BS ISO 25297-1:2012

BSI Standards Publication

Optics and photonics — Electronic exchange of optical data

Part 1: NODIF information model

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National foreword

This British Standard is the UK implementation of ISO 25297-1:2012. It supersedes BS ISO 25297-1:2010 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/172/1, Optics and Photonics - Fundamental Standards.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 25297-1

Second edition
2012-03-01

Optics and photonics — Electronic exchange of optical data —

Part 1: NODIF information model

Optique et photonique — Transfert électronique des données optiques —

Partie 1: Modèle de données NODIF

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 25297-1 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 25297-1:2010), which has undergone a minor revision to correctly identify the status of Annex A as being normative rather than informative and to apply corrections to Figures 1, 2, A.8, A.14, A.18 and A.23.

ISO 25297 consists of the following parts, under the general title *Optics and photonics — Electronic exchange of optical data*:

— *Part 1: NODIF information model*

— *Part 2: Mapping to the classes and properties defined in ISO 23584*

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Introduction

This part of ISO 25297, dealing with the Neutral Optical Data Interchange Format (NODIF), is the International Standard that describes the way optical information is transferred from one computer-aided-design program (CAD, CAE, CAM) to another, in a machine-independent and language-independent format.

ISO 10303 (all parts) is the International Standard for Exchange of Product model data (STEP) that describes the computer-interpretable representation and exchange of product data. Its objective is to provide a neutral mechanism capable of describing any product data throughout the life cycle of the product, independent of any particular system. This description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and for archiving. ISO 10303 (all parts) has been designed to support an extensive domain of product data-communication requirements, i.e. all product data necessary to completely define any product for all applications over the product's life cycle.

STEP is organized in a series of parts, each published separately. Each part falls into one of the following categories: descriptive methods, integrated resources, application integrated constructs, application protocols, abstract test suites, implementation methods and conformance testing. The series is described in ISO 10303-1.

A fundamental concept is the definition of the application protocol (AP), which is the mechanism for specifying information requirements and for ensuring reliable communication. An application protocol defines the context, scope and information requirements for a particular product and specifies the resource constructs required to satisfy these requirements. Application protocols employ three types of information models:

a) an application activity model (AAM), which describes the activities and processes that use and produce the product data in a specific application context;

b) an application reference model (ARM), which defines the terminology within the application context and specifies the conceptual structures and constraints that are used to describe the information requirements for an application;

c) an application interpreted model (AIM), which is a model of selected integrated resources that are constrained, specialized or completed to satisfy the information requirements of the ARM.

This part of ISO 25297 for NODIF is intended to conform to the requirements of ISO 10303 (all parts) as a member of the application protocol series.

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Optics and photonics — Electronic exchange of optical data —

Part 1:
NODIF information model

1 Scope

This part of ISO 25297 specifies the information requirements for optical systems and parts, and provides an information model to support the processes of optical design, optical evaluation and analysis for these optical systems and parts when using computers with CAD and CAE.

NOTE Generally, an optical system means an optical unit as an optical product, which performs optical functions, and is composed of optical elements and the barrels in which these elements are mounted. In this part of ISO 25297, an optical system is a collection of optical parts and optical assemblies, e.g. the viewfinder system or the taking lens system of a leaf shutter camera.

This information model adds the data peculiar to optical design specification based on STEP to ISO 10303 (all parts). The additional information is product specification information, optical design information, optical evaluation information and analysis information.

This part of ISO 25297 is generically called the Neutral Optical Data Interchange Format (NODIF).

The following are within the scope:

— information on product specification, optical design, optical evaluation and analysis;

— optical systems and parts in imaging systems, such as cameras and copiers, viewing systems for telescopes and microscopes and the other optical systems, such as projectors and pick-up lenses;

— multiple-configuration optical systems, including zoom lenses and inner focusing systems;

— optical path definition, including ray-path sequence and optical surface arrangement;

— optical assemblies, including cemented parts and dynamic parts;

— mathematical description of the optical surface form;

— description of diffractive surfaces;

— machining process designation, such as polishing, moulding or replicating;

— optical material specifications, such as material names, lot numbers and measured refractive indices;

— optical tolerances for the shape and material property of each optical part;

— assembly tolerances, such as separation, parallelism, displacement and tilt;

— effective diameters, coatings and protective surface treatment;

— paraxial evaluation, such as focal length, back focal length, principal points and f-number;

— ray-tracing evaluation, such as geometrical ray-tracing results (i.e. ray directions and intersection points on each surface and optical path lengths), aberrations and wavefront aberration;

— OTF evaluation based on geometrical and/or physical optics;

— illuminance distribution on a detection surface or a projection surface;

— spectral characteristics;

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— ghost image evaluation;

— thermal analysis accompanying optical surface deformation and material property value change;

— stress analysis accompanying optical surface deformation and material property value change;

— veiling glare and surface imperfections.

