Whitepaper

Development of STEP AP 242 ed2 "Managed Model Based 3D Engineering"

Version 1.0
2014-03-30

Executive summary

STEP AP 242 ed1, to be published in the next weeks, is focused on the convergence of AP 203 ed2 and AP 214 ed3, with the introduction of the new capability of STEP XML implementation based on the business object model and with 3D PMI enhancements. It was already foreseen in 2009 that enhancements and new functionalities will be added in future editions.

The main benefit of AP 242 ed2 is the extension of AP 242 ed1 to the electrical design domain, completed with specific enhancements in the following domains: PDM, 3D geometry, 3D PMI, composite and mechanical design.

The AP 242 ed2 project aims at defining and using a single integrated ISO standard covering product information interoperability capabilities for: Product Data Management, 3D model based design with PMI (e.g, Geometric Dimensions and Tolerances), Mechanical, Composite, and Electrical harness design.

This standard will be consistent with the ISO 10303 STEP modular Application Protocols:

- AP 209 “Multi-Disciplinary Analysis and design”,
- AP 210 “Electronic assembly, interconnect, and packaging design”,
- AP 233 “Systems Engineering”,
- AP 238 “Application interpreted model for computer numeric controllers",
- AP 239 “Product Life-Cycle Support”.

Together they will be the foundation for specifications, engineering simulation and 3D model based design information interoperability of aerospace, automotive and other transportation industries. This should extend the use of STEP by the main manufacturing industries and the support by PLM software suppliers and integrators.

The present white paper describes the context, the industry requirements, the targeted business usages, the proposed enhancements compared to AP 242 ed1, the interdependencies with other standardization projects, the project risks, and the associated project plan. It takes into account the answers received to the “Questionnaire for the prioritization of enhancements to be considered for STEP AP 242 ed2”.

The final prioritization of the scope of AP 242 ed2 will be decided by the stakeholders committed to support the AP 242 ed2 project with the appropriate resources, once the white paper is published.

The project is planned with a 27-month duration, and includes the setting up of pilots to validate new functionalities. It takes into account close coordination with other related standardization projects (e.g, LOTAR, OASIS PLCS / STEP AP 239 ed3, STEP AP 210, VDA VEC, future PDM IF, CAx IF, ISO 14739 PRC, 14306 JT ed2).

The planned actions further to this white paper are:

- The official confirmation of participation of the associations, manufacturers and stakeholders, before the 4th of July 2014,
- If needed, the update of the project plan according the stakeholders resources and funding,
- The start of the ISO AP 242 ed2 New Work Item ballot, planned beginning of May 2014,
- The setting up of the project with the stakeholders, and the detailed WBS,
- The preparation of the contracts to the STEP experts,

The project kick-off, after the acceptance of the NWI ballot, end of August, followed by a 1st project workshop last week of September 2014, in Charleston

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Document history

Version	Date	Summary of the change	Name
V0.1	2013-10-10	Initial version	J. Brangé, JY Delaunay
V0.2		Chapter 1.2 “Lessons learnt of AP 242 ed1”	P. Rosche, M. Ungerer
V0.3		Changes: chapter 3	JY Delaunay
V0.4		Main changes: chapters 1, 3, creation of chapters 4, 6.	J. Brangé, E. Moura, S. Herail, R. Murrish
V0.5	2013-11-27	Chapter “Risk management”	E. Moura
V0.6	2013-11-28	Chapter “Project management”	J. Brangé
V0.7	2013-11-29	Update of the table of content, list of figures and tables	S. Herail
V0.8	2013-11-29	Chapters “Introduction”, ”Summary–next actions” “Project management”, chapter 5	J. Brangé, JY Delaunay
V0.9	2014-03-05	Several comments and clarification of all chapters	D. Harbin
V0.10	2014-03-11	Enhancement of 4.3 : “electrical harness design”	LOTAR Electrical WG
V0.11	2014-03-11	4.4.2 Enhancement of 3D PMI information model	LOTAR 3D PMI WG
V0.12	2014-03-11	4 .4.4 Enhancement of 3D composite design model	LOTAR Composite WG
V0.13	2014-03-16	Update of the organization of the chapters (same content), with completion of missing sections.	Y. Baudier, J. Brangé, JY Delaunay
V1.0	2014-03-30	Update taken into account the comments of the review of the final draft	J. Brangé, JY Delaunay E. Moura

References

Whitepaper "Development of a Convergent Modular STEP Application Protocol Based on AP 203 and AP 214: STEP AP 242 – Managed Model Based 3D Engineering". Version 1.0 2009-11-05

Links: http://www.ap242.org/ap242ed1

1 Introduction, context and rationale

1.1 Introduction

Successful engineering and manufacturing enterprises and their supply chain partners increasingly use ISO PLM interoperability standards to develop product using **seamless digital 3D model based definitions**, shared around the world. They rely mainly on ISO STEP standards, recognized by the aerospace and automotive industries as the most powerful standards for describing product data for exchange, collaboration and long term archiving. In the last 15 years, there have been overlaps of AP 203 and AP 214 standards, which resulted in duplication of maintenance costs for both projects and additional delays in the development of solutions by vendors. In addition, the monolithic AP214 was becoming unsupportable and needed to migrate to the modular architecture introduced in 1999. Based on this analysis, the automotive and aerospace industries launched a joint initiative in 2009 called **"Development of a Convergent Modular STEP Application Protocol Based on AP 203 and AP 214: STEP AP 242 – Managed Model Based 3D Engineering".** The outcome is STEP AP 242 ed1, planned to become an ISO "international standard" in the beginning of 2014.

The main priority of AP 242 ed1 was the merge of AP 203 ed2 and AP 214 ed3 functionalities, with some minor extensions. It was already foreseen that enhancements and new functionalities would be added in future editions. **AP 242 ed2 is planned to cover the extension to electrical design, and specific enhancements of the following existing functionalities: PDM, 3D geometry, composite and mechanical design**.

This white paper intends to provide an overview of these enhancements as well as evidences in regards to the need and appropriateness of these enhancements. **It is the basis for confirmation of participation by the stakeholders to the AP 242 ed2 project.**

AP 242 ed2 will be upwardly compatible with the ed1, and will protect the investments of the industries starting to use AP 242 ed1 in 2014.

The main usage scenarios for AP 242 ed2 are the same as those of ed1:

- 3D model based design (MBD),
- Supplier data exchange,
- Long Term Archiving (LTA),
- Data sharing on a service oriented architecture (SOA) basis,
- Engineering visualization (e.g., for 3D composite tessellated plies information),
- Domain integration (Engineering analysis, Manufacturing simulation, Inspection Planning, etc.)

AP 242 ed2 standard will be complementary to ISO visualization standards, such as ISO 14739 PRC (pdf 3D), and ISO 14306 JT ed2.

In addition, AP 242 ed2 will extend support to new use case scenarios:

- Collaborative platform and increasingly use of the internet technology with shared repositories and cloud storage,
- Engineering design knowledge management (as company digital assets).

With the increasing worldwide competition and the market pressure for providing better products and services in a shorter time span, the scope of business process optimization is being extended to cover the full product life cycle, based on Systems Engineering principles. As a result, new development methods of complex products emphasize the need for smooth transition/integration between the different disciplines and life cycle stages. Therefore, the objective of AP 242 ed2 is to consolidate the consistency with all the other relevant ISO 10303 Application Protocols, more specifically:

- AP 209 ed2 “Multi-disciplinary analysis and design”,
- AP 210 “Electronic assembly, interconnect, and packaging design”,
- AP 233 “Systems Engineering”,
- AP 238 “Application interpreted model for computer numeric controllers",
- AP 239 “Product Life Cycle Support”.

The next table sums up the planning of the AP 242 ed1 project and the target planning of the AP 242 ed2 project.

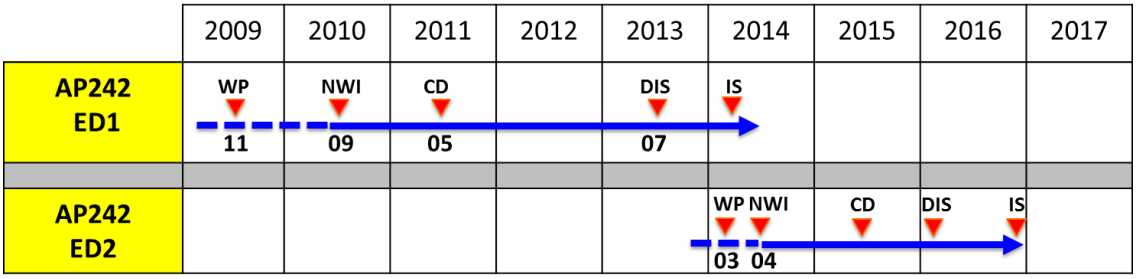


Table 1: Planning of AP 242 ed1 and target planning of AP 242 ed2

1.2 Reminder of AP 242 ed1 project

The STEP AP 242 ed1 project has started in 2009, with a joint workshop organized in September 2009 by AIA, ASD SSG, ProSTEP iViP and PDES Inc, identifying the mutual benefits to promote the convergence of STEP AP 203 ed2, led by the US aerospace and defense industries and of STEP AP 214 ed3, driven by the automotive industries. The result was the publication in November 2009 of the white paper “Development of a Convergent Modular STEP Application Protocol Based on AP 203 and AP 214: STEP AP 242 – Managed Model Based 3D Engineering”. This document describes the benefits, scope of the AP 242 ed1 and the associated project plan. An initial key decision was to focus first on the convergence of AP 203 ed2 and AP 214 ed3 with minor extensions, in order to deliver the AP 242 ed1 in a short timeframe. For this reason, the AP 242 ed1 white paper described also planned extensions, such as electrical harness or tubing, to be covered by further editions (Ref. §5.4 of the white paper).

The AP 242 ed1 introduced a new capability, the Business Object Model, driving a new XSD implementation model. This capability was not part of the STEP modular application protocol framework, and has requested extensions of STEPmod (infrastructure of publication of STEP documentation). This has resulted in delay in the edition of AP 242 documentation.

As described in the scope of the project, a special interest of the aerospace industry was to ensure the PDM harmonization between AP 242 BO model and STEP AP 239 / OASIS PLCS PSM. This effort

was carried out during Q4 2011 until Q3 2013. Some recommendations of harmonization were not compatible with the planning of AP 242 ed1 and have been postponed to AP 242 ed2.

Moreover, extensions of the initial scope of the AP 242 ed1 have been agreed during the project, mainly the extension of the BO model XML capability to Kinematics and the extension to 3D tessellated geometry.

The AP 242 ed1 project is led by ProSTEP iViP and co led by PDES Inc., under the supervision of the AP 242 project steering committee, gathering representatives of the stakeholders (AIA, ASD SSG, GIFAS, NIST, PDES Inc, ProSTEP iViP, VDA).

The next table sums up the main milestones for the development of the AP 242 ed1 standard.

Start of AP 242 NWI ballot :	September 2010	3 months duration
Start of the Committee Draft ballot:	March 2012	3 months duration
Start of the DIS ballot:	June 2013	2 + 3 months duration

Table 2: AP 242 ed1main ballot milestones

The next figure sums up the development process of the AP 242 ed1 project.

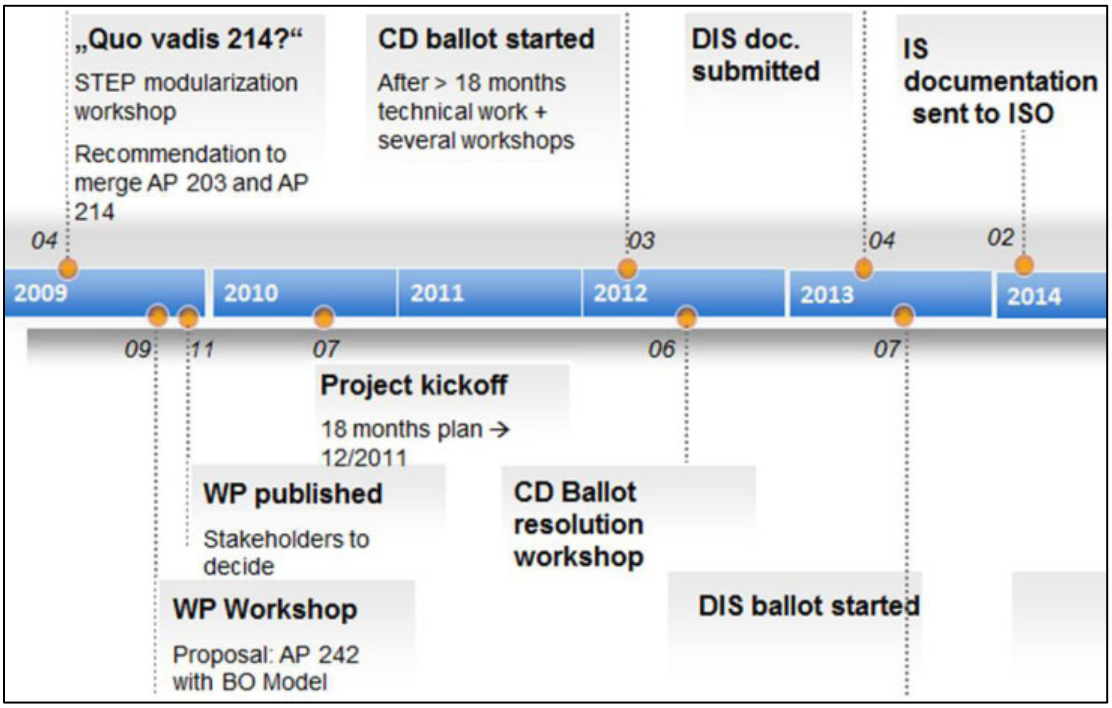


Table 3: Detailed planning of AP 242 ed1

1.3 Lessons learned from AP 242 ed1 project

The STEP AP 242 ed1 project was the first international joint ISO 10303 Application Protocol development project between the Aerospace and Automotive industries. The next sections sum up the lessons learned from this experience, to be taken into account in the AP 242 ed2 project.

Items to be improved:

- Create specific user requirements,
- Decrease harmonization iterations,
- Place dependencies under the control of the project (e.g. harmonization with OASIS PLCS)
- Propose concurrent development cycles,
- Create a realistic schedule,
- Create a charter that includes project organization (reporting, minutes, …),
- Remove scope creep,
- Recommend proper resources for the following:
  - development of PDM recommended practices as part of the PDM Implementer Forum,
  - Program management,
- Provide funding in a timely manner.
- Remove document development infrastructure deficiencies that caused schedule slippages and higher resource utilization than planned.
- Organize more calls between AP 242 project and ISO/TC 184/SC4 /WG21,
- Maintain a shared calendar,
- Allocation of a portion of the project budget for the maintenance and enhancement of STEPmod.

