National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

COTS at JPL

Jeff Sokol

January 12, 2005

Presented at The JEDEC/G12, DSA Meeting

What is a COTS part?

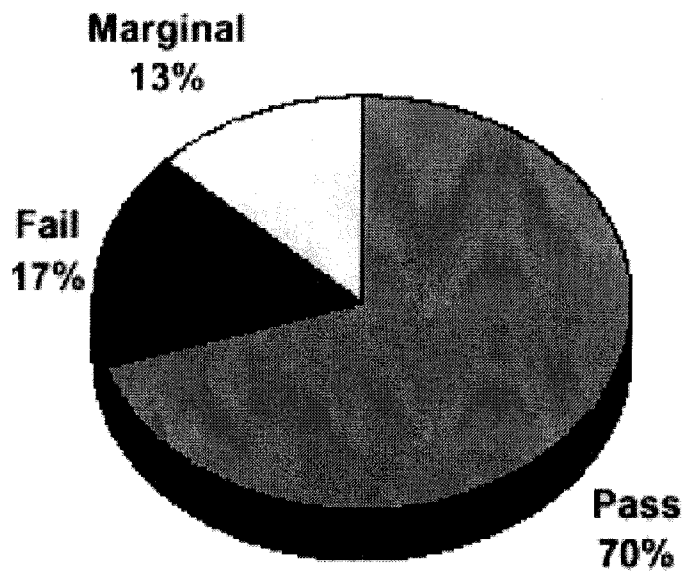
- **Generally, a COTS part can be considered to be any part that does not come off a government monitored/certified fabrication line.**
  - **PEMs**
  - **Commercial grade ceramics**
  - **883b**

Some COTS Issues

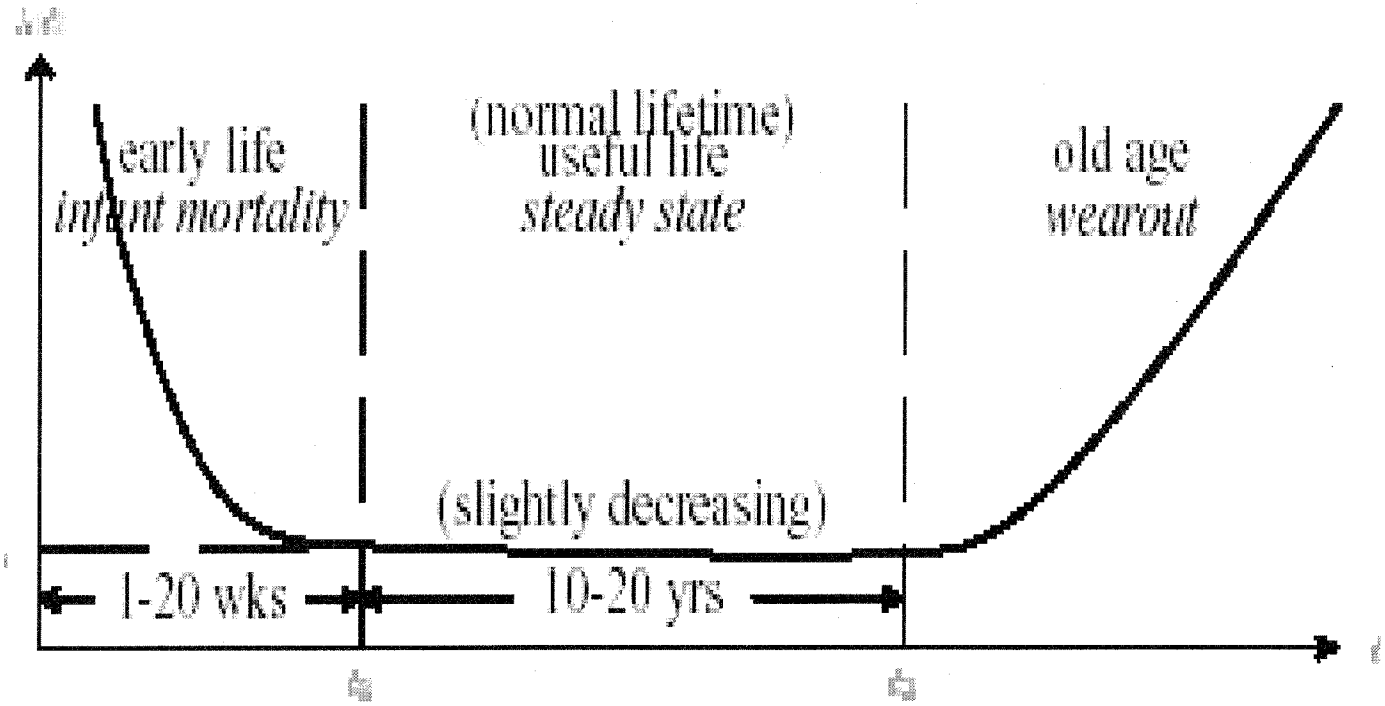
- **Reliability**
  - **COTS parts may or may not be as reliable as QML product**
- **Useful life**
  - **COTS parts with inadequate burn-in may result in degraded circuit design margins during deployment**
- **Non-homogeneity**
  - **COTS parts tend to have a higher degree of non-homogeneity than QML (particularly when compared to Class S product) parts**
    - **Lot qualification becomes more problematic as a function of the degree of non-homogeneity**
- **Up-screening temperatures may result in damage to PEMs**
  - **Glass transition temperature of plastic encapsulant needs to be addressed**