The following are outside the scope of this part of ISO 25297:

— mechanical design, electronic design and embedded software design;

— optical systems in which the optical path is changeable, e.g. beam splitters or variable magnification converters;

— tolerances for mechanical parts;

— parts with a diameter less than 10 times the wavelength of light;

— parts made from materials whose dielectric constant, σ, electric permittivity, ε, and magnetic permittivity, μ, are uninfluenced by interaction between the materials and the light;

— graphical documents resulting from design, evaluation and analysis of products;

— optical wave guide for optical communications;

— product planning information concerning market research and customer analysis;

— product definition and configuration control information irrelevant to design, evaluation and analysis;

— analysis information, except thermal and stress analysis, e.g. vibration analysis;

— information on trial production, production process including production planning and production control, and processes after production, such as shipment and repair;

— ophthalmic optics.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10110-1, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 1: General*

ISO 10110-2:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 2: Material imperfections — Stress birefringence*

ISO 10110-3:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 3: Material imperfections — Bubbles and inclusions*

ISO 10110-4:1997, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 4: Material imperfections — Inhomogeneity and striae*

ISO 10110-5:2007, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 5: Surface form tolerances*

ISO 10110-6:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 6: Centring tolerances*

ISO 10110-7:2008, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 7: Surface imperfection tolerances*

ISO 10110-8, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 8: Surface texture; roughness and waviness*

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ISO 10110-12:2007, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 12: Aspheric surfaces*

ISO 10110-17:2004, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 17: Laser irradiation damage threshold*

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*

ISO 10303-203, *Industrial automation systems and integration — Product data representation and exchange — Part 203: Application protocol: Configuration controlled 3D design of mechanical parts and assemblies (modular version)*

ISO 23584-2, *Optics and photonics — Specification of reference dictionary — Part 2: Classes' and properties' definitions*[1)]

ISO 25297-2, *Optics and photonics — Electronic exchange of optical data — Part 2: Mapping to the classes and properties defined in ISO 23584*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
application
group of one or more processes creating or using product data

[ISO 10303-1:1994, 3.2.2]

3.1.2
application activity model
AAM
model that describes an application in terms of its processes and information flows

[ISO 10303-1:1994, 3.2.3]

3.1.3
application object
atomic element of an application reference model that defines a unique concept of the application and contains attributes specifying the data elements of the object

[ISO 10303-1:1994, 3.2.6]

3.1.4
application protocol
AP
one of the parts of ISO 10303-1 that specifies an application-interpreted model satisfying the scope and information requirements for a specific application

NOTE This definition differs from the definition used in open system interconnection (OSI) standards. However, since ISO 10303-1 is not intended to be used directly with OSI communications, no confusion should arise.

[ISO 10303-1:1994, 3.2.7]

1) To be published.

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3.1.5
application reference model
ARM
information model that describes the information requirements and constraints of a specific application context

[ISO 10303-1:1994, 3.2.8]

NOTE See Annex B for diagrams of example application activity models.

3.1.6
assembly
product that is decomposable into a set of components or other assemblies from the perspective of a specific application

[ISO 10303-1:1994, 3.2.10]

3.1.7
component
product that is not subject to decomposition from the perspective of a specific application

[ISO 10303-1:1994, 3.2.11]

3.1.8
data
representation of information in a formal manner suitable for communication, interpretation or processing by human beings or computers

[ISO 10303-1:1994, 3.2.14]

3.1.9
data exchange
storing, accessing, transferring and archiving of data

[ISO 10303-1:1994, 3.2.15]

3.1.10
design_discipline_product_definition
one of the organizational definitions or views of a part in accordance with ISO 10303-203:2005, 4.2.8

NOTE A part version is the identification of the representation of a part after its design has undergone a formal release or change.

