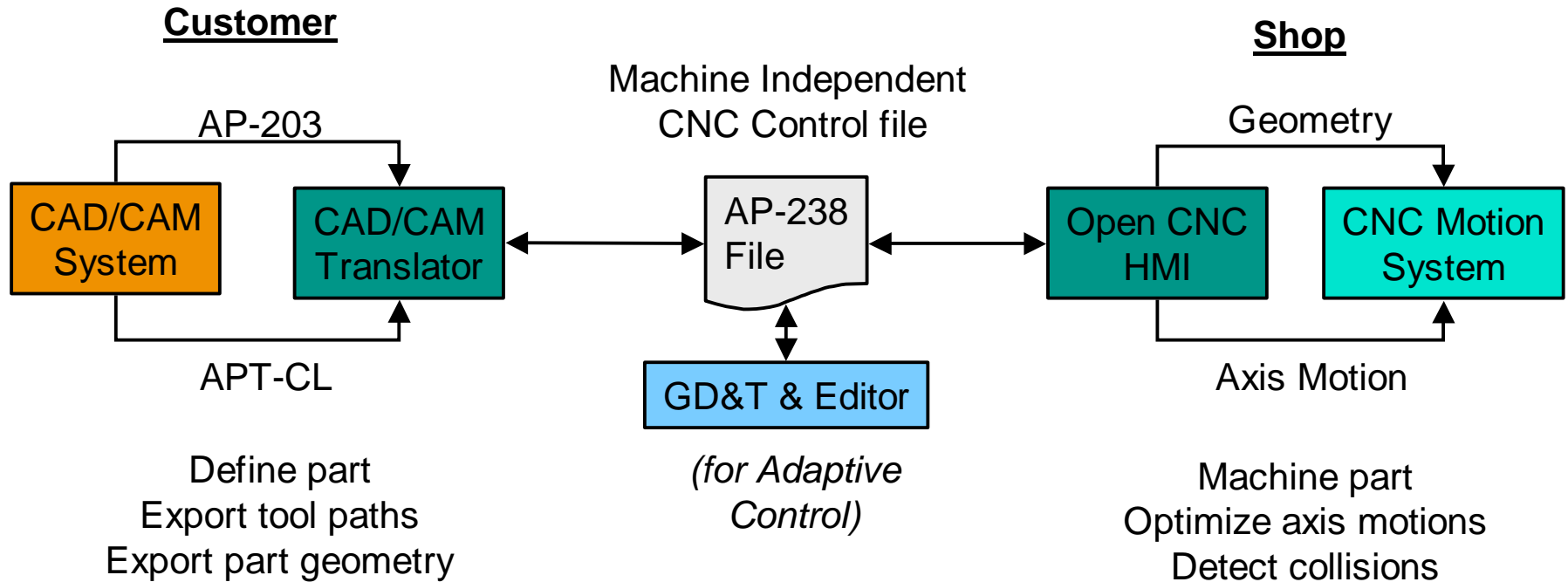**http://www.stepnc.com**

STEP *NC*

- **STEP-NC AP-238 is a new language for CNC control**
  - Complete, unambiguous model of the part and process
  - Upward compatible extension of AP-203 (geometry) and AP-224 (features)
  - Makes CNC systems
    - » More interoperable
    - » Faster to program
    - » Safer to operate
- **STEP-NC AP-238 can enable many savings in lean, agile manufacturing**

AP-238 integrates tool path and design data

STEPNC

geometry — workpiece
— S[0:?] —

workplan
— L[0:?] —

geometry — machining_feature — machining_workingstep

machining_feature —1—

pocket   plane   hole   region

— S[0:?] —

machining_operation —1—

plane_milling   side_milling   drilling

— L[0:?] —

tool

technology

geometry — toolpath —1—

strategy

cutter_contact_trajectory   cutter_location_trajectory   parameterized_path

Courtesy WZL RWTH Aachen

M. Hardwick

Slide 3

Evolving architecture

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"Faster milling, drilling and turning"

Customer

Shop

Machine Independent
CNC Control file

AP-203

Geometry

CAD/CAM
System

CAD/CAM
Translator

AP-238
File

Open CNC
HMI

CNC Motion
System

APT-CL

Axis Motion

GD&T & Editor

Define part
Export tool paths
Export part geometry

*(for Adaptive
Control)*

Machine part
Optimize axis motions
Detect collisions

■ CATIA, Unigraphics, Pro/Engineer, other APT-CL data sources

■ GE Fanuc 16i, Siemens 840D, MDSI, other Open controls

Near term benefits

> **Replace RS274D axis data with**
> **AP-238 tool path and design data**

- **Reduce overhead**
  - More frequent direct load of customer data into CNC
  - Faster set-up, less programming

- **Less waste**
  - Detect wrong program and workpiece
  - Detect collisions

- **Increase throughput**
  - Optimal use of the machine
  - Faster reprogramming

Example cost savings (1)

Description	Quantity	Annual Savings
Machined parts in the UK Navy inventory	90,000 (approx)	$640M
Parts in one depot (submarine)	25,539	
Parts with available design data.	13,748	**STEP-NC Opportunity**
Savings using AP-224 for rapid manufacture	1,500	$4M

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Reduction of overhead (parts need less programming)				
	CAM programmer hours	2000	$ 80.00	
				$ 160,000.00
Less waste (0.5% error rate=3 parts per month)				
	Scrapped parts	36	$ 750.00	
	Scrapped cutting tools	36	$ 250.00	
	Lost machining hours	576	$ 100.00	
	Repair time (2 people)	1152	$ 50.00	
				$ 151,200.00
Faster thruput (12,000 hour base)				
	20% Increased utilization	2400	$ 100.00	
				$ 240,000.00
			TOTAL	$ 551,200.00
Example data for a machine shop in aerospace				
	Three high speed machines. Two eight hour shifts.			
	Machine 7,200 parts per year. 150 new parts per year.			

AP-238 Timeline

Date	Milestones.
1999	Project funded by NIST ATP Program
2001	Committee Draft of standard with milling model. First industry tests at General Dynamics Land Systems
2002	First industry benchmark tests at NASA JPL
2003	First release of ST-Plan (AP-203 to AP-238) conversion. First release of ST-Machine for GibbsCAM and Mastercam. First release of the STIX programming libraries. STEP-NC wins Industry Week "Technology of Year" award
2004	NGSS and BIW demonstrate application of STEP-NC to shipyard data Boeing demonstrates conversion of APT CL files to AP-238. STEP GD&T data for CAD, CNC and CMM harmonized Draft International Standard released for milling and turning
2005	Extensive industry testing Final Draft International Standard released CAD, CAM and CNC vendors announce support for AP-238
2006	International Standard released by ISO CAD, CAM and CNC vendors release products with AP-238 interfaces

AP-238 Conformance Classes

- ## CC1 – CNC Independent tool paths
  - Tool path data
  - Workingstep infrastructure necessary to support tool paths

- ## CC2 – Collision detection
  - AP-203 design geometry
  - Tool and fixture information necessary to detect collisions

- ## CC3 – Conditional Programming
  - Conditional and parallel programming constructs
  - In-process feature data sufficient to constrain ordering

- ## CC4 – Generative programming
  - GD&T data sufficient to compute optimal speeds and feeds
  - Final feature data sufficient to compute tool paths

Questions?
(Plug for Lean Manufacture Workshop in Seattle on October 6th)