Successful items, to be reused:

- Harmonization of implemented standards,
- STEP Modular architecture,
- Regular PSC calls,
- Co-leadership,
- Pilots, to check, when useful, the relevant subset of new AP 242 ed2 information model,
- Reuse of ISO WebEx.

1.4 Use of the AP 242 public web site for communication

Communication is a key criterion for the success of the AP 242 ed2 project. The objective of the industries involved in the STEP AP 242 ed2 standardization project is not only to develop a standard, but also includes the following:

- Ease the access to relevant information for different communities (OEM, SME, PLM software suppliers and integrators, R&D centers and universities),
- Provide an easy understanding of the functionalities supported by the AP 242 ed2 standard, by the descriptions of the main use cases supported,
- Identify the STEP recommended practices complementary to the desired standard, via links to the appropriate web sites, such as that of the CAx IF,
- Create a roadmap of operational solutions supporting interoperability capabilities defined by the AP 242 ed2 standard. It will reference specific web sites dedicated to interoperability testing of PLM vendor solutions, such as the CAx IF or the future PDM IF.

The AP 242 ed2 project will rely on the AP 242 public web site: www.ap242.org to present the project status and results.

See next figure for the screenshot of the AP 242 web site.

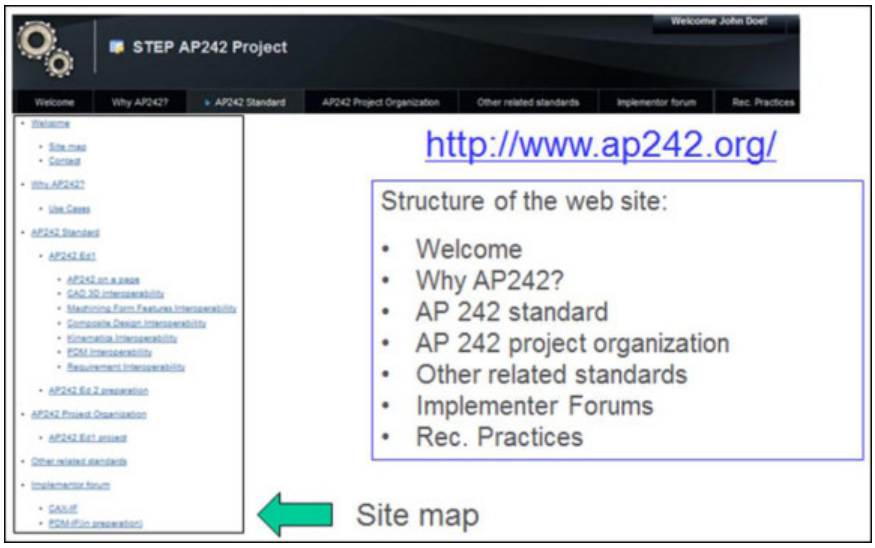


Figure 1: STEP AP 242 public web site

1.5 Overview of the scope of AP 242 Ed1

The scope of the AP 242 ed1 standard can be summed on the following figure:

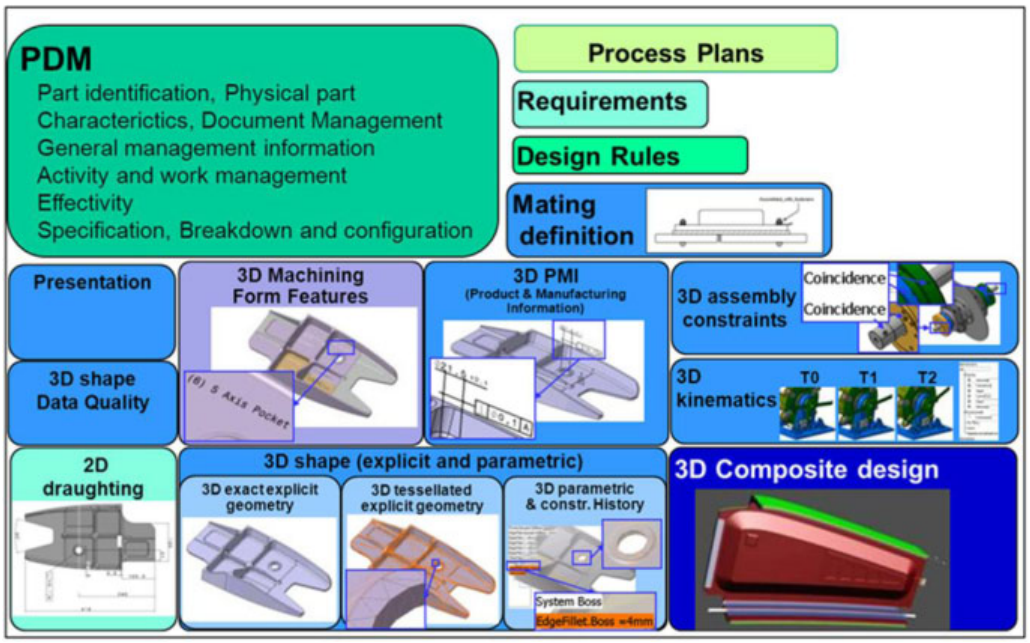


Figure 2: AP 242 ed1 scope

1.6 Planned evolutions of AP 242 ed1

The planned evolutions of AP 242 ed1 are of 2 types, described in the following paragraphs:

Planned evolution of AP 242 ed1 described in the 2009 white paper for a "convergent modular STEP Application Protocol based on AP 203 and AP 214"

It was agreed by the aerospace and automotive industries that AP 242 will be the cornerstone ISO 10303 Application Protocol for "Managed Model Based 3D Engineering". As a result, AP 242 has to be regularly updated to cover extensions of 3D PMI model based methods. The AP 242 ed2 will have to include new PMI entities defined in ISO and/or ASME standards (e.g. new 3D symbols, new GD&T). Based on the STEP modular architecture, these enhancements of STEP AP 242 ed2 will be integrated in STEP AP 210 and AP 209.

It was also anticipated in the 2009 white paper that AP 242 will be extended to electrical harness information interoperability. Mechanical and electrical development processes are closely interrelated. The AP 242 ed1 was limited to the convergence of AP 203 and AP 214. But AP 214 was closely related with STEP AP 212 (used as the starting point of the VDA KBL / VEC specifications) and AP 203 was closely related to AP 210. The extension of AP 242 to electrical harness was identified as a main priority for the ed2.

Finalization of PDM Harmonization between AP 242 ed1 BO model and OASIS PLCS PSM

PDM harmonization activities between the STEP AP 242 ed1 project and the OASIS PLCS project have been successfully set up from 2011 to 2013. But some recommendations could not be taken into account by the AP 242 ed1 project without shifting the agreed publication date of AP 242 ed1 as an International Standard. Therefore, it was agreed to postpone the implementation of these recommendations to AP 242 ed2.

2 Industry requirements

2.1 Basic requirements of the aerospace industries

The aerospace industries develop new products in a worldwide supply chain, with an increasing trend to rely on 3D model based definitions for design, manufacturing and support. The consequence of this is an increasing need for 3D core design information interoperability based on international open standards: the suite of ISO 10303 STEP modular Application Protocols. AP 242 ed2 will extend the scope of the ed1 to electrical harness design.

General business drivers

The main aerospace and defense business drivers for AP 242 ed2 are the following:

- Consistency between simulation, design, manufacturing and quality control of 3D model based technical information,
    - Requirements for a set of consistent ISO standards, ensuring the consistency along the aerospace product life cycle. For example, AP 242 ed2 will finalize the PDM harmonization with AP 239, providing an AP 239 ed3 project is launched (adaptation of both AP242 and AP239 will be needed to reach this consistency).
- Long term archiving and retrieval of the 3D model based type design information,
    - For example, AP 242 ed2 continues to enhance the capabilities of ed1 for interoperability of 3D PMI semantic representation, and extends the scope to electrical harness design information.
- PDM information integration and sharing between the different applications within the company and with the other PDM / ERP applications of the extended enterprise,
- Contribute to securing the companies 3D engineering digitals assets, by increasing the scope of interoperability of product information created by COTS applications (Support to long term archiving and/or migration of 3D model based data).

Business drivers for Electrical harness extension

New aerospace products increasingly include complex electrical systems and harnesses. With the lack of support of STEP AP 212, (previously identified as too generic and too complex to implement) there is no international standard available for electrical harness information interoperability. As planned in the convergence white paper of November 2009, once the AP 242 ed1 published, the next priority of the aerospace industry was to ensure the availability of interoperability functionality for the electrical harnesses and wiring systems in the following areas:

- Interoperability between the functional and the physical electrical harness design,
- Long term archiving and retrieval of physical electrical harness for certification, for support in operation, and for reuse,
- Ease downstream processes in the extended enterprise,
- Migration of legacy data to new electrical harness systems,
- Support interoperability of multi-disciplined, model-based design, based on an integrated standard (mechanical, composite, electrical).

From the aerospace perspective, the objective is to further develop an international standard that is usable by different industries, leverages established standards, and reduces the cost of new development.

Business drivers for Mechanical extension

The business drivers to enhance the AP 242 ed1 capabilities for mechanical information interoperability include the following:

- Supply-chain integration by bringing the supply-chain into the 3D model based paradigm, with for example, no more manual re-entry of PMI semantic representation,
- Drive downstream applications such as computer aided manufacturing (CAM), NC & CMM, by adding new machining form features,
- Contributes to the integration and automation of NC process automation, including quality inspection control,
- Extend the AP 242 ed1 model to support Additive Manufacturing design information interoperability,
- Support 3D Model re-use and repurposing for technical publication, manufacturing / quality plans, First Article Inspection documentation, manufacturing instructions, etc…

Business drivers for Composite design extension

Although the composite design capability is already available in AP 242 ed1, there are some specific extensions that can enhance this protocol, such as:

- Addition of new PMI entities for Composite design (Rosette, frame edge, …),
- Composite assemblies.

Business drivers for PDM extension

The business drivers for a PDM extension are summed as follows:

- Expand integration with downstream processes like manufacturing & resources planning (ERP, MES) and customer support,
- Enable standards-based PDM web services,
- Continue to secure the long term preservation of PDM information,
- Provide interoperability between AP242 ed2 and STEP AP 239 ed3 Product Life Cycle Support.

2.2 Basic requirements of the automotive industries

The requirements may differ from the different associations; for the same national trade associations, there are complementarity of requirements regarding automotive equipment manufacturers and automotive manufacturers. They are summed up as following:

- Extension to electrical schematics and electrical harness design,
- Extension to assembly PMI representation,
- Extend the capabilities of AP 242 ed1 to 3D curved tessellation, surface texture, voxels, …
- Extension of 3D PMI semantic representation to take into account the enhancements of the new versions of ISO and ASD standards dealing with GD&T,
- Maintenance of AP 242 ed2.

2.3 Basic requirements of other industries

Other manufacturing industries have expressed interests to the extension of AP 242, more specially the energy, and transportations industries. SME manufacturers associations working for several industries supports also the project, more specially to enable product data exchange in the supply chain, collaboration with the different OEMs and with equipment manufacturers.

3 Benefits of and Business drivers for STEP AP 242 ed2

In today's context of increased competition, many companies are struggling to properly address customer needs for better products, lower manufacturing costs, faster time-to-market, and higher profits.

The ISO STEP AP242 standard helps these companies to achieve these and other goals imposed by marketing conditions and stakeholders expectations, by enhancing the portfolio of STEP technology, which is one of the main technologies used to streamline the flow of PLM information throughout the extended enterprise. In this sense, the STEP AP242 ed2 Project should be considered as a technological business driver for most manufacturing companies.

In fact, as it will be shown below, by joining in this project, a company will get a head start, and be several steps ahead of the competition in mastering and enhancing a new technology designed to change the way CAD-PDM information is managed, integrated and communicated through the lifecycle of their products.

3.1 Summary of main business drivers

The creation of the convergent AP 242 was based on the following **business drivers**, still fully relevant for AP 242 ed2:

- 3D model based design,
- Supplier data exchange,
- Long Term Archiving,
- Data sharing on SOA basis,
- Engineering visualization,

In addition, new business drivers have been identified for AP 242 ed2:

- Wider domain integration (Engineering analysis, Manufacturing simulation, Inspection Planning, ...) for structural parts and assemblies (mechanical, composite, etc.) and for electrical harness.
- Collaborative platform. It aims at easing the product development processes through the sharing of product information via collaborative hubs, or via communication between the different proprietary PLM COTS based development platforms set up by OEMs.
- Engineering design knowledge management (as company digital assets),

The next figure sums up the main business process which will take benefits from STEP AP242 ed2 project:

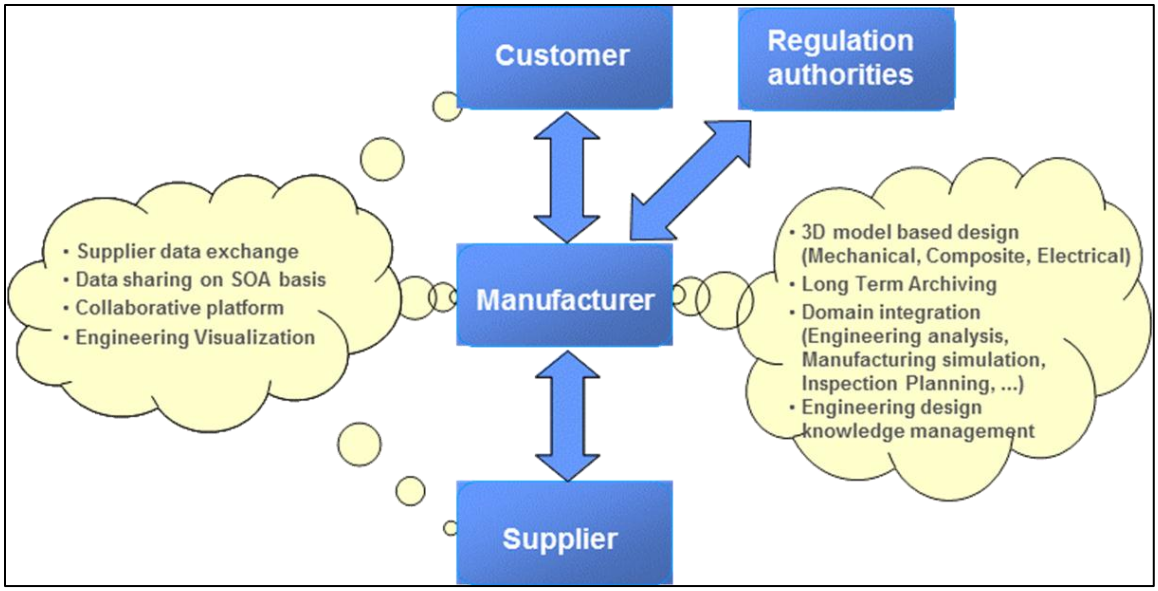


Figure 3 : Usage scenarios covered by AP 242 ed2

3.2 Related business processes supported by of AP 242 ed2

As a technological business driver, the ISO STEP AP242 ed2 standard affects the business of most engineering and manufacturing companies by adding value mainly in the following business processes. They are summed up hereafter, with their main related use cases:

- Product Development

  - Domain integration (engineering analysis, manufacturing simulation, manufacturing planning, quality inspection etc.),
  - 3D model based design,
  - Knowledge management,
  - Engineering collaboration,
  - Visualization of engineering data.