3.1.11
external definition
definition of product information defined outside NODIF

3.1.12
external file reference
locator of an external file to identify a collection of information whose contents are excluded from the data structure of NODIF

3.1.13
information
facts, concepts or instructions

[ISO 10303-1:1994, 3.2.20]

3.1.14
product
thing or substance produced by a natural or artificial process

[ISO 10303-1:1994, 3.2.26]

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3.1.15
product data
representation of information about a product in a formal manner suitable for communication, interpretation or processing by human beings or by computers

[ISO 10303-1:1994, 3.2.27]

3.1.16
unit of functionality
collection of application objects and their relationships that defines one or more concepts within the application context such that removal of any component would render the concepts incomplete or ambiguous

[ISO 10303-1:1994, 3.2.33]

3.2 Abbreviated terms

AAM	application activity model
AP	application protocol
ARM	application reference model
BOM	bill of material
CAD	computer-aided design
CAE	computer-aided engineering
ICAM	integrated computer-aided manufacturing
ID	identification
IDEF0	ICAM definition language 0
LEW	line equivalent width
MTF	modulation transfer function
OTF	optical transfer function
PDM	product data management
SED	spot equivalent diameter
STEP	standard for the exchange of product model data (generic term for ISO 10303)
UoF	units of functionality
VGI	veiling glare index

4 Information requirements

4.1 General

In 4.2 and 4.3 the information requirements for NODIF are specified. The information requirements are specified as a set of units of functionality and application objects.

A mapping of these information requirements to the classes and properties defined in ISO 23584-2 is specified in ISO 25297-2.

A diagram of the manufacturing process for optical products is given in Figure 1.

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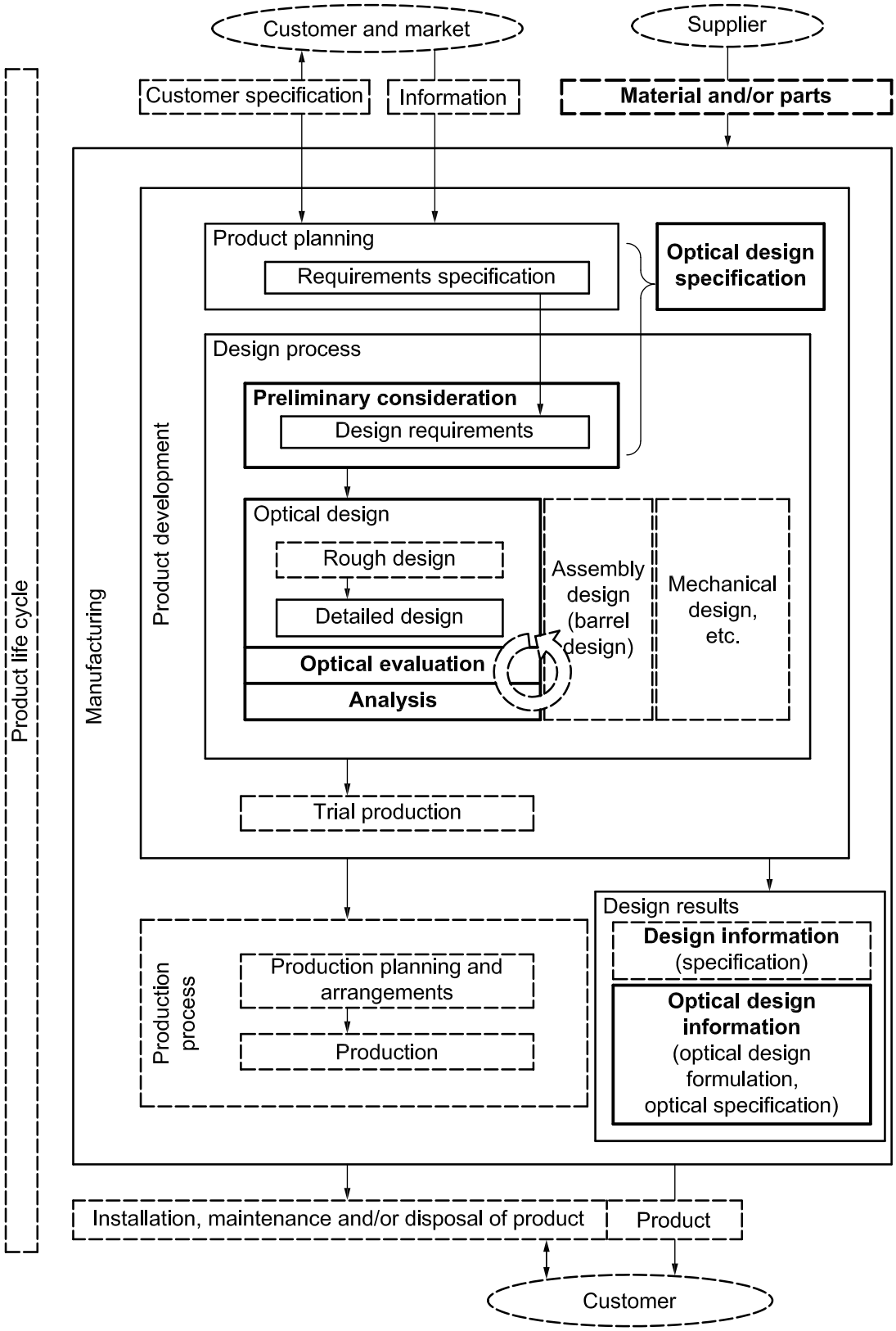