PEM Reliability Performance

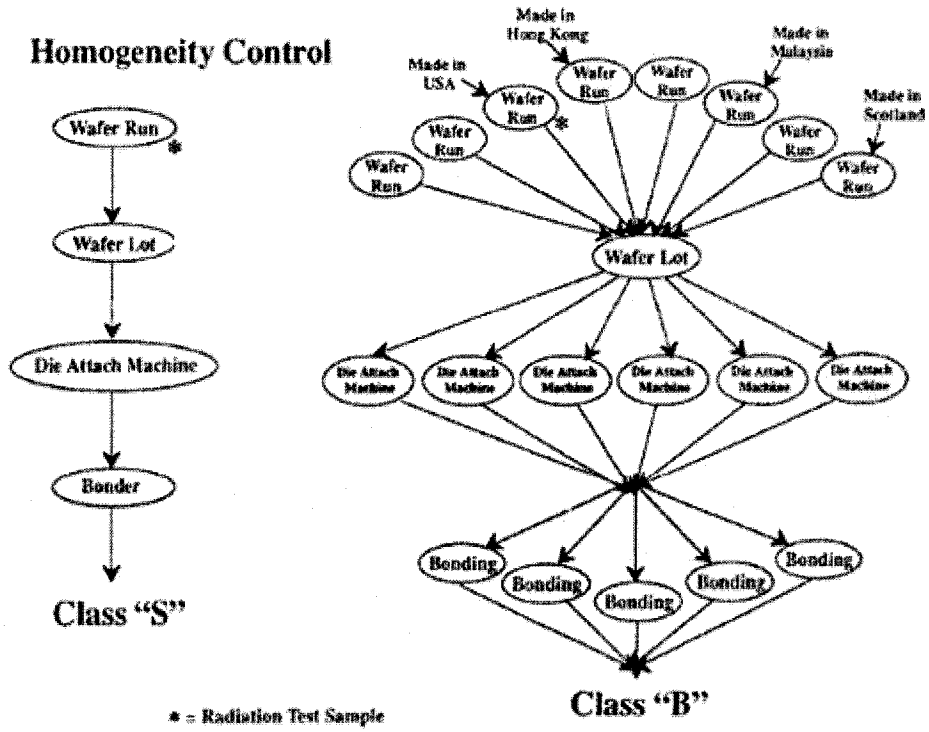
PEM Assessment Results
(1997-1999 data)



Life of a Part



Homogeneity Control

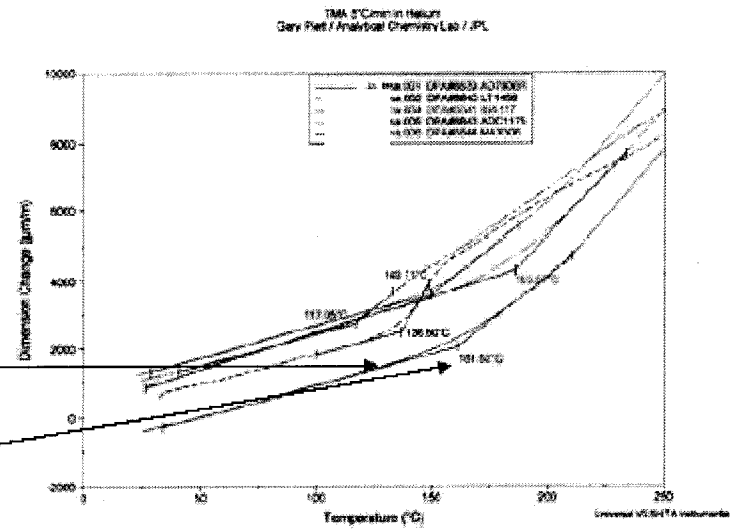


Glass Transition Temperature

Required Tj(Burn-In/operating) or Storage Temperature(Ts) vs Recorded Tg

Tj or Ts should be 20°C min. below the recorded Tg to mitigate any reliability failure modes:

- The measurement error using TMA method is ±2°C
- The beginning of Tg phase change can be up to 10°C or more below the recorded Tg.