- Supplier Chain Integration

  - Supplier product data exchange,
  - Supplier data sharing,
  - Supplier engineering collaboration.

- Customer Support

  - Data exchange with customers,
  - Data sharing with customers,
  - Collaboration between OEM manufacturers and customer engineering teams.

- Compliance to liability and governmental regulations, by extending and enhancing the STEP open standard format to better support Long Term Archiving and Retrieval of product data of the following disciplines:

- Electrical harness design,
- Composites design,
- Product data management (PDM),
- Mechanical design.

3.3 Extended usage scenarios and use cases

The following tables sums up the added value of the proposed enhancements of AP 242 ed2 according to the preceding business drivers and usage scenarios.

Notation: +++: high added value, ++: Medium added value, +: low added value.

	Use cases						
Matrix of AP 242 E2 enhancements / usage scenarios	3D Model based design	Supplier data exchange	Long term archiving	Data sharing on SOA basis	Engineering visualization	Collaborative platform	Engineering design knowledge management
Electrical extension	+++	+++	+++		+	+++	++
PDM enhancements	++	++	+++	+++	+	+++	+++
3D Geometry enhancements	+++	++	+++		+++	++	++
Mechanical enhancements	+++	++	+++		++	++	
Composite design enhancements	++	++	+++		++	++	

Table 4: Overview of AP 242 ed2 functional extensions according to generic use cases (1/2)

	Use cases				
Matrix of AP 242 E2 enhancements / usage scenarios	Design to Engineering Analysis	Design to Manufacturing data exchange	Design to Manufacturing simulation	Design to NC planning	Design to Inspection planning
Electrical extension	++	+++	++		
PDM enhancements	++	++			Yes
3D Geometry enhancements		+	+	+	+
Mechanical enhancements		++		+	+
Composite design enhancements	++	++	+	+	+

Table 5: Overview of AP 242 ed2 functional extensions according to generic use cases (2/2)

4 Proposed AP242 ed2 technical content

4.1 Overall scope of the standard

The STEP AP 242 ed2 project aims at extending the functionalities of AP 242 ed1 standard to the following domains:

- Extension of AP 242 ed1 to include new functionalities:
  - Physical electrical harness for design and construction,
  - Electrical functional connectivity information.

This extension will allow the provision in the same standard for the functionalities that include interoperability of mechanical design, composite design (based on the ply definitions), and electrical wiring and harnesses design.

- Enhancement of existing functionalities of AP 242 ed1, listed here after:
  - STEP CAD 3D generic resources (for example, iso-geometric surfaces and solids, 3D tessellated curves, 3D voxels),
  - 3D Geometric dimensions and tolerance (GD&T), to take into account the extensions of the related ISO and ASME standards,
  - Mechanical (for example, new form feature for additive manufacturing design),
  - Composite design (new specific PMI entities, such as rosette).

The overall scope of the STEP AP 242 ed2 project can be summed up in the following figure:

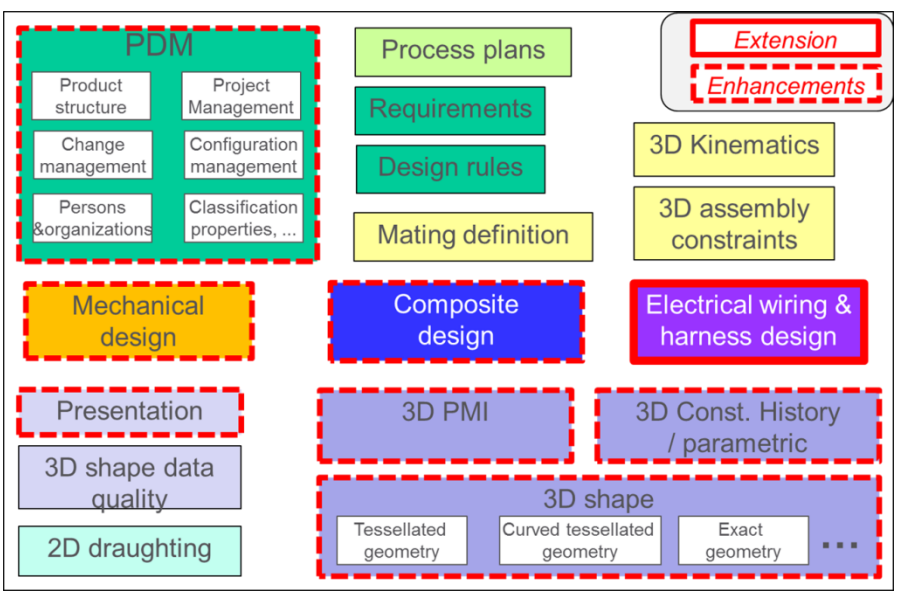


Figure 4 : overview of the enhanced functionalities of AP 242 ed2

STEP AP 242 ed2 will be the unique ISO standard allowing covering in a single and integrated information model:

- The configured requirements management information, consistent with STEP AP 233,
- The PDM configuration management information,
- The CAD 3D with PMI information (graphic presentation and semantic representation) , useful to suppress 2D drawing and support the downstream process (NC machining, NC Inspection,…)
- Key CAD disciplines information:
  - Mechanical design,
  - Composite design,
  - Electrical wiring and harness design.

The resulting scope of STEP AP 242 ed2 standard is summed up in the following figure:

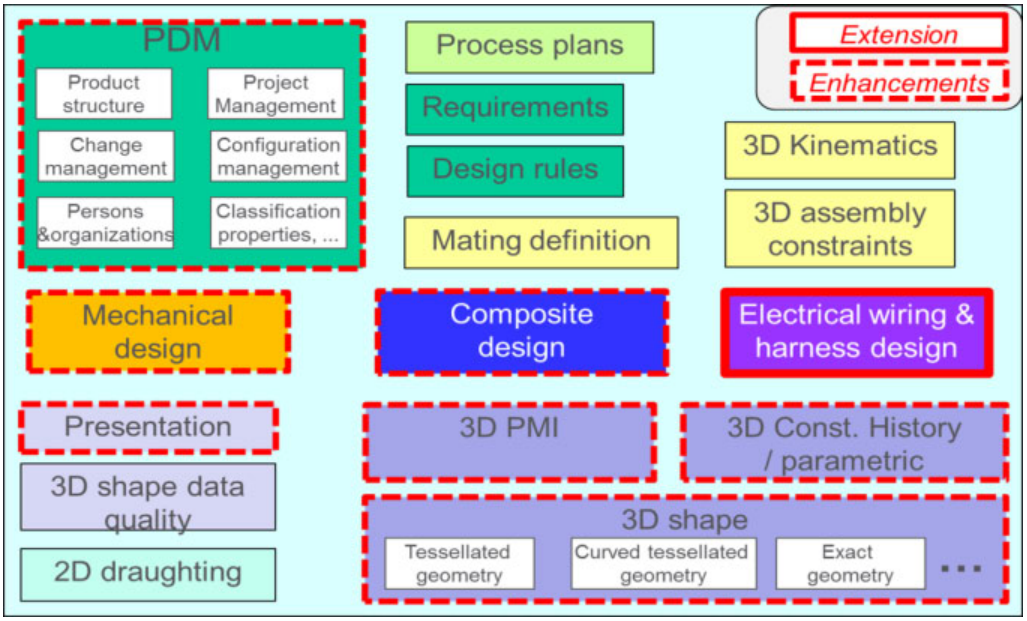


Figure 5 : AP 242 ed2 high level functionalities overview

4.2 Planned extensions not covered by AP 242 ed2

A key principle of the AP 242 ed2 project is to develop a new version of the standard in 2 years duration, with a predefined scope and budget plan agreed by the project stakeholders. As a result, the STEP AP 242 ed2 project does not take into account all the potential business requirements for improvement of AP 242 ed1. For instance, it will postpone the following requests of enhancement to a next version of AP 242:

- Heating, Ventilation and Air Conditioning (HVAC)
- Tubing.
- Electrical schematic.

4.3 New functionalities of AP 242 ed2: electrical harness design

The European industries have developed between 1995 and 2000, the standard AP 212 "*Electrotechnical design and installation*". Despite some successful implementations in certain domains, this standard was not maintained, judged as relying on too much generic information, complex to be implemented. As a result, there is no ISO standard used as the reference for interoperability of wiring and electrical harness design information. AP 242 ed2 aims to close this gap.

The proposed extensions of AP 242 ed2 cover the following functionalities, detailed in the next paragraphs:

- Physical electrical harness model for design and construction,
- Electrical functional connectivity information.

4.3.1 Extension to physical electrical harness model for design and construction

This extension covers the physical harness model i.e. the information needed for the design and manufacturing of the harness (harness topology, connectors, wires, protections, backshells, supports…)

4.3.1.1 Development of an Electrical Harness data model

The next figure presents the different methods used by the aerospace or automotive companies for electrical harness design.

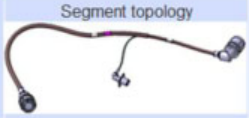
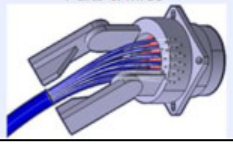
Types of methods	Name	2D	3D	Electrical PDM (no 3D information)
1	3D Harness definition As installed		Segment topology 	Wire list / part list
2	Elec PDM with 2D stick line	Segment topology		Wire list / part list
3	flexible harness definition (parameterized)			Wire list / part list & Segment topology
4	"all 3D"		Parts & wires 	

Figure 6: Overview of the different methods used for electrical harness design

The data model for electrical harness could be separated in 3 capabilities:

- Harness parts: connector, fixing, backshell, grommet, splice, wire, protection…

Harness connectivity: wires, contacts, etc.

Topology and Geometry: segment, node, fixing place, protection location, routing, 2D & 3D shape…

It corresponds to the functional scope of the VDA KBL specification and corresponding VDA VEC specification subset. Additional entities will have to be defined, such as: internal splices, poke home, electrified backshell, end caps.

Another capability may be necessary to manage the references between several harnesses (connectors belonging to several harnesses, split of the harness in several zones…).

The illustration bellow gives an example of some entities of the different capabilities.

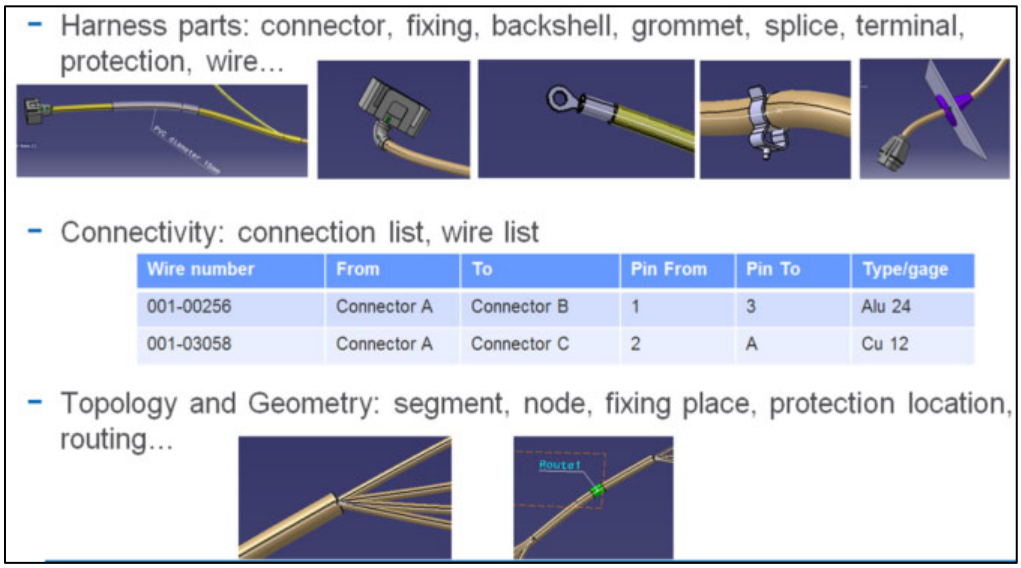


Figure 7: Illustration of 3D electrical harness characteristics

It will include the extension of the BO implementation model in XML format.

4.3.2 Extension to include the AP210 electrical functional connectivity

The scope of this extension is to cover electrical functional connectivity information (coming from schematic drawings such as wiring diagrams or functional diagrams. It covers the functional information (schematic connectivity & reference designators) but not the schematic diagram. It corresponds to the current scope of the VDA VEC specification regarding schematics.

It will reuse the existing modules of functional connectivity that have contributed to AP 210, and will be accompanied by a BO implementation model in XML.

4.3.3 Ensure the compatibility with other "Electrical" standards

4.3.3.1 Ensure the compatibility with STEP AP 210

AP210 "Electronic assembly interconnect and packaging design" covers a majority of AP212 "Electrotechnical design and installation" functionalities, with a few exceptions such as schematic drawings, multi-wire connections, and some topological aspects, e.g., splices.

AP210 covers not only printed circuit boards (PCBs), but also higher levels of assemblies, including all kinds of interconnects and electrical connectivity. The AP 210 assembly definition is already today suitable to represent the overall connectivity of a vehicle.

The goal is to ensure the compatibility with the existing relevant AP210 concepts and see how these concepts can be merged, enhanced or restructured to fulfil the requirements in order to achieve an integrated model over all relevant APs, and to avoid any double or alternative standardization.