NOTE The dotted line means “out of scope”.

Figure 1 — Manufacturing process of optical products

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4.2 Units of functionality

4.2.1 General

4.2.1.1 Subclause 4.2.1 specifies the units of functionality (UoF) for optical design, optical evaluation and analysis in the application protocol of optical systems, parts, and assemblies.

This part of NODIF specifies the following units of functionality:

— optical_part_identification;

— optical_design_specification;

— optical_design_information;

— optical_evaluation_information;

— analysis_information.

4.2.1.2 The following units of functionality make use of UoFs defined in accordance with ISO 10303-203:

— end_item_identification;

— part_identification;

— authorization;

— design_activity_control;

— bill_of_material;

— shape;

— design_information;

— effectivity;

— source_control.

The UoFs and application objects, and the relations between them, are illustrated in the simple ARM diagram shown in Figure 2.

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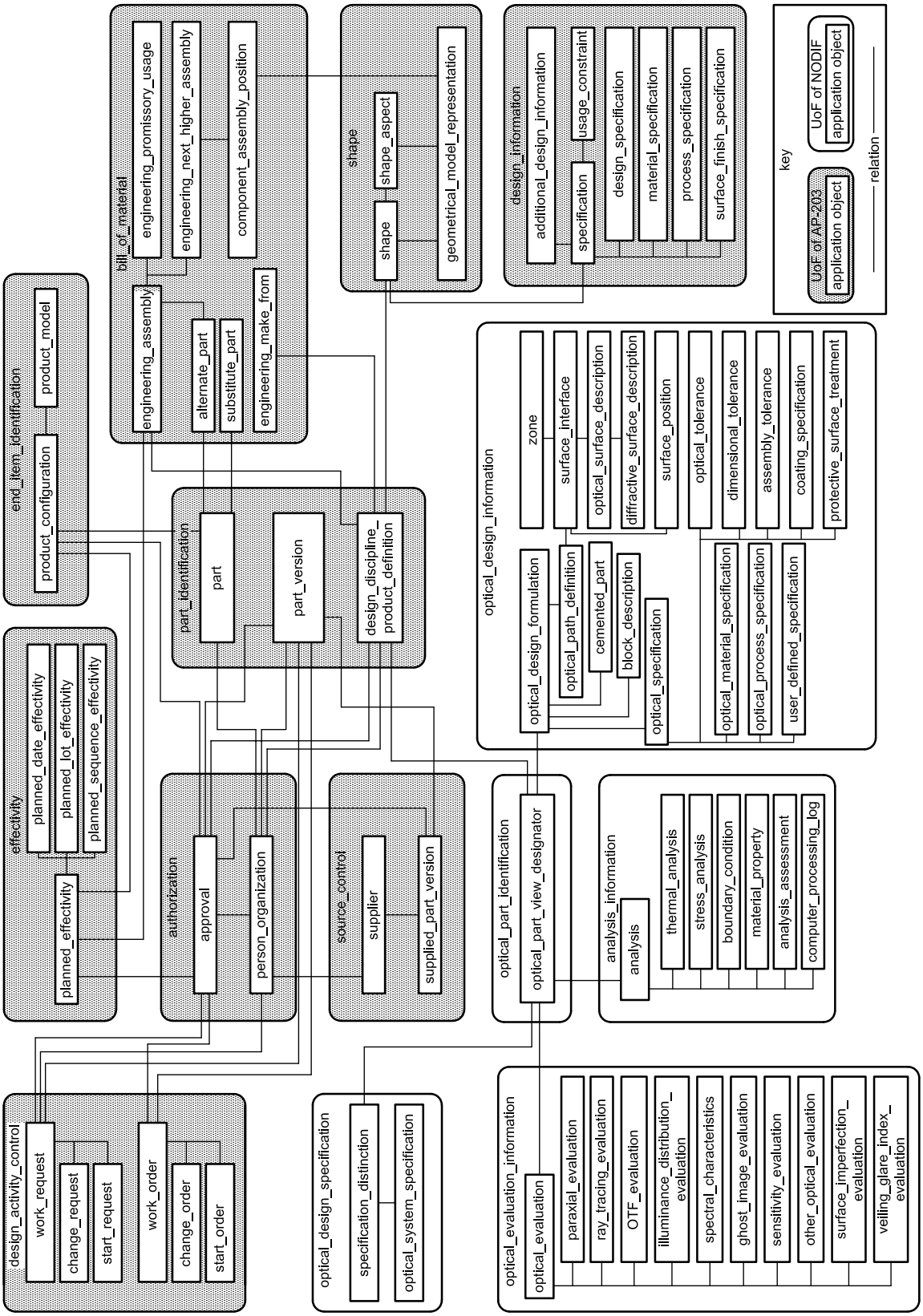

