



Symposium 98

C++ Versus Ada

The Debate Continues

PRICE

- **Current Airborne and Space Systems were developed using Ada83**
- **Trade studies are currently being accomplished on translating legacy systems from Ada83 to C++**
- **This paper will look at the differences between the two Languages, and the issues encountered when accomplishing the trade-studies**

- Introduction
- Acquisition Issues
- LCC Issues
- Conclusions

- **Background Ada**
 - **Ada83 was developed by DOD**
 - **Real Time/Complex Systems**
 - **Special Training Required**
 - **Object Based Language**
 - **Ada95 - Object Oriented Language**

DOD Weapon Systems

3 Generation Languages	SLOC (Millions)
ADA83	49.70
C	32.50
Fortran	19.55
CMS-2Y/M	18.55
Jovial	13.80
C++	5.15
Pascal	3.91
PL/1	1.00
Other 3GLs	4.22

Commercial Use Of Ada



Air Traffic Control

Australia
Belgium
Brazil
Canada
China
Czech Republic
Denmark
Finland
France
Germany
Greece
Hong Kong
Hungary
India
Ireland
Kenya
Netherlands
New Zealand
Pakistan
Scotland
Singapore
South Africa
Spain
Sweden
United Kingdom
United States
Vietnam

Banking and Financial Networks

Reuters news service
Swiss Postbank Electronic Funds
Transfer system

Commercial Aircraft

Airbus 330
Airbus 340
Beechjet 400A (US business jet)
Beech Starship I (US business
turboprop)
Beriev BE-200 (Russian forest fire
patrol)
Boeing 737-200, -400, -500, -600, -700,
-800
Boeing 747-400
Boeing 757
Boeing 767
Boeing 777
Canadair Regional Jet
Embraer CBA-123 and CBA-145
(Brazilian-made regional airliners)
Fokker F-100 (Dutch DC-9-size airliner -
American Airlines flies these)
Ilyushin 96M (Russian jetliner)
Saab 2000
Tupolev TU-204 (Russian jetliner)

Communication and Navigational Satellites and Receivers

INMARSAT - voice and data
communications to ships and
mobile communications
Intelsat VII
NSTAR (Nippon Telephone and
Telegraph)
PanAmSat (South American Intelsat-like
consortium)
United States Coast Guard Differential
Global Positioning System (GPS)
Rockwell Collins NavCore V GPS
receiver
ESA/Alcatel-SEL GPS receiver
TDRSS Ground Terminals - NASA

Scientific Satellites

Cassini command subsystem
ENVISAT-1 - European Space Agency
(ESA), Earth observation satellite
XMM - ESA
EOS - NASA's Earth Observing System
GOES
RadarSat (Canada)
UK Space Technology Research Vehicle,
auxillary payload on Ariane4

Railway Transportation

Cairo Metro
Calcutta Metro
Caracas Metro
Channel Tunnel
Conrail (major U.S. railway
company)
French High-Speed Rail
(TGV)
French National Railways
Hong Kong Suburban Rail
London Underground
Paris Metro
Paris Suburban Rail

Television Industry

Canal+ (French pay-per-view
TV, remote cable box
control software)

Medical Industry

JEOL Nuclear Magnetic
Resonance

- **Background C++**
 - **Developed as an extension of C**
 - **Object Oriented Language**
 - **Used primarily in the Commercial Software Sector**
 - **Training is not a major issue**
 - **Lower startup costs**
 - **Open Architecture**

- **Advantages of C++ - Object Oriented Programming (OOP)**
 - Testing
 - Modifications to Existing Programs
 - Re-Use

- Acquisition/Development Issues
 - Software Size
 - Auto Code Generation vs Traditional Development
 - Training

- **Software Size**

- **Will the C++ Software Result in Less or More Instructions than the Current System?**