It is critical to ensure the connectivity traceability, by the population of the relationships between logical and physical views of the harness.

4.3.3.2 Ensure the compatibility of AP 242 ed2 with STEP AP 239 ed3 PLCS

The goal is to ensure the compatibility of AP 242 ed2 and AP 239 ed3 regarding the concepts of interfaces and connectivity management.

4.3.3.3 Ensure the compatibility with the VDA VEC specification

Starting from the STEP AP 212 "Electrotechnical design and installation", the German Association of Automotive manufacturers (VDA) has developed a suite of specifications for electrical harness data exchange: VDA GEO, KOMP, ELOG and KBL. These specifications were merged to create the VDA VEC V1 ("Vehicle Electrical Container") specification in 2013, to be updated in 2014 (VEC V1.1). The VDA VEC is not an ISO standard and is not consistent with the ISO 10303 STEP Application protocols.

For the common scope of AP 242 ed2 and of the VDA VEC, the goal is to ensure as much as possible the compatibility of concepts; transformation of the contents will be done when necessary. It will allow the automotive industries to complement the use of the VDA VEC specification, for example, for use cases of long term archiving of electrical harness definitions. This convergence will decrease the implementation cost of AP 242 ed2 for software vendors that have implemented the VDA VEC. This commonality will reduce the cost of maintenance of the software for the 2 standards.

The level of compatibility is dependent on the support of the VDA VEC community.

The scope of the VDA specifications for electrical harness is described in the following figure:

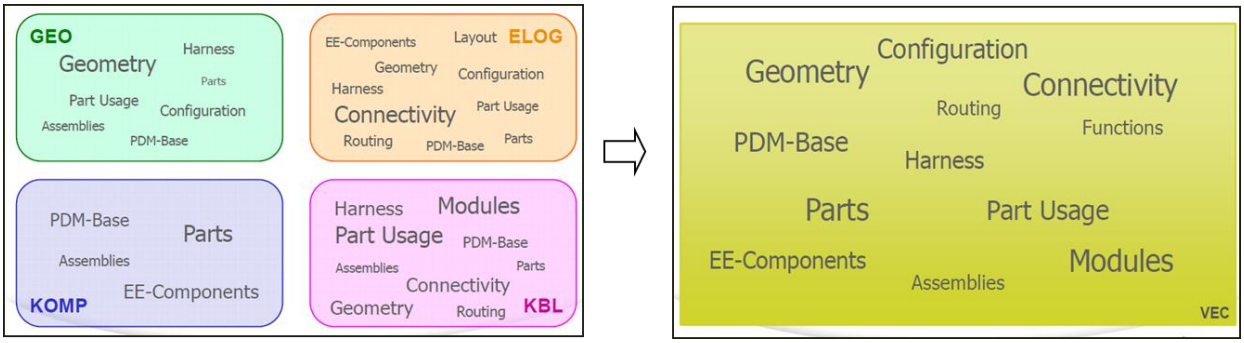


Figure 8: Overview of VDA KBL, ELOG, KOMP, GEO specifications and the resulting VDA VEC.

4.3.4 Proposed new modules

The AP 242 ed2 project will create modules for the following requirements:

- Single and Multi Core Wires,
- Connector design,
- Connector mapping,
- Connector usage,

- Connector slot and cavity reference,
- Wire harness topology,
- Wire harness routing and placement,
- Wire harness protection,
- Wire harness 3D installation,
- Edge based wireframe shape representation 2D,
- Electrical harness geometry 2D,
- Electrical harness geometry 3D,
- Physical component interface terminal behavior

4.4 Extensions of capabilities already available in AP 242 ed1

4.4.1 Enhancement of 3D geometry information model and other generic resources

4.4.1.1 Enhancements of specific construction history and parametric entities

AP 203 provides functionalities for interoperability of construction history and parametric design, included in AP 242 ed1. PDES Inc pilots have demonstrated the feasibility of such functionalities on a limited use cases. Specific extensions or enhancement / simplification have been identified, to be included in AP 242 ed2.

4.4.1.2 Support of 3D scan data

The support of 3D scan data was initially proposed for Part 42 ed4 but was postponed to a future edition in order not to impact the AP242 ed1 planning. New entities are needed to support very large sets of points (> 10 million points in a single set), and attributes on points or triangles (color, normal, etc).

Target use case: Exchange and Archiving of data coming from 3D scanners.

4.4.1.3 Curved triangles

Static tessellation can generate big files. A way to reduce the size of data to exchange / archive is to store in the STEP file the minimum necessary information to recreate the tessellation in the receiving system. The proposal is to introduce Curved Triangles, meaning non-planar triangles. Only a small number of curved triangles are needed to represent a sphere, when thousands of planar triangles are necessary to represent the same sphere with good accuracy. For example, it may be used to decrease the size of STEP files with 3D composite tessellated plies representation.

Various CAD systems and formats (like AMF) support this kind of tessellation. For systems supporting Dynamic Tessellation these Curved triangles will be easily converted into their own structures. Systems not supporting Dynamic Tessellation will convert the curved triangles into a static tessellation with the accuracy they want.

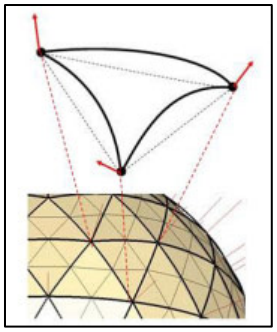


Figure 9: Curved triangle converted into 4 planar triangles

4.4.1.4 Voxels

Additive manufacturing systems can use voxels to represent the production result. The objective is to add a voxel representation into the appropriate STEP Integrated Resource, for example, Part 42. Target use case: exchange and long term archiving of additive manufacturing result (see also: enhancements for design information for 3D additive manufacturing parts).

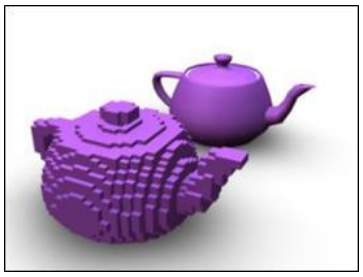


Figure 10: Illustration of voxels

4.4.1.5 Surface texture

Tessellated data is often provided with textures: display of logos, complex drawings and better display of material. Textures are also used to reduce the size of context data: geometry is simplified to have fewer triangles, visual details are provided by textures (e.g. emboss).

Figure 11: Illustration of texture need

Target use case: exchange and long term archiving of 3D context information.

4.4.2 Enhancement of 3D PMI information model

The enhancement of 3D PMI information model covers 2 main enhancements:

- New entities corresponding to unsupported features and enhancement of ISO and ASME Design standards,

- Extension of the AP 242 ed2 XML implementation model to include 3D PMI semantic representation.

4.4.2.1 New entities corresponding to unsupported features and enhancement of ISO and ASME Design standards

The industries increasingly use 3D model based design methods. It results in the regular evolution of the associated ASME and ISO standards; therefore the AP 242 ed2 information model has to be extended to cover the new PMI entities, in order to ensure the interoperability of the related information.
There are also a few features of the current version of the ISO and ASME PMI standards that are not yet supported by the ed1.

The main extensions planned in AP 242 ed2 are:

- Dimensioning and tolerancing of manufacturing features such as threads and fits, complex hole, including spotface, countersunk and counterbore, …
- Complex patterns of toleranced features,
- ISO and ASME roughness specifications and more generally Surface Textures to comply with ISO 1302 and associated standards,
- Welding.
- ISO 1101:2012 features not supported in AP 242 ed1, such as:
  - Direction feature,
  - Relating Theoretical Exact Dimensions (TED) to datum systems and group of tolerance elements.
- Additional extensions supporting the upcoming editions / amendments of ISO 1101 and ISO 5459 such as:
  - Combined zone, Separate zone, united feature,
  - circle-A on datums,
  - Specific cross section, any longitudinal section,
  - Orientation only,
  - Contacting, tangent and hull features,
  - Association criteria: Min/max, least square, maximum inscribed, minimum circumscribe, constrained external/internal to material,
  - Association criteria: Reference-to-peak/valley, peak-to-valley, root mean square,
  - Filter types with limits and nesting indices: G, S, W, RG, RS, H, OB, OH, OD, CB,CH, CD, AB, AH, AD, H
- Unsupported features of the current ISO 14405 version, and additional extensions supporting the upcoming edition of ISO 14405,
- Additional extensions supporting the upcoming editions of ISO 1660 and ISO 5458,
- Support of ISO/TS 17863:2013 GPS -- Geometrical tolerancing of moveable assemblies,
- Support of potential extensions to cover ISO/TS 8062 series: GPS for Dimensional and geometrical tolerances for molded parts.

The maintenance activities have to include the bugs of the STEP AP242 ed1 already identified during the PMI activities of the CAX-IF and the issues listed in bugzilla as GD&T.

4.4.2.2 Extension of the AP 242 ed2 BO model XML implementation to include 3D PMI semantic representation

This extension shall:

- be consistent with the BO model ,
- cover both part and assembly PMI semantic representation,
- have the same scope as the corresponding AIM data model,
- be compatible with the AIM Part 21 implementation method, and documented by mapping.

It may include some enhancements to facilitate compatibility with the QIF and AMF standards.

4.4.3 Enhancement of 3D mechanical design information model

4.4.3.1 Enhancements for new Manufacturing machining features and quality analysis

Several pilots are planned to test CAD-CAM exchange based on AP 242 ed1 3D machining form features. Based on the results, specific enhancements for AP 242 ed2 can be anticipated, to facilitate the downstream process from Manufacturing Engineering to Manufacturing. It may include some enhancement to facilitate compatibility with AP 238.

Example of use case: communication between the OEM and the manufacturing supply chain.

4.4.3.2 Enhancements for design information for 3D additive manufacturing parts

The aerospace and automotive industries are assessing the use of the new "3D additive manufacturing" technology. This new technology will result in a new integrated process, similar to the composite structure process. Specific CAx functionalities and information will be developed to cover design, simulation, manufacturing and inspection of 3D additive manufacturing parts and assemblies. AP 242 ed2 will be extended to support design information interoperability for the "3D additive manufacturing" technology.

Example of new entities to add:

- "Organic" shapes,
- Multiple materials,
- Variable densities,
- Microstructures,
- Graded materials enabling a progressive evolution of material properties according to the geometry.

4.4.4 Enhancement of 3D composite design information model

In the current AP242 ed1 BO Model for composite there are no entities specific to composite PMI.

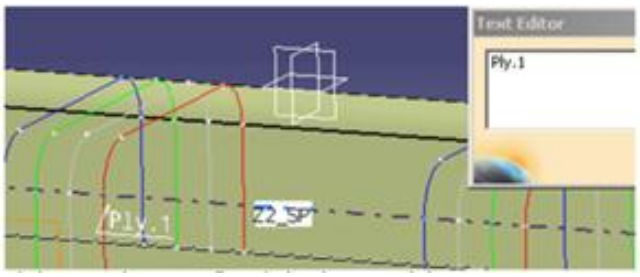
The PMI needed for composite is not very different from other PMI, but the need has to be taken into account for ed2 in order to ensure the capability to store or exchange PMI on CAD 3D composite structure design.

Currently, 3 types of entities are being analyzed for incorporation:

1) PMI on composite entities (Plies, Rosettes,…)

There is several way of defining Rosette in composite structures (Cartesian, Polar, on a spline…) and it is useful to clearly indicate the kind of rosette on the CAD 3D design of the composite structures.

In the current CAD tools, it is possible to attach annotations on composite entities (example: plies).



2) Rosette Attributes

In design there are only two ways to represent a rosette. The first is a 3-dimensional axis system with x, y, and z directions corresponding to fiber orientation directions and ply stacking direction. Then there is a sub-class using 2 perpendicular vectors related to the fiber orientation directions and a derived stacking direction based on a normal to the plane generated by those vectors. But, to make Model Based Definition really work in downstream applications like repair – there has to be a defined method of moving a rosette to any position on the part or in model space. Currently, there are 3 standard ways of accomplishing this translation - Cartesian, Polar, and along a spline. So for AP242ed2, it will be necessary to attach a "Type" attribute to each rosette indicating how it is to be interpreted as it is moved to a new location. Type 1 would be associated with Cartesian, Type 2 linked to Polar and Type 3 used for Rosettes required to follow a spline/curve. There may also be a Type 4 that would be "User Defined".

3) LAAI (Limited Area Application Indicator).

LAAI's are used to relate graphical areas with specific applications. For example, a bounded set of curves or surfaces could be used to indicate a "no splice zone" or an area requiring a tighter tolerance for fiber orientation. While quite useful for the Model Based Definition of Composites, the concept of an LAAI to convey PMI will be needed in all MBD disciplines.

These PMI are business information linked to composite entities so maybe would have to be defined at BO Model level (see enhancement of 3D mechanical design information model).

4.4.5 Enhancement of PDM information model

The development of aerospace and defense products integrates the full life cycle, including maintenance and retirement. This results in the need for strong consistency and no disruption of PDM information flow between engineering, manufacturing and support phases. As summed in the chapter 3, PDM harmonization activities have been carried out between AP 242 ed1 and OASIS PLCS PSM information models. See the figure on next page.

By lack of time, some important recommendations have not been taken into account and have been postponed to be included in the AP 242 ed2 project. Furthermore, the AP 242 ed1 project has identified needs for the enhancement of the integration of the BO model in the STEP modular

architecture. As a result, several aerospace and defense standardization projects or associations have indicated their interest to finalize the PDM harmonization with the parallel development of STEP AP 242 ed2 and AP 239 ed3 (BO model based on OASIS PLCS PSM).