How Rigorous Does the COTS Upgrade Regimen Need to be?

- **There is no one universal Upgrade Regimen for all space missions**
- **Which ever regimen you pick must consider the following**
  - **Part application**
    - **Mission impacting application (e.g. ACS) vs. non-mission impacting application (e.g. instrument)**
  - **Cost vs. risk reduction**
    - **At what point does risk reduction bang for the buck fall below a reasonable level for the intended part's application?**
  - **Potential Schedule slip vs. risk reduction**
    - **When does potential schedule slip impact offset the return from the risk reduction regimen?**

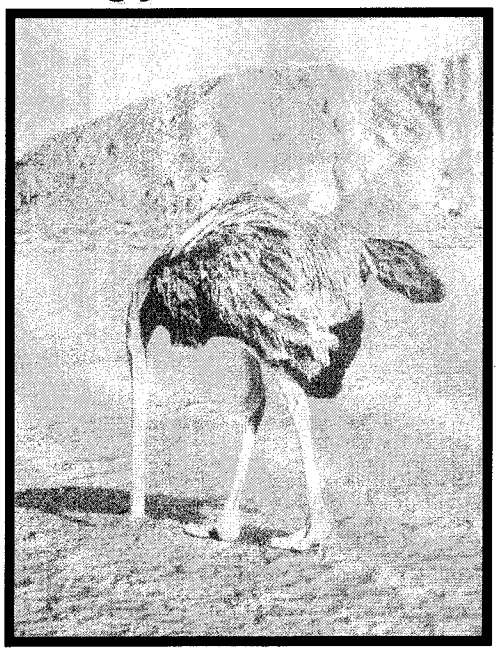
National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

Comparative PEMs Suggested Upgrade Regimen as a Function of Mission Duration

	COTS (1)**	COTS (5)**	COTS (10)**	COTS (15)**
Mission Time	<1 yr (1500hrs)	5yr (43800hrs)	10yr (87600hrs)	15yr (131400hrs)
X-recommended				
DPA (Sample)				
1.External Visual	X	X	X	X
2.Radiographic	X	X	X	X
3.Internal Visual	X	X	X	X
4.SEM				
a. Metalization	X	X	X	X
b. Glassivation Integrity		X	X	X
c. Cross-sections	X	X	X	X
5. Bond Pull		X	X	X
6. Glass Transition Temp.	X	X	X	X
7. Lead Free Solder	X	X	X	X
UpScreen (100%)				
8. Serialization	X	X	X	X
9.Electricals	X	X	X	X
10.Temperature Cycle	X	X	X	X
11. X-Ray	X	X	X	X
12. C-SAM	X	X	X	X
13.Electricals	X	X	X	X
14.Dynamic Burn-in(ELFR)	X	X	X	X
15.Electricals	X	X	X	X
Qualification (Sample)				
16.Dynamic Life Test (HTOL)	X	X	X	X
17.Electricals	X	X	X	X
18. Post Life Bond Pull		X	X	X
19. Outgassing if Required			X	X
20. ESD			X	X
21. PDA			X	X
22. Preconditioning (MSL)	X	X	X	X
23. HAST		X	X	X
24. Hand Soldering Temp+Flux	X			
25. Temperature Cycling	X	X	X	X
26. Traceability (QML)			X	X
27. Current Density Cal.			X	X
28. DPA on Life Samples		X	X	X
29. Voltage Breakdown	X	X	X	X
30. Pwr Sequence Latch-Up if Required				
Packaging/Handling				
31. Moisture Controls		X	X	X
32. ESD Controls		X	X	X
33. Contamination Controls		X	X	X
Documentation				
34.Data R/R (Review)	X	X	X	X
35. QA C of C	X	X	X	X

Conclusion

- **Be very careful when utilizing COTS parts!**
  - **Not all COTS parts manufactures were created equal**
    - **Not all COTS parts manufactures remain equal with time**
  - **Understand the parts application in the intended mission**
    - **Just because it flew on some mission that was successful doesn't mean it is qualified for all missions**
  - **Understand the parts inherent residual risk as a function of the upgrade regimen instituted**
  - **Be careful of the potential for significant cost growth due to the upgrading regimen when COTS parts are to be used in very high reliability applications**

Remember!

Characterize your COTS parts over the "full environment" or you're just hiding your head in the sand.