Figure 2 — NODIF simple ARM diagram

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4.2.2 optical_part_identification

The optical_part_identification UoF contains the linkage between the information on optical systems and parts described in NODIF and the information on assemblies and parts described in other APs in ISO 10303, especially AP 203. The application object, optical_part_view_designator, is used in the optical_part_identification UoF.

4.2.3 optical_design_specification

The optical_design_specification UoF contains optical design specifications, such as optical performance, accuracy, quality, operating environment, dimensions and mass for an optical system. The following application objects are used in the optical_design_specification UoF:

— specification_distinction;

— optical_system_specification.

4.2.4 optical_design_information

The optical_design_information UoF contains a collection of information on optical design. The following application objects are used in the optical_design_information UoF:

— optical_design_formulation;

— block_description;

— cemented_part;

— optical_path_definition;

— surface_interface;

— surface_position;

— optical_surface_description;

— diffractive_surface_description;

— optical_specification;

— optical_material_specification;

— optical_process_specification;

— optical_tolerance;

— dimensional_tolerance;

— assembly_tolerance;

— zone;

— coating_specification;

— protective_surface_treatment;

— user-defined_specification.

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4.2.5 optical_evaluation_information

An optical_evaluation_information UoF contains a collection of information concerned with optical evaluations, such as initial conditions and computation results. The following application objects are used in an optical_evaluation_information UoF:

— optical_evaluation;

— paraxial_evaluation;

— ray_tracing_evaluation;

— OTF_evaluation;

— illuminance_distribution_evaluation;

— spectral_characteristics;

— ghost_image_evaluation;

— optical_sensitivity_evaluation;

— surface_imperfection_evaluation;

— veiling_glare_index_evaluation;

— other_optical_evaluation.

4.2.6 analysis_information

The analysis_information UoF contains a collection of information on thermal analysis, stress analysis and the assessment results from these analyses. Thermal change causes deformation of shapes and optical surfaces, and material property changes. This information is described in thermal_analysis. Stress also causes deformation of shapes and optical surfaces and material property changes. This information is described in stress_analysis. The following application objects are used in the analysis_information UoF:

— analysis;

— thermal_analysis;

— stress_analysis;

— boundary_condition;

— material_property;

— analysis_assessment;

— computer_processing_log.