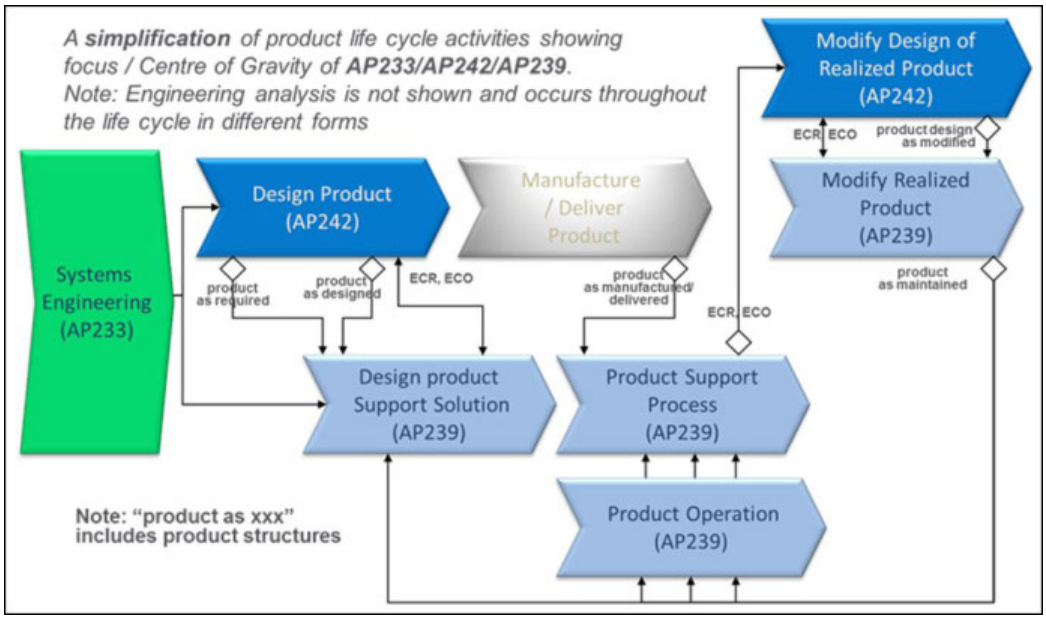


Figure 12 : Links between STEP AP 242 and STEP AP 239 related business processes

Based on the common scope, the AP 242 ed2 project will finalize the implementation of the recommendations of PDM harmonization between AP 242 BO model and AP 239 ed3. It will cover the following topics not taken into account for the first edition of STEP AP242:

Certification	Proposed harmonization between AP 242 ed1 and PLCS PSM not implemented
Contract	Proposed harmonization between AP 242 ed1 and PLCS PSM not implemented
Product group	New, not in AP 242 ed1
Information rights	Proposed harmonization between AP 242 ed1 and PLCS PSM not implemented
Collection	New, not in AP 242 ed1
Project	Proposed harmonization between AP 242 ed1 and PLCS PSM not implemented
Security	Proposed harmonization between AP 242 ed1 and PLCS PSM not implemented
Message and envelope	New, not in AP 242 ed1
Validation & verification	New, not in AP 242 ed1
State	New, not in AP 242 ed1

Table 6: list of enhancements of the AP 242 ed2 PDM information model.

5 Principles for the development of AP 242 ed2

The principles for the development of AP 242 ed2 have to fulfil the business requirements of chapter 2. These principles are summed up in the following paragraphs:

- Modeling principles of AP 242 ed2,
- Enhancement of STEP files functionalities,
- Development of pilots to validate the AP 242 ed2 data model.

5.1 Modeling principles of AP 242 ed2

The development of the AP 242 ed2 standard is based on the following modeling principles, described in the following paragraphs:

- Model based Application Activity Model,
- Consistency with the STEP modular Application Protocols architecture,
- Definition when useful of 2 Implementation models (AIM and BO implementation model),
- Enhancement of the STEP modular architecture, taken into account of the BO model,
- Enhancement of the information model, when necessary, to support efficient validation properties for quality control checks automation,
- Robustness, reliability and maintainability through time of the AP 242 information model,
- Upward compatibility of STEP files for "Managed Model Based 3D Engineering",
- Complementarity of AP 242 standard with other related standards,

Model based Application Activity Model (AAM)

The project will use a model based method to define the AP 242 ED 2 AAM. It will allow controlling the consistency between the ARM and the industry requirements during the development process.

Consistency with the STEP modular Application Protocols architecture.

The AP 242 ed2 standard shall be based of the STEP modular architecture principles defined by ISO/TC 184/SC 4.

Extension or enhancement of the BO model and associated XSD.

In compliance with the STEP architecture, the AP 242 ed2 standard will include the enhancement or extension of the Application Reference Model (ARM), and of its associated Application Interpreted Model (AIM). In addition, the AP 242 ed2 standard will include the extensions or enhancement of the associated BO model and of the related XSD, as described in the following table:

Summary of extensions or enhancement of AP 242 ED2 BO models and associated XSD	BO model / XSD
PDM	Enhancement
Composite	Enhancement
Electrical Harness	New (extension)
PMI semantic representation	New (extension)
Additive Manufacturing design information	New (extension) - N1

Table 7: Extensions or enhancement of AP 242 ed2 BO models and associated XSD

Note: N1: In liaison with the ISO/TC 261 AMF project.

Enhancement of the STEP modular architecture, taking into account the BO model.

The AP 242 ed2 project will take into account the enhancements proposed in the new white paper "state of STEP AP modularity - Requirements for the STEP future architecture"[1], to be discussed during the ISO/TC 184/SC 4 meeting of May 2014, such as:

- Principles for the convergence and consistency of the concepts of modular ARMs and modular BO models.
- Adaptation of the methods of development of the BO model in the STEP modular architecture, taking into account the lessons learnt of the PDM harmonization of AP 242 ed1 BO model and OASIS PLCS PSM, and of the AP 242 BO model for composite design and requirement management, e.g. principles of BO Models subsets used in several Application Protocols.

Enhancement of the information model to support efficient validation properties for quality control checks automation

The development of the AP 242 ed2 models will take into account the possibility to define specific validations properties associated to key product information, for the automation of end to end quality controls checks. Example of potential enhancements:

- Mechanism to support the complementarity of validation properties associated to 2 related product representations: E.g., PMI graphic presentation and PMI semantic representation,

Robustness, reliability and maintainability through the time of AP 242 information model

The AP 242 standard supports 2 implementation models and formats: the AIM / P21 on one hand, and the BO model / XSD on the other hand. The AP 242 project will take care to ensure the reliability and maintainability of both models. The AP 242 ed2 project will contribute to define rules for the optimized use of the 2 implementation models, in coordination with the related Implementer Forums. The AP 242 ed2 project will also recommend to develop a detailed bi directional mapping between the 2 AP 242 ed2 implementation models, when they cover the same functionality (e.g., CAD assembly structure, PDM, …).

Upward compatibility of STEP files for "Managed Model Based 3D Engineering"

The AP 242 ed2 project will take into account:

- The upward compatibility of STEP AP 242 ed1 with AP 242 ed2, through the Application Interpreted Model (AIM) and the BO model / associated XSD,
- The maintenance of the compatibility of AP 242 ed2 with AP 203 and AP 214 STEP legacy files,

Complementarity of AP 242 standard with other related standards

The AP 242 ed2 project will be based on:

[1] Action launched during the 6th – 7th of March 2014 workshop for STEP information models & formats for the A&D industry for PLM interoperability and LOTAR.

- Well defined principles to ensure complementarity between collaborative processes based on STEP files exchanges, and integration / sharing processes based on other standards related to STEP AP 242 information model, e.g.:
  - Next version of OMG PLM services, initially based on AP 214 ARM.
  - Future use of OSLC
- Powerful reference mechanisms between AP 242 files and other ISO standard formats (such as ISO PRC, ISO JT ed2, …) or native formats,

5.2 Enhancement of STEP files functionalities

This section will cover two needs, detailed in the next paragraphs:

STEP file structure in DATA_SECTIONS to support the increasing complexity of product information.

- Enhancements of the P21 and P28 standards to support a mechanism for the structuration of the information in a same STEP file according to the different product functionalities and types of representations, for example:

  – A DATA SECTION for the 3D external shape,
  – A DATA SECTION for composite implicit surface design,
  – A DATA SECTION for composite 3D tessellated plies,
  – A DATA SECTION for PMI polyline presentation,
  – A DATA SECTION for PMI semantic representation, …

It will improve the readability and maintainability of the STEP file; it will allow managing the IPR by facilitating the suppression of specific DATA SECTIONS. The precise use will be specified by the CAx IF and the future PDM IF and its associated STEP recommended practices.

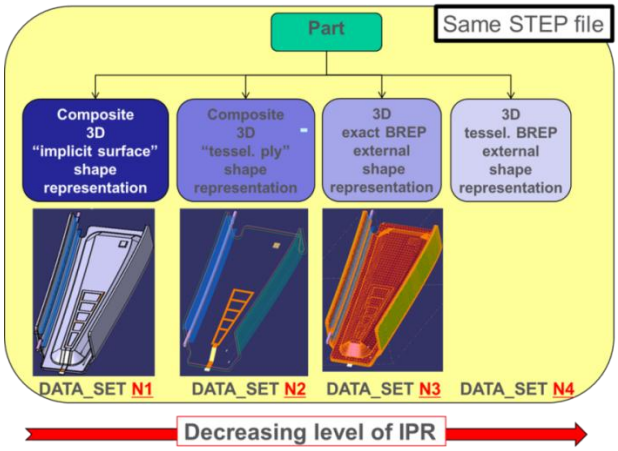


Figure 13 : structuration of STEP files based on DATA_SET for filtering of IPR

Use of Global Unique Identifier (GUID) in STEP files.

The AP 242 ed2 project will leverage the use of Global Unique Identifier in STEP files, e.g.

- For exchange and persistency of links with External Element Reference,

- To ease the end to quality control validation between source native model, STEP model and the target native model.
- For collaborative and reconciliation processes based on incremental or delta exchange,
- For end to end quality control checks,
- To enable easier use of the external element reference.

It may result in the possible modification of the Parts 21, 26, and 28 to support the principles of persistent Global Unique Identifiers for STEP business entities.

5.3 Development of pilots to validate the AP 242 ed2 data model

The development of the AP 242 ed2 project will include pilots allowing validation, when requested, of the new capabilities or extensions. The goal is to provide a proof of concept to demonstrate the adequacy of the extensions. The pilots will involve a limited number of PLM vendors or integrators; the objective being not to organize an Implementer Forum.

Proposed rules to define and manage the pilots

The technical domain determines the need for pilots, e.g. PMI representation, electrical harness:

- To test sensitive, complex or unclear functionalities,
- The companies involved in the project will prepare the related test cases, of increasing complexity,
- The preparation of a pilot shall determine and secure the funding sources and the associated resources / expertise,
- A part of the pilots are fully funded by the AP 242 ed2 project. Other projects may contribute to fund another part of the pilots (E.g., funding by the AIA – ASD-Stan LOTAR projects, …),
- The AP 242 ed2 project will define the management rules for the funding of pilots: date of the planned funding availability per year, etc.

Planning of the pilots

The pilots for the AP242 ed2 project will be organized according to the following schedule:

- Start with the AP 242 ed2 CD version.
- First results of the pilot before the DIS.
- Second loop of the pilot for final results as input for comments during DIS ballot.

Input for the review of the AP 242 ed2 documentation by the ISO/TC 184/SC4 convener

The results of the pilots will be documented and provided as part of the technical documentation accompanying the AP 242 ed2 CD and DIS.

The successful organization of pilots, in time and quality, is one condition of success of the AP 242 ed2 project.

6 Interdependencies with related standardization projects

The full benefit to use PLM interoperability capabilities based on open standards requests to overcome silos between technical disciplines and product life cycle stages. To overcome this risk, the development of the AP 242 ed2 standards will have to take into account close coordination with other related standardization projects, which can be classified in 4 main categories:

- Projects focused on development of PLM interoperability processes and use cases, such as EN / NAS 9300 LOTAR standards, …
- Projects focused on development of product information model standards for a specific discipline or lifecycle stage (e.g. AP 209, AP 233, AP 238, AP 239)
- Projects focused on a specific category of interoperability use cases and related implementation methods
  - 3D visualization standards (ISO PRC, ISO JT ed2, X3D, …)
  - Product information integration and sharing (e.g., update of OMG PLM services, MoSSEC, …),
  - Product and process linked data (new OASIS OSLC technical committees, …),
- Projects focused on the development of recommended practices and interoperability test rounds, generally covered by Implementer Forums.

These coordination actions are described in the following paragraphs.

6.1 NAS 9300 / EN9300 standard, for long term archiving and retrieval of 3D digital aerospace product information

The American and European aerospace industries develop the NAS / EN 9300 standards, for long-term archiving (LTA) and retrieval of digital data, such as 3D CAD and PDM data. The development of the technical standards is organized by disciplines: 3D CAD with PMI and mechanical, PDM, Composite, Electrical, 3D visualization. The LOTAR standards do not define ISO information models, but reference the appropriate ISO 10303 STEP standard. As described on the next figure, AP 242 ed1, then ed2 is a cornerstone ISO information model standard for the LOTAR standards.

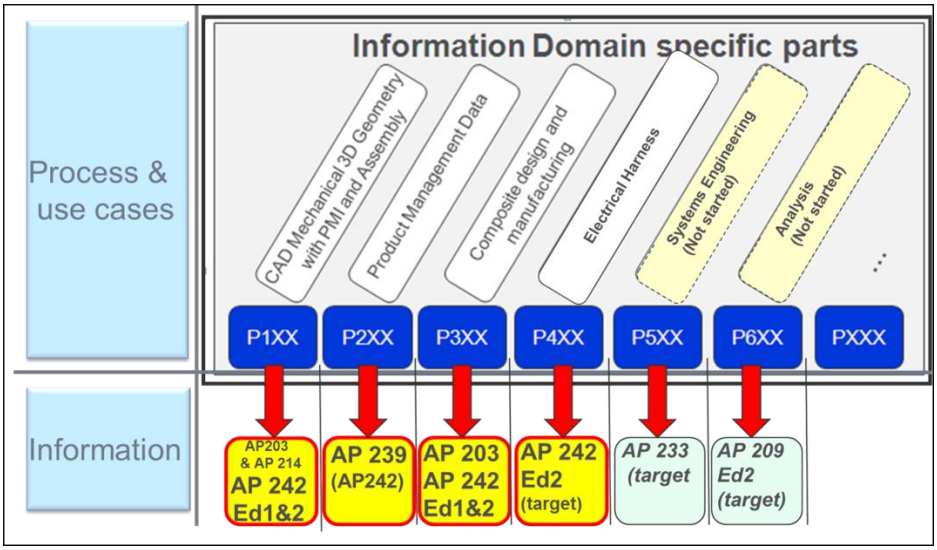


Figure 14**: Links between the LOTAR standards and AP 242 ed1 and ed2**

As for the AP 242 ed1 project, the LOTAR project will continue to be part of the steering board of the AP 242 ed2 project, and will contribute, when necessary, to the support of AP 242 ed2 pilots relevant for the LOTAR project.

6.2 Links with complementary ISO product information model standards

Design of complex products such as aerospace and defense systems, automotive vehicles, trains or ship building, is based on concurrent engineering methods, requesting close integrations with upstream and downstream processes. As a result, STEP AP 242 ed2 has to be developed taking into account interdependencies with other related international standardization projects, such as:

- Upstream product information models standards (Systems Engineering, Simulation, …),
- Other cross domain PDM interoperability standards,
- Links with ISO 3D visualization standards,
- Downstream product information model standards (Manufacturing, Support, ...).