- ☐ **Ada83 - Average of 71 SLOC per Function Point**

- ☐ **Ada95 - Average of 49 SLOC per Function Point**

- ☐ **C++ - Average of 53 SLOC per Function Point**

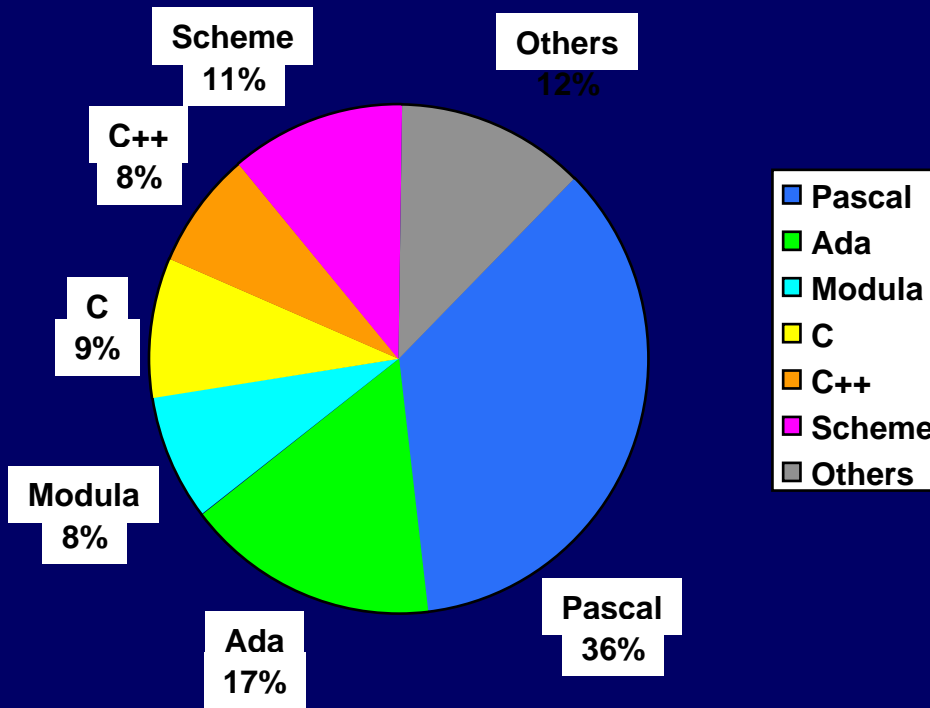
- **Auto Code Generation Vs Traditional**
 - May only be viable for a small percentage of the overall software for military real time systems

- **Memory Management**
 - **Memory Management Problems have been reported with C++**
 - **Thru-Put Speed problems have been reported with C++ - Auto - Code Generation**

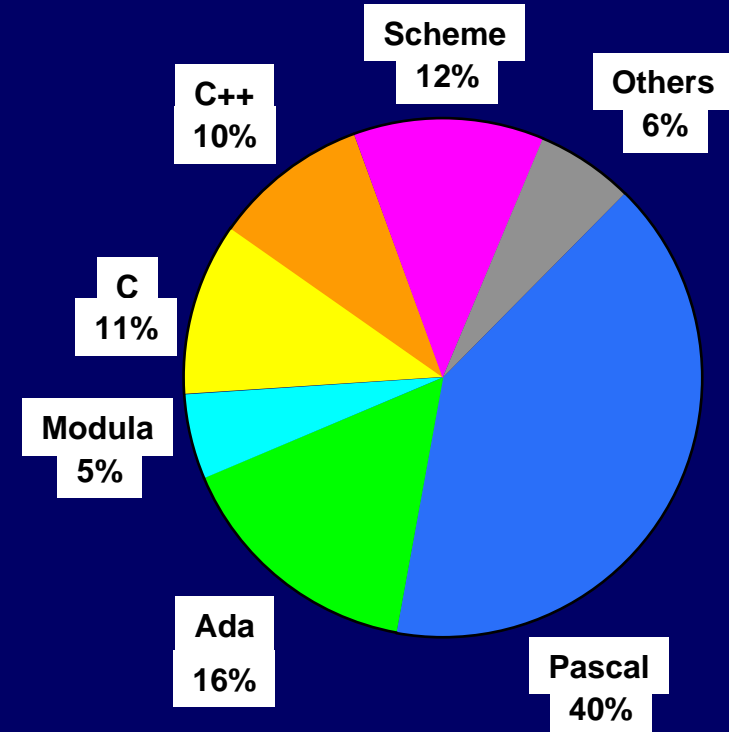
- **Training**
 - **Foundation Language**
 - **Company Training**

