System Engineering Process Improvement using the CMMI in Large Space Programs

Revital Goldberg, Sarit Assaraf
Israel Aerospace Industries

Israel Aerospace Industries (IAI)

- Largest aerospace & defense company and the largest industrial exporter in Israel (> 15,000)
- Missiles, Satellites, UAVs, Avionics, Upgrades, RADARS, etc.
- Activities encompassing: Development, Production, Maintenance and Service of Aerospace Systems
- IAI divisions are certified for ISO9000 and AS9100
IAI Organizational Chart

Military A/C Group (3 Div.)
Commercial A/C Group (4 Div.)
BEDEK Aviation Group (3 Div.)
Headquarters Organizations
Engineering Group (2 Div.)
Systems Missiles Space Group (5 Div.)
ELTA Systems Group Ltd. (4 Div.)
Process Improvement – WHY?

Watts Humphrey

“Software Process Program” founder at the Carnegie Mellon’s Software Engineering Institute:

“The Quality of a System is Governed by the Quality of the Process Used to Develop it”
IAI Process Improvement Path

Starting Software Process Improvement Program (SPIP) based on CMM

Starting activities for project management process improvement

Starting System Process Improvement (SYSPI)

Starting CAI activities and NPI development

Starting Advanced System & SW Technology: based on CMMI

CMMI ML 5:
1 Group
1 Division

CMMI ML 3:
1 Group
1 Division

2010
Current Status

SW-CMM

SE-CMM

CMMI

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The CMMI implementation is managed as a program for process improvement at the group level.

**SAPIR** – Standard Annual Process Improvement Roadmap

The management concept is based on the CMMI ORG and Support PAs.
Discipline based PITs - Process Improvement Teams

(Process Leader + Project Representatives)

PM, SE, VVT, SW, HW, QA, CM, SAM, ORG

Each PIT conducts meetings and activities, managed by PIT Leader

ORG PIT comprises of all PITs Leaders

CMMI Integrated plan consisting of all PITs’ plans
IAI Process Improvement Strategy

**IAI Corporate Level**

- IAI VP Operations Engineering & Development CMMI Program Office
- • Sponsorship
  • Coordination
  • Budget Allocation
  • Process Assets Development
  • Support and Implementation

**IAI Groups and Divisions**

- Process Improvement Activities
  - • Local Sponsorship
  - • Local Budget & Resources
  - • Process Assets Adaptation and Development
  - • Process Implementation
  - • Process Feedback
Process Definition and Tailoring Method

IAI Corporate level
Company HDQ

A set of SE standard processes, methodologies, tools, tailoring guidelines & training material

Tailoring

At the Group level
within the SE PIT

Tailored HDQ SE set

Deployment

Feedback

Project SE
Space systems

The Satellite Program = A System of Systems Program

- TECSAR
  Synthetic Aperture Radar
- OFEQ
- AMOS 1,2
- AMOS 3
- AMOS 4
- Advanced comm. Sat.
- OPTSAT 3000
- EROS C
- Observation satellites
- Shavit launch vehicles
- Ground control stations
- Venus
- Observation satellites
- Communication satellites

SE Processes Improvement using CMMI in Space Programs

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Decentralized SE at the group level –

The **SOS** and the **Systems SE** are part of the program office, also managing the Sub-Contractors. The **Sub Systems SE** are part of the Engineering Departments.

Different views and meanings of SE activities adequate to each level of the system: SOS, System, Subsystem.

Large project teams (often, geographically dispersed)
FORMAL *mutual commitment* between the Program office and the Engineering Groups supports implementation of

**PP SP3.3, PMC SP1.2, REQM SP1.2 & IPM SP2.2:**

- The Program Office issues Internal Customer–Supplier Agreements
- The Program Office allocates budget for the engineering groups against their commitment to supply adequate products on time

The program establishes Integrated teams consisting of different disciplines (IPT = Integrated Product Teams)

*CMMI V1.3 - New Version IPM & OPD*
IAI SPACE Programs Main Characteristics
Many Sub Contractors & Suppliers

- Complex coordination
  - Internal (IAI) sub contractors
  - External sub contractors
  - Suppliers

Supports implementation of

**IPM SP2.1, SP1.5; SAM SPs; TS SP2.4; DAR**

- Complex System Integration aspects – Integration Strategy planning requires special attention (**PI SP1.1**):
  - Scheduling
  - Sub Contractors Monitoring
  - Interfaces definition correctness and completeness (**TS SP2.3, PI SP2.1**)
  - Integration Readiness Review (**PI SP3.1**)

Sub Contractor  Int. Sub Contractor  Supplier  Sub Contractor  Supplier
Each Satellite is “One of a Kind”

however …

Verification & Validation are limited, especially by the ability to simulate the environmental conditions.

Support implementation of **VER & VAL SP1.1, SP1.2, SP1.3**

Once Launched – Repair activities are limited to SW corrections and updates. Requires special attention to:

- **Requirements validation** at early development stages (**RD SP3.5**)
- **Analysis of Failures** found on PI, VER & VAL stages (**PI, VER SP3.2, VAL SP2.2**)
- Special efforts in Engineering and Management activities to **minimize typical Space Programs risks (**RSKM**)**
Conclusions & Lessons Learned

The IAI process deployment method relies on a Corporate Level processes definition, followed by Group/Division Level tailoring and implementation.

The products and projects characteristics require special attention to the RD, TS, PI, VER & VAL process areas.

Using the internal Customer–Supplier Agreements and IPT’s ensure
- Better definition and management of the commitment
- Integrated team work along the projects’ life cycle
CMMI V1.2 Process Area Abbreviations

- **CAR** Causal Analysis and Resolution
- **CM** Configuration Management
- **DAR** Decision Analysis and Resolution
- **IPM** Integrated Project Management
- **IPPD** integrated product and process development
- **MA** Measurement and Analysis
- **OID** Organizational Innovation and Deployment
- **OPD** Organizational Process Definition
- **OPF** Organizational Process Focus
- **OPP** Organizational Process Performance
- **OT** Organizational Training
- **PI** Product Integration
CMMI V1.2 Process Area Abbreviations

- **PMC** Project Monitoring and Control
- **PP** Project Planning
- **PPQA** Process and Product Quality Assurance
- **QPM** Quantitative Project Management
- **RD** Requirements Development
- **REQM** Requirements Management
- **RSKM** Risk Management
- **SAM** Supplier Agreement Management
- **TS** Technical Solution
- **VAL** Validation
- **VER** Verification
Thank you

Revital Goldberg - rgoldberg@iai.co.il
Sarit Assaraf - sassaraf@iai.co.il