6.2.1 Interdependencies with upstream ISO product information standards

6.2.1.1 Systems Engineering (ISO STEP AP 233)

The aerospace industries need to ensure the consistency of Systems Engineering model based methods with 3D model based design methods. As such, the requirement management capability has been introduced in AP 242 ed1, based on the requirement management capability of STEP AP 233. It results in the need of coordination and maintenance of consistency of AP 242 ed2 with ISO STEP AP 233 “Systems Engineering” standards.

6.2.1.2 Multidisciplinary simulation and analysis (ISO STEP AP 209 ed2)

Based on the STEP modular approach, STEP AP 209 ed2 “Multi-disciplinary analysis and design” includes AP 242 ed1 as a module. AP 242 ed2 project will take into account feedback from the implementation of CAE applications based on AP 209 ed2, regarding the scope of AP 242 ed1.

6.2.1.3 Printed Circuit Board and assembly (ISO STEP AP 210 ed3)

The US Aerospace and defense industries have developed AP 203, AP 209 and AP 210 as a suite of consistent standards, based on the modular architecture. This is maintained and reflected in the interdependencies of AP 209 and AP 210 with AP 242 ed1. It shall be preserved with AP 242 ed2.

The main extension of AP 242 ed2 is related to electrical design interoperability functionalities; it will take into account the consistency of electrical design with printed circuit board design.

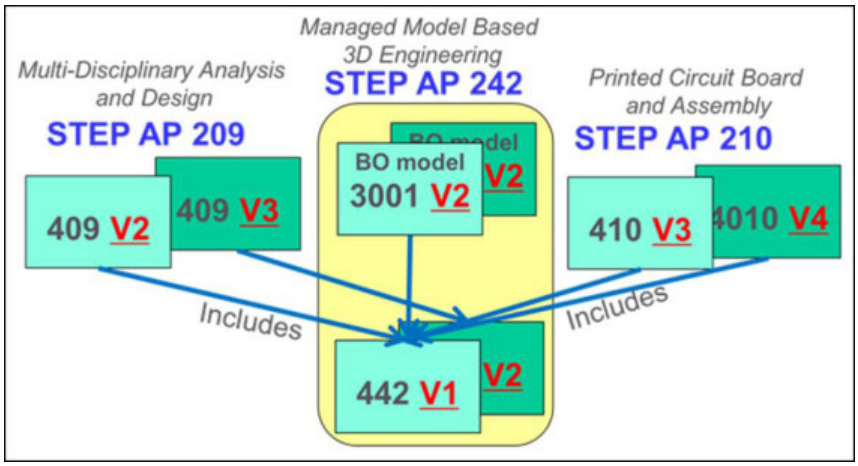


Figure 15**: AP 242 and related STEP modular Application Protocols**

6.2.2 Interdependencies with other PDM interoperability standards

Based on the funding of the AIA – ASD-Stan LOTAR project, important achievements have been reached for PDM harmonization between AP 242 ed1 BO Model and OASIS PLCS PSM V1. In order to finalize the AP 242 ed1 as an International Standard for Q1 2014, it has been agreed to defer some proposed recommendations for PDM harmonization to AP 242 ed2 and in a next version of OASIS PLCS PSM, basis of AP 239 ed3 project.

The AP 242 ed2 project will set up a close coordination with the AP 239 ed3 project, as soon as this project is started.

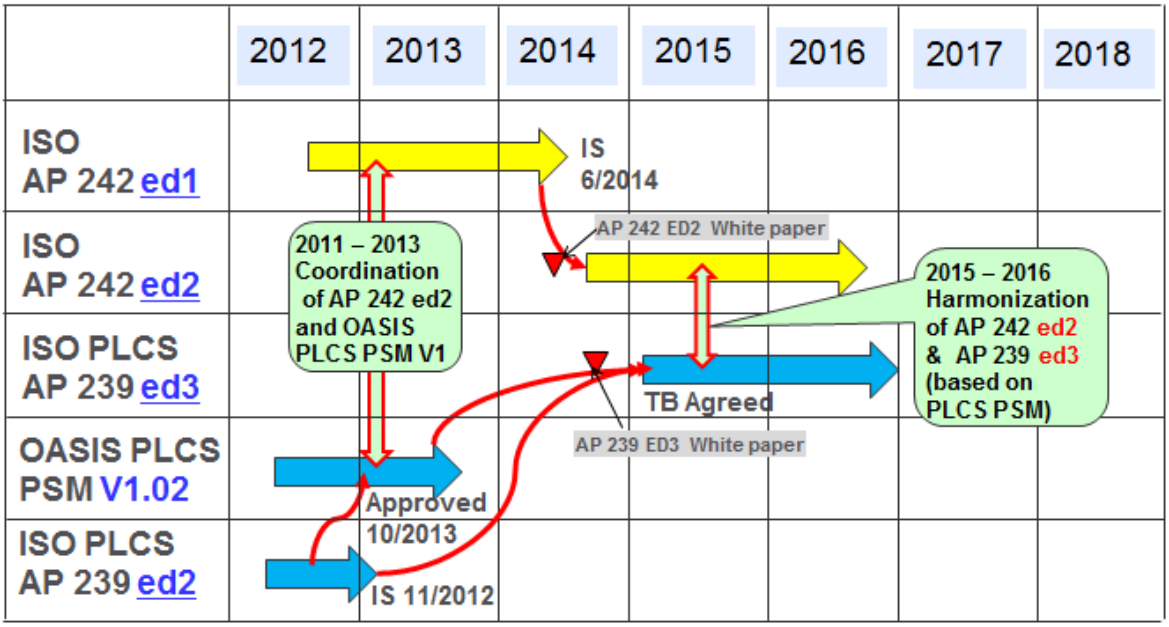


Figure 16: finalization of PDM harmonization with AP 242 ed2 and OASIS PLCS.

6.2.3 Links with other ISO 3D visualization standards

- ISO 14306 JT ed2

ISO 14306 ed2 also known as ISO JTed2 is the required evolution of ISO 14306 by TC 184/SC 4 to include 3D exact B-rep geometry in the scope of the standard by adding a STEP segment in JT. The STEP segment is in development as AP 243 and is derived from a subset of the AP 242 geometry schema.

Some Use Cases are integrating ISO 14306 with the AP242 BO model XML.

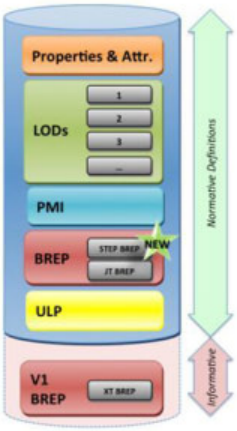


Figure 17: JT file structure

- ISO 14739 PRC

ISO 14739 PRC is one method to embed 3D interactive data and models into a PDF file. A PDF file containing PRC based 3D model can be viewed in using the Adobe Reader as well as other tools. The ISO 14739 PRC ed2 project plans to integrate the STEP AP 242 data model for 3D PMI semantic representation.

The AP 242 ed2 project will set up a liaison with the PRC ed2 project to facilitate the mapping / transformation of STEP AP 242 3D with PMI data to PRC 3D visualization data.

6.2.4 Interdependencies with downstream manufacturing standards

The aerospace and automotive industries are increasing the business priorities to ensure a seamless integration between the Engineering and the Manufacturing. It results in the requirements to ensure the consistency of the 3D model based design with the 3D model based manufacturing, by sharing common information models for 3D exact geometry, 3D PMI semantic representation, 3D machining form-features, …

It will result in the setting up of coordination with downstream standards, such as:

- for 3D Numerical Control machining (STEP NC),
- for 3D Dimensional Inspection (E.g., QIF, …),
- for 3D Additive Manufacturing standard (E.g., AMF, …)

6.3 Links with STEP Implementers forums

The AP 242 ed2 project will benefit from a close coordination with the related STEP Implementer Forums. These relationships may enhance the AP 242 ed2 information model, based on feedback and potential requests for improvement of the data models, to improve the performance or simplify the development of applications.

The AP 242 ed2 project and these STEP implementer Forums will take into account the important requirement of the aerospace industry to ensure upward compatibility between AP 242 ed1 and ed2, since a lot of companies start to implement solutions for long term archiving of CAD 3D models in STEP AP 242 for the certification of their products.

The following table sums up the STEP IFs associated to the extension or enhancements of AP 242 ed2.

AP 242 "functionalities" and associated STEP Implementer Forums	Associated STEP Implementer Forums (Dev. of Rec. Practices and test rounds)
Composite	CAx IF
Kinematics	CAx IF
Geometry and Assembly Structure	CAx IF
Mechanical	CAx IF
Electrical Harness	CAx IF
PDM	Future PDM IF
Requirement Management	Future PDM IF ?

Table 8: AP 242 functionalities and related STEP implementer forums

7 Risk management

According to the size and complexity of the AP 242 ed2 project, risks are possible in various areas. The following risks, the probability of them occurring, their severity, and the mitigation strategy are detailed below. For the probability and severity, the following abbreviations apply:

Notation: Prob. = probability, Sev. = severity, L = Low, M = Medium, H = High..

Risk	Prob	Sev.	Mitigation
Cost			
Lack of funding for development of the AP 242 ed2	H	H	1) AP 242 ed2 development will not start until a minimum amount of funding is available 2) Committed organizations will pursue funding aggressively
Lack of funding for development of the AP 242 ed2 pilots, allowing to verify the quality of the complex extensions / enhancements	H	M	1) AP 242 ed2 pilots will be carefully monitored, planned and funded. 2) Committed organizations will pursue funding aggressively 3) The large CAD vendors will not be funded.
Organization			
Unbalanced sharing of responsibilities and/or resources between the AP 242 ed2 Project partners (Aerospace / Automotive industries or , America, Europe, and Asia regions)	M	H	1) Committed joint ownership between the relevant international associations 2) Memorandum of Agreement between all committed organizations 3) Regular communication at the management, PSC, and technical levels
Lack of procedures for the project management of the AP 242 ed2 development	L	M	1) Committed joint ownership between the relevant international associations 2) Creation of a STEP AP 242 ed2 Project Charter and Quality plan with written procedures
Interdependencies			
Lack of coordination with the AP 239 ed3 project	M	H	1) Define a resource in the AP 242 ed2 PSC to be responsible for the liaison with the AP 239 ed3 project. 2) Coordination of the development of AP242 ed2 with AP 239 ed3 in liaison with ISO /TC 184 /SC 4. 3) Track PDM development of STEP AP 239 ed3, and report it to AP 242 ed2 PSC

Risk	Prob	Sev.	Mitigation
Lack of coordination with the VDA VEC community	M	M	1) Continue to reach out to the VDA VEC community in the AP 242 ed2 project 2) Reduce the scope of the dependent activities.
Lack of coordination with CAx-IF	L	M	Appropriate involvement and supports from stakeholders in the CAD Implementers Forum
Lack of coordination with PDM-IF	M	M	Appropriate involvement and supports from stakeholders in the PDM Implementers Forum
Lack of AP 242 ed2 interface implementation by main PLM vendors	M	H	1) Timely involvement of IT vendors 2) Timely availability of recommended practices and sample files
No PDM-IF available in a timely fashion to assure coordination of activities for common topics	L	M	Support to the setting up of the PDM Implementer Forum by the AP 242 ed2 PSC
Scope			
No automotive companies join the AP 242 ed2 Project	M	H	1) Committed joint ownership between the relevant international associations 2) Memorandum of Agreement between all committed organizations 3) Regular communication at the management and technical levels
Undefined scope of development for the different work packages of AP 242 ed2 project (electrical , composite, mechanical, 3D PMI, 3D geometry, PDM)	L	M	Confirm the precise scope of development of the different AP 242 ed2 project work packages during the 2nd AP 242 ed2 workshop (Dec. 2014)
Management			
Lack of availability of AP 242 ed2 project leader and co project leader	L	M	Identify, and assure the availability & time commitment of the AP242 ed2 Project leader and co project leader
Lack of adoption of the AP 242 ed2 NWI	M	H	Set up regular interactions with the ISO community through existing liaison and national standards bodies, and ensuring that ISO participation rules are followed.

Risk	Prob	Sev.	Mitigation
Lack of integration with other developments through the ISO process.	M	H	Regular coordination with the SC4 groups to be ensured.
Shift of project plan during the AP 242 ed2 Project	L	M	1) Alignment on agreed project plan and ensure appropriate consensus between all committed organizations 2) Memorandum of Agreement between all committed organizations 3) Regular Project Steering Boards.
Stakeholders change their priorities during the AP 242 ed2 Project	L	H	1) Alignment on agreed scope and ensure appropriate consensus between all committed organizations 2) Memorandum of Agreement between all committed organizations
AP 242 ed2 not available in the time requested by stakeholders (timely availability of funding)	H	H	1) The stakeholders will provide resources as required, due to their commitment to STEP AP 242 ed2 Project 2) Careful preparation of the project plan, with precise milestones 3) Project management resources will be made available by committed organizations
Lack of STEP experts to develop the AP242 ed2	M	M	1) Identify, secure necessary funding for, and assure the availability of key STEP experts for the AP242 ed2 Project 2) Recruit new STEP experts to develop the AP242 ed2 3) Train new STEP experts to develop the AP242 ed2
Communication			
Lack of internal communication in the AP 242 ed2 Project	L	M	1) Regular communication at the management and technical levels. 2) Organization of regular project team teleconferences 3) Organization of at least 1 workshop / year
Lack communication of STEP AP 242 ed2 Project to external stakeholders	L	M	1) Define a communication plan in the STEP AP242 ed2 Project 2) Organization of at least 1 teleconf. / year
Quality			
Lack of quality of the documentation of the AP 242 ed2 BO Model/ARM	M	H	1) Every effort will be made to ensure that the documentation of AP 242 ed2 will be of a high quality and understandable to the

Risk	Prob	Sev.	Mitigation
			appropriate communities. 2) Enhancement of the AP 242 ed1 ARM documentation, (to take into account the quality of AP 209 ed2 ARM documentation)
Lack of pilots to validate the quality of the AP 242 ed2 BO Model/ARM	H	H	Identity the key areas that should have pilots, and assure availability of resources and funding to their execution
Technical			
Lack of upward compatibility between AP 242 ed1 and ed2	L	H	1) Include upward compatibility between AP 242 ed1 and ed2 as a strong technical requirement in AP 242 ed2 Project 2) Include upward compatibility between AP 242 ed1 and ed2 use-cases in the AP 242 ed2 pilots
The STEPmod infrastructure is not available anymore during the development of AP 242 ed2	L	H	1) Ensure the support of PDES Inc and NIST to maintain STEPmod during the development of AP 242 ed2 2) Specific funding of the AP 242 ed2 project to contribute to the maintenance of STEPmod
The timeframes for the development of the AP 242 ed2 subprojects are much different	L	M	1) Define clearly the scope, and estimate carefully the effort of each subproject during the construction of the AP 242 ed2 Project Plan 2) Adjust the scope of the subprojects during the AP 242 ed2 Project, if necessary, to maintain the project deadlines
Infeasibility or difficulty to implement new concepts required by AP 242 ed2 in the STEP AP 242 ed1 architecture	L	H	Review and adjust the scope of the AP 242 ed2 Project when necessary to tailor it to STEP AP 242 ed1 architecture
Infeasibility or difficulty to implement new BOs required by AP 242 ed2 due the granularity of the AP 242 ed1 BO Model	L	M	1) Review and adjust the scope of the AP 242 ed2 Project when necessary to tailor it to STEP AP 242 ed1 BO Model . 2) Propose enhancements of the STEP modular architecture, if necessary.