Foundation Language

WORLDWIDE



USA



Source: University of Michigan Computer Science Dept. survey

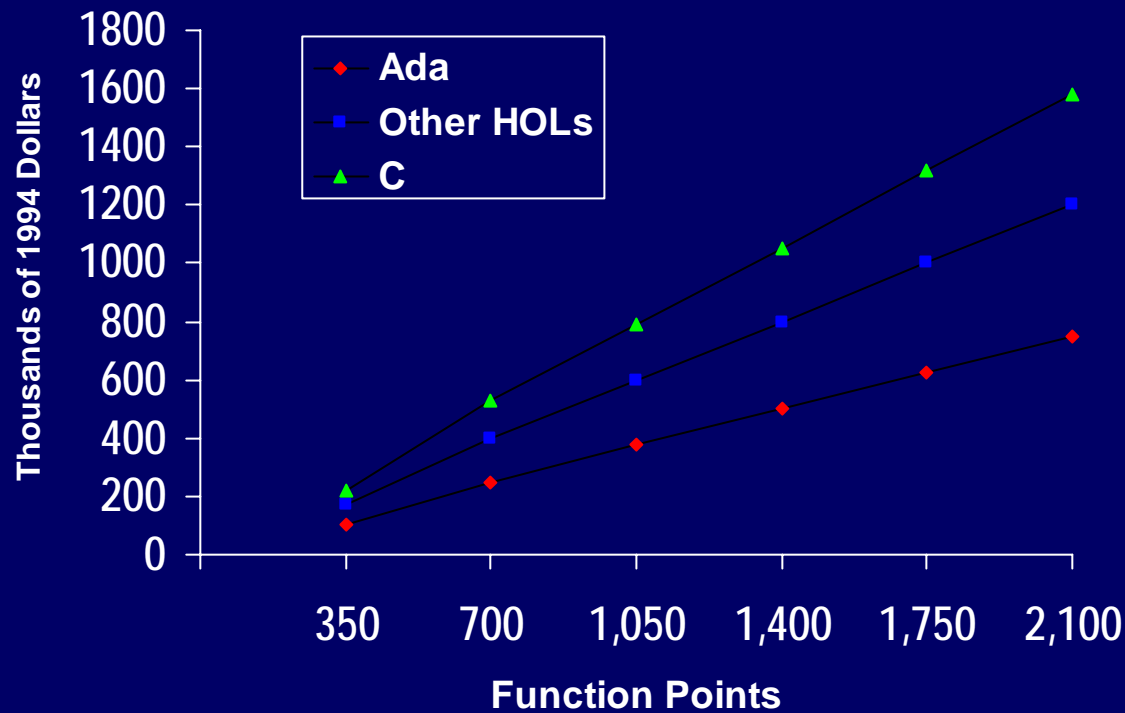
- **LCC Issues**

- **Reported Error Rates of C++ Exceed Reported Error Rates of Ada83 and Ada95**

	Integration Defect Rates (defects/KSLOC)	FQT Defect Rates (defects/KSLOC)	Number of Data Points
Norm (all languages)	33	3	543
Average (Ada)	24	1	153
Average (C++)	31	3	23

Source: CTA follow-on study, 1991

Average Annual Costs for Software Maintenance



Source: MITRE (Avionics domain)

- Case Study Using PRICE S
 - SLOC
 - Timing
 - CPLX1
 - New versus Reuse
 - Integration

Life Cycle Costs / CSCI				
	Ada Development Item		Waterfall	
	Costs in Person Hours		20 YEAR OPERATIONAL LIFE	
	Maintenance	Enhancement	Growth	TOTAL
Des	6271	3944	48006	58220
Pgm	4180	3148	29352	36680
Data	3317	1554	16518	21389
SEPM	3619	2634	33332	39586
Q/A	3364	1295	14207	18866
CFM	3364	1295	15870	20528
TOTAL	24114	13870	157285	195269
Summary				
	SLOC	100000		
Acquisition Costs	116328 *	Initial Defects/KSLOC :	1.20	
Support Cost	195269			
TOTAL	311597			

Life Cycle Costs / CSCI				
	C++ Development Item			
	Costs in Person Hours		Waterfall	
	20 YEAR OPERATIONAL LIFE			
	Maintenance	Enhancement	Growth	TOTAL
Des	9121	4770	57363	71254
Pgm	6080	3822	35218	45120
Data	4900	1915	20024	26839
SEPM	5302	3197	39843	48342
Q/A	4949	1601	17279	23830
CFM	4949	1601	19287	25838
TOTAL	35300	16907	189014	241221
Summary				
	SLOC	100000		
Acquisition Costs	171050 *	Initial Defects/KSLOC :	1.40	
Support Cost	241221			
TOTAL	412271			

■ Conclusions

- C++ may not be a Viable choice for Current Airborne Weapon Systems
- PRICE S can be used to Evaluate Acquisition and O&S Costs in Support of these types of Evaluations