Table 9: AP 242 ed2 project risk synthesis

8 Project management

The project management activities of AP 242 ed2 include the following:

- Project organization,
- Deliverables,
- Financial principles,
- Management of liaisons with other standardization projects
- Scheduling, Planning of international workshops and associated topics,
- Total Costs, Financial plan,
- Preparation of yearly project plan to secure resource availability,
- Communication

8.1 Project organization

The AP 242 ed2 project organization is summed up on the next figure, detailed in the following paragraphs.

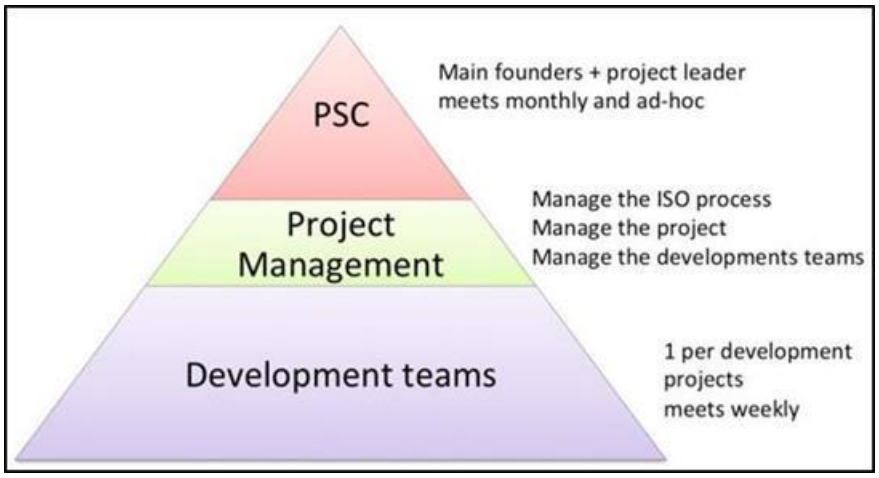


Figure 21: Overview of the AP 242 ed2 project organization

8.1.1 Project contributors

The project contributors will provide contributions monetarily or in man-days. The cash contributions will be used to fund the STEP experts needed to develop the standard in cooperation with the industry man-days contributions. The project contributors which are providing monies to found the sub projects are called founding members.

8.1.2 Project Steering Committee

The project will be under the management of a project steering committee (PSC). The PSC is composed of one representative of each of the founders and of the project management team. All project contributors are invited to the PSC.

The PSC meets by web-conference every month. The meeting schedule will be defined in order to have PSC meetings 2 weeks before the ISO milestones and ISO meetings, and to review the ISO AP 242 ed2 ballots within a week.

The PSC is in charge of:

- Validating the development budget allocation on the work packages,
- Controlling the progress of the project,
- Validating the communication actions.

8.1.3 Hosting associations

In addition to contributions to the projects, like the other sponsoring associations (fees or expertise), the hosting associations appoints the Project Team and the needed external expert resources accordingly to the agreed project plan.

8.1.4 Project Team

Project Leader

The Project leader will be appointed by PDES Inc. to provide an alternating cycle of European and American leadership of the AP 242 project. The project leader is responsible for the following:

- Manage the ISO process,
- Report the project status to the PSC,
- Schedule, manage and report to all the PSC meetings ,
- Schedule and manage a monthly meeting with the development teams in order to identify synergies or divergences,
- Provide the agenda and the minutes of the meetings.

If needed a co-leader will be appointed to assists the project leader in his tasks.

Project Editor

The project editor is in charge of assembling the ISO documentation from the elements published in STEPmod by the development teams. He provides, when requested, the status of edition of the different sections (target status, achieved status, potential risk, …).

Development teams

There will be several development teams organized by work-packages, corresponding to sub projects agreed for the final scope and work plan of the AP 242 ed2 project. The development work will be distributed among the contributors and the STEP and ISO experts based on priorities and effort needed. Each development team will have a responsible, nominated for the duration of the project. Each development team will have weekly web-conference meeting during the development phases, and will meet all together by web conferencing once a month to review the work progress and the dependencies between the work packages.

There are 3 main work packages identified so far:

- WP1: Development of the Electrical Harness capabilities in AP242, as the main work package of AP242 ed2 (Reference to section 4.3 of this document for more details),

- WP 2: AP242 ed1 extensions on CAD 3D , PMI, Mechanical, PDM and composite (Reference to section 4.4 of this document for more details).
- WP 3: AP242 ed1 maintenance following first implementation feedbacks.

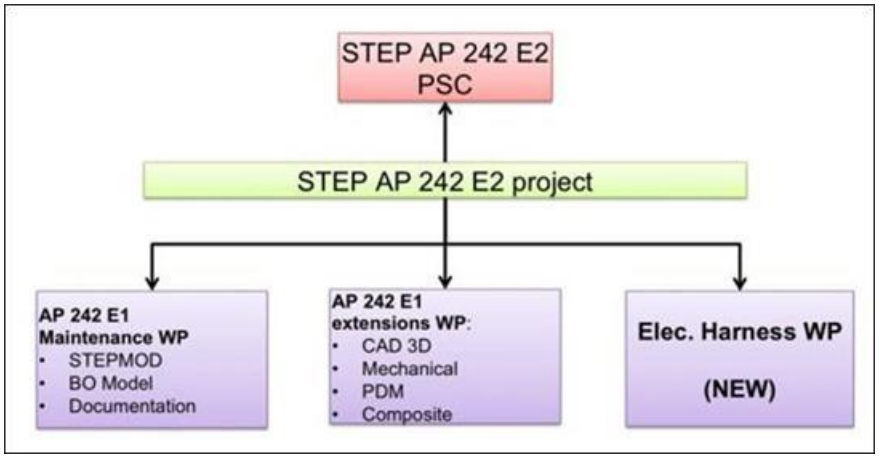


Figure 22: project organization breakdown structure.

8.1.5 Face to face workshops of all the project team

Face to face workshop will be held in order to bootstrap or speed up the critical phases of the project: at kickoff, after the first pilots round, for the CD comments resolution, and before the finalization of the DIS document. The workshop will be held at alternate location between Europe and the US, and will be synchronized with the STEP CAx-IF or LOTAR workshops.

8.1.6 Participation to the ISO/TC 184/ SC 4/WG 12 & WG 21

The project leader or co-leader will contribute to the WG12 "STEP product modeling and resources" and WG21 "SMRL Validation Team" weekly teleconferences to report any issue related to the project. The Project will use the standards WG12 management tools: ISO web-conferencing, ISO Livelink repositories and forums, STEPmod, and Bugzilla. The project deliverables: Express Schemas, documentation, etc..., will be delivered directly in the STEPmod environment by the AP 242 ed2 developers.

8.2 Deliverables

The main deliverable is a new edition of the modular application protocol – AP 242 ed2, and any associated new components of the ISO/TC 184/SC 4 standards (modules, BO model, reference data, etc). The project plan includes the delivery of NWI, draft document, its submission for CD and DIS ballot, and the resolution of any comments received, the management of change requests (CR) and SMRL updates.

The feasibility of the development of critical functionalities will be checked through 2 rounds of pilots, one before the CD ballot and one before / during the DIS ballot (see chapter 5.3 for more details).

Besides the ISO document itself, STEP AP 242 Recommended Practices will have to be updated and AP 242 interfaces tested. These tasks are not part of the project, but liaisons with the related projects (for example, the CAx IF, the future PDM implementer forum) will be set up.

In addition, the project team will carry out the appropriate communication actions (see section 8.8).

Set of modified application modules

For AP 242 ed2, several modules have to be modified and new versions submitted to the SMRL maintenance process. The following categories of modules will be identified for enhancements: PMI, Composite, 3D geometry, Kinematics, data quality, and PDM.

New application modules

New modules for electrical harness have to be created and submitted to the SMRL maintenance process (see 4.3.4 for more details).

New BO model, extension of the AP 242 ed1 BO Model, and associated XSD

The main implementation model for the extension to electrical design will the BO model and its associated XML schema. The AP 242 ed1 BO model will be also extended with:

- a new capability covering 3D PMI semantic representation,
- the other relevant enhancements of AP 242 ed1 (composite, PDM, …) covered by the edition 2.

8.3 Financial principles

In addition of the ISO development process and review, which is open to all TC 184/SC 4 members, the AP242 ed2 project will need funding to develop the main components of the standard and its management. The financial principles of the AP 242 ed2 project are the following:

- Project management + maintenance are multiplied by 2 in order to provide funding for maintenance of the STEP development infrastructure and manage the project risks (e.g. 15% + 15% of overall costs).

  It corresponds to the minimum fee to be member of the project.
  This fee is paid equally by all members of the project.
  This fee includes the maintenance of the AP 242 ed1.
  It provides a provision of the budget, available to manage the risks along the project life.

- The rest of the funding (e.g. 70%) is shared equally by the main funding partners as follows:

  – The main funding partners are the voting members of the PSC. As such, the steering of new the functionalities of the AP 242 ed2 standard is ensured by the companies / associations funding these subprojects.
  – All the funding partners are involved in the Project Steering Committee.
  – The transparency of all subprojects is ensured to all the funding members.

The financial principles are illustrated by the following figure:

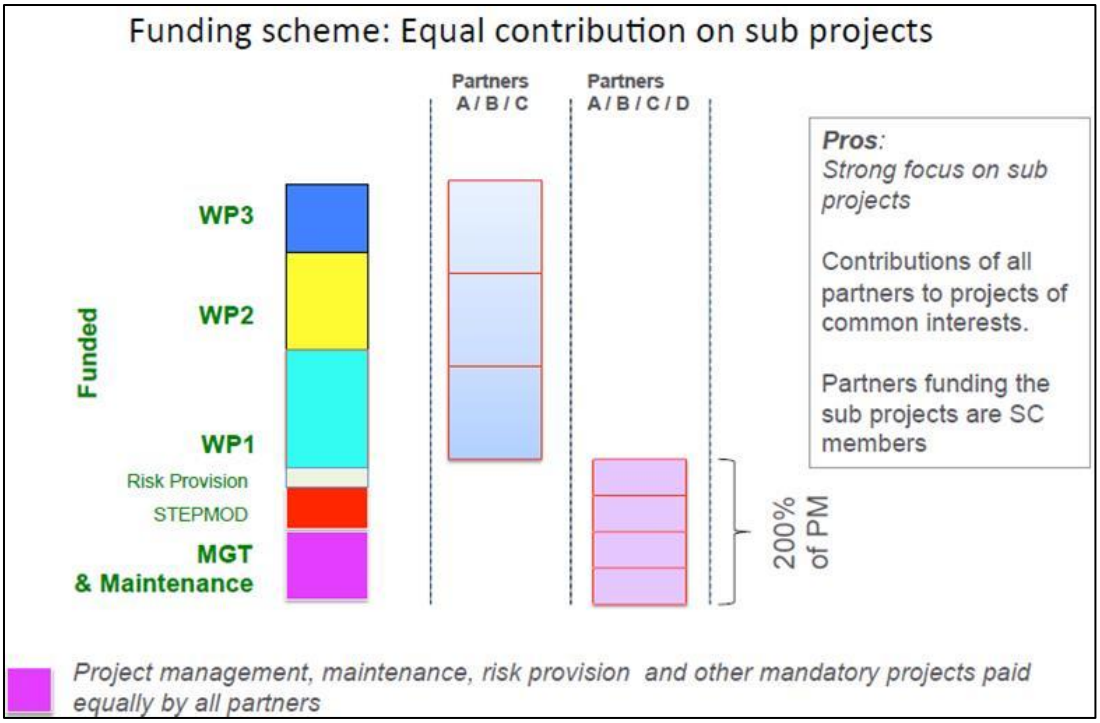


Figure 23: Financial principles of the AP 242 ed2 project

8.4 Management of liaisons with other standardization projects

As presented in the introduction and in the section 6, the full benefits of the AP 242 ed2 standard will be reached if efficient liaisons are established and maintained during the AP 242 ed2 development.

The next table sums up the main interdependencies and liaisons to establish and maintain during the AP 242 ed2 project development. The liaisons and coordination with the other STEP APs will be ensured through the weekly teleconferences of the WG12 "STEP product modeling and resources" and WG21 "SMRL Validation Team". The other main liaisons will be set up at the beginning of the project, such as:

AP242 Work Packages	Other STEP APs	Liaisons with other standards	STEP Implementer Forum
Enhancement of PDM	AP239 ed3	Update of OMG PLM Services OASIS PLCS	PDM-IF
Enhancement of composite	AP209 ed2		CAx IF
Enhancement of mechanical design	AP238	STEP-NC	CAx IF
Enhancement of 3D geometry generis resources	AP209 ed2 AP210 ed3	ISO 14739 PRC ISO 14306 JT ed2	CAx IF
Enhancement of 3D PMI	AP209 ed2 AP210 ed3	ISO /TC 213 standards	CAx IF

	AP 238	AMF, QIF	
Extension to electrical	AP210 ed3 AP239 ed3	VDA VEC	CAx IF

Table 10: AP 242 ed2 interdependencies and liaisons

8.5 Scheduling

The project is divided in 6 main sections:

- Maintenance of AP 242 ed1,
- AP 242 ed2 enhancement of ed1 functions,
- Development of the new Electrical harness design functionality,
- Assembly and edition of AP 242 ed2 (development of AP 242 ed2 and AM 442 ed2),
- Communication,
- Project management.

The duration of the overall project including the preparation of the NWI ballots is planned to be 27 months.

The pure development phase for the AP242 ed2 ready for a first DIS Ballot at ISO/TC 184/SC4 is scheduled for 21 months after M0. Besides the logical dependencies between the different tasks, three main factors that impact the project schedule have to be taken into account:

1) The availability of resources. The AP 242 ed2 project will rely on a limited amount of human resources, around 10 persons, each of them having other activities in the time frame of the project.
2) The necessary iterations which will be needed to reach consensus between the AP242 ed2 stakeholders and also between the development team and the ISO/TC 184/SC4/WG 12.
3) The coordination with other related standardization projects (e.g., for the PDM enhancement: coordination with STEP AP 239 ed3 project)

The schedule starts from the hypothesis that the work shall not be distributed over too many people to benefit from the best synergies through the whole project.

To guarantee the consensus, iterations reviews and approvals tasks are included at the end of each major section in the project plan. The review and approval tasks are concurrent with the end of the development tasks and extend the development tasks schedule by a few weeks/months.

Milestones

Starting with a M0 at NWI Preparation, the following milestones are on the critical path:

- M0 + 1 month : Start NWI Ballot
- M0 + 4 months: Project KickOff ,
- M0 + 12 months: End of CD development and Start assembly of CD document
- M0 + 13 months: start of CD ballot process (CD ballot : 3 months)
- M0 + 16 months: End of CD Comment resolution / Start of DIS development.
- M0 + 22 months: start of DIS ballot process (DIS ballot duration: 3 months)
- M0 + 27 months: IS Publication / End of project

Detailed Schedule

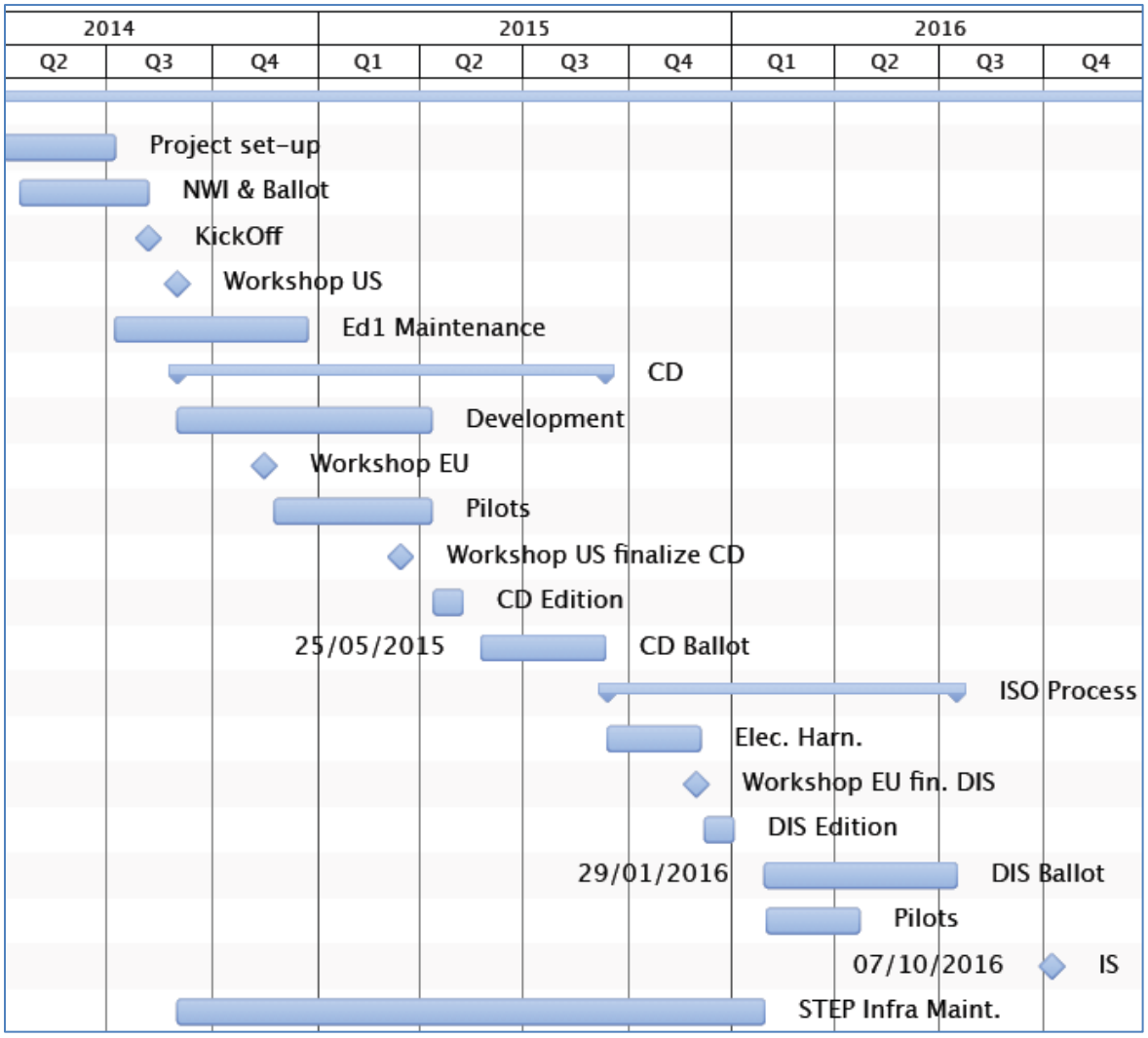


Figure 24: Detailed planning of the AP 242 ed2 project

Summary of the planning of the AP 242 ed2 project, and comparison with the AP 242 ed1 project. See next figure:

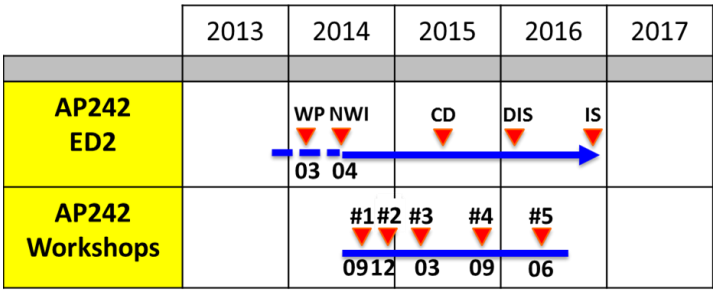


Figure 25 : Overall planning of the AP 242 ed2 project and associated international workshops

Planning of international workshops and associated topics

The development of the AP 242 ed2 projects based on the organization of 4 international workshops

	Date	Location	Main topics
Workshop 1 (after LOTAR workshop)	22 – 26 Sept. 2014	USA, PDES Inc, Charleston	Main workshop to define the key concepts of AP 242 ed2, including the BO model (3 days for the elec. Team) (3 days for the 3D PMI team)
Workshop 2 (after LOTAR workshop)	8 – 12 Dec. 2014	Europe	Consolidation of AP 242 ed2 data models and specs for pilots
Workshop 3 (before LOTAR workshop)	March 2015	USA, Gaithersburg	Finalize AP 242 ed2 CD/SMRL #N)
Workshop 4 (before LOTAR workshop)	End Nov 2015	Europe	Finalize AP 242 ed2 DIS documentation
(TBC – workshop 5)	March 2016	USA, Gaithersburg	Finalize AP 242 ed2 DIS comments resolution + prep. IS technical document

Table 11: Planned dates of AP 242 ed2 international workshops.

8.6 Total Costs and financial plan

The total cost of the AP 342 ed2 project is summed up in the following table:

	2014				2015				2016				TOTAL		
	S1		S2		S1		S2		S1		S2				
	externs USD	Intern MD	externs USD	Intern MD	externs USD	Intern MD	externs USD	Intern MD	externs USD	Intern MD	externs USD	Intern MD	externs USD		Intern MD
NWI		20													20
Edition 1 maintenance			40	20	40	20	20	10					100	6%	50
edition 2 enhancement of edition1 functions			80	70	80	70	20	40					180	11%	180
Edition 2 new functionality : Electrical Harness			160	100	160	70	210	105	50	10			560	35%	265
Pilots					150	30	30	10	100	20			280	17%	60
Publishing			50		20	5	70	5			20	5	160	10%	15
Communication		2	5	5	5	5	5	5	5	5	5	5	20	1%	22
Project Management		1	66	9,5	90	9,75	70	8,5	30	1,5	8	0,5	256	16%	30,3
Risk Provisioning			35		10		10		10		5		65	4%	
													16%	100%	
Total USD			436		555		435		195		38		1621		
Total internal Man Days		23		205		210		184		36,5		10,5			642
Annual need in K USD:			436				990				233		72%		28%

Table 4: Total costs of the AP 242 ed2 project.

The internal resource cost is assessed in Man.Days (M.D)

The project represents a total cost of 1 621 K$ + 642 Man.Days.

The funding of the project is based on the following:

1) Fees paid by project member organizations (associations or companies),
2) Internal Man.Days provided by experts of the organizations participating in the project.

During the preparation of the white paper, several companies and associations have confirmed their interest in participation to the project, and have started to prepare the funding for the duration of the project. The detailed sharing of funding by organizations will be known once the confirmation of interest received, following the distribution of the completed white paper. According to the official confirmation of participation, the project members will have to review the project scope and schedule activities accordingly (e.g. pilots, functionalities).

8.7 Preparation of yearly project plan to secure resource availability

In order to avoid any shift in the planning by lack of funding of the subcontracted STEP experts, the AP 242 ed2 project will prepare a yearly project plan and send the request for payment of the project fees, a minimum of 3 months before the date of payment. See the following figure.

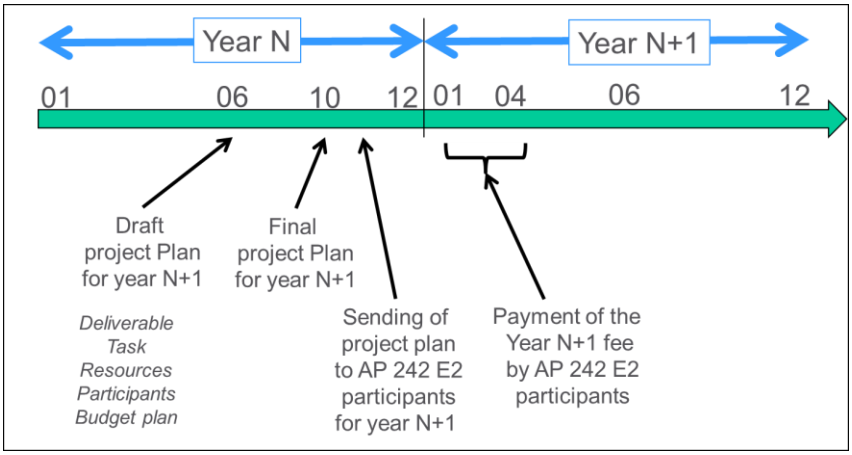


Figure 25: Preparation of yearly project plan

8.8 Communication

A set of communication material will be assembled by the project to promote the AP242 ed2 to the Industry: Slides, Website, Poster, Logo, status of progress of the different tasks to the related involved parties. It includes more specially:

Type of communication	**Frequency**
Reporting to the stakeholder associations	Quarterly
Status of progress to the PLM software suppliers and integrators	At least one time per year
AP 242 ed2 project annual report,	Yearly
Update of the AP 242 ed2 web site	Every 6 months, or according to ISO ballot stages
Contributions to international conferences, directly or via the stakeholders representatives	Case by case; for example: Europe: PDT Days, ProSTEP Symposium, GIFAS , Galia, STEP Industry days, NASA/ESA conference; USA: 3D CIC, …

Table 12: AP 242 ed2 project communication actions

9 Summary – next actions

As stated during the preparation of AP 242 ed1 by aerospace and automotive industries, STEP is the most powerful standard for describing product data, more specifically, "AP 242 is our strategic standard for supporting Model Based 3D Engineering"[2]. The first version was focused on the convergence on AP 203 ed2 and AP 214 ed3, with the introduction of the new capability of STEP XML implementation based on the business object model and with 3D PMI enhancements. **The main benefit of AP 242 ed2 is the extension to the electrical design domain**, completed with specific enhancements in the following domains: PDM, 3D geometry, composite, mechanical design.

The AP 242 ed2 is the opportunity to define and use a single integrated ISO standard covering product information interoperability capabilities for: - Product Data Management, - 3D model based design with PMI, - Mechanical, - Composite, - and Electrical design. It will decrease the evolution and maintenance efforts of CAD-PDM STEP interfaces for the software vendors, and then the costs of usage for the manufacturers community.

This standard will be consistent with:

- AP 209 "Multi-Disciplinary Analysis and design",
- AP 210 "Electronic assembly, interconnect, and packaging design",
- AP 233 "Systems Engineering"
- AP 238 "Application interpreted model for computer numeric controllers"
- And AP 239 "Product Life-Cycle Support",

Together they will be the foundation for specifications, engineering simulation and 3D model based design information interoperability of aerospace, automotive and other transportation industries. It will strengthen the acceptance and support of STEP by the main manufacturing industries.

The present white paper describes the context, the business usages, the enhancements of AP 242 ed2, interdependencies with other standardization project, project risks, and the associated project plan. It takes into account the answers received to the "Questionnaire for the prioritization of enhancements to be considered for STEP AP 242 ed2" describing potential enhancements of functionalities of AP 242 ed2.

The final prioritization will be decided by the stakeholders committed to support the AP 242 ed2 project with the appropriate resources, once the white paper is published.

The main next actions are as follows:

1. The official confirmation of participation of the associations, manufacturers and stakeholders before the 4th of July 2014,
2. If needed, the update of the project plan according the stakeholders resources and funding,
3. The start of the ISO AP 242 ed2 New Work Item ballot, planned beginning of May 2014,
4. The setting up of the project with the stakeholders, and the detailed WBS,

[2] Reference : "AP 242 Project Vendor Briefing, February 17, 2011"

5. The preparation of the contracts to the STEP experts,
6. The project kick-off, after the acceptance of the NWI ballot, end of August, followed by a 1st project workshop last week of September 2014, in Charleston.

The kick-off of the project is planned 5 months after the distribution of the published white paper.

If there are any questions about this whitepaper, they should be directed to one of the following three persons:

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