4.3 Application objects

4.3.1 General

In 4.3 are specified the application objects for NODIF. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given in 4.3.2.

The application objects and their attributes are specified in ARM diagrams using the EXPRESS-G graphical notation; see Figures A.1 to A.25.

The default unit of length for dimensions, positions and coordinates is millimetres. The default unit of wavelength is nanometres.

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4.3.2 optical_part_view_designator

An optical_part_view_designator indicates the linkage between the information on optical systems and parts described in NODIF and the information on assemblies and parts in other APs in ISO 10303 (all parts), especially AP 203.

4.3.3 specification_distinction

4.3.3.1 General

A specification_distinction indicates a type of optical design specification: official specification requirements of an optical system or design requirements for an optical system. The data associated with a specification_distinction are the specification_type.

4.3.3.2 specification_type

The specification_type represents a type used to indicate specification requirements or design requirements.

4.3.4 optical_system_specification

4.3.4.1 General

An optical_system_specification is a collection of specifications of an optical system. The data associated with an optical_system_specification are the following:

— specification_item;

— literal_specification_data;

— numerical_specification_data;

— specification_item_adjective;

— specification_unit.

4.3.4.2 specification_item

The specification_item specifies the item that is being specified for an optical system. See examples in Table 1.

Table 1 — Examples of specification items in optical systems

angle of view	angular aperture	angular magnification
aperture ratio	back focal distance	circle of least confusion
clear aperture	cost	cover glass thickness
diameter	dioptre adjustment range	dioptre scale
entrance pupil diameter	exit pupil diameter	eye relief
field number	field of view	filter size
flange focus	f-number	focal length
image size	image distance	length
magnification	mechanical tube length	MTF
numerical aperture	object distance	optical tube length
parfocalizing distance	reference wavelength	resolving power
veiling glare index (VGI)	vignetting factor	wavelength range
mass	working distance	zoom ratio

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4.3.4.3 literal_specification_data

The literal_specification_data specifies the character data in specification items.

4.3.4.4 numerical_specification_data

The numerical_specification_data specifies the numerical data in specification items.

4.3.4.5 specification_item_adjective

The specification_item_adjective specifies an adjective of a specification item.

EXAMPLE Maximum, minimum.

4.3.4.6 specification_unit

The specification_unit specifies a unit of one of the numerical specification data.

4.3.5 optical_design_formulation

4.3.5.1 General

An optical_design_formulation is a collection of information relevant to optical design. The data associated with an optical_design_formulation are the following:

— optical_design_code;

— optical_design_source;

— optical_design_addition.

4.3.5.2 optical_design_code

The optical_design_code identifies an optical_design_formulation. The code is unique within the source organization.

4.3.5.3 optical_design_source

The optical_design_source specifies the organization that is responsible for the optical_design_formulation.

4.3.5.4 optical_design_addition

The optical_design_addition specifies an external file reference whose file can contain documents and drawings associated with an optical design.

EXAMPLE Optical drawings or coating characteristics can be stored in an external file.

4.3.6 Block_description

4.3.6.1 General

A block_description indicates the moving range of an optical block to vary optical characteristics, such as for zoom blocks and an adjustment block. The data associated with a block_description are the following:

— block_purpose;

— block_first_surface;

— block_last_surface.

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4.3.6.2 block_purpose

The block_purpose represents the application purpose of an optical block.

EXAMPLE Zoom, focusing, floating, auxiliary diaphragm (for preventing flare), image stabilization, tilt and/or shift lens, collapse, adjustment.

4.3.6.3 block_first_surface

The block_first_surface designates the first surface of an optical block.

4.3.6.4 block_last_surface

The block_last_surface designates the last surface of an optical block.

4.3.7 Cemented_part

4.3.7.1 General

A cemented_part indicates cemented optical parts. The data associated with a cemented_part are the following:

— optical_element;

— optical_adhesive.

4.3.7.2 optical_element

The optical_element designates an optical element that is being cemented.

4.3.7.3 optical_adhesive

The optical_adhesive designates an optical adhesive for cementing optical elements.

4.3.8 optical_path_definition

4.3.8.1 General

An optical_path_definition specifies the data necessary to trace rays through an optical system. The data associated with an optical_path_definition include the following:

— coordinate_system;

— optical_axis;

— meridional_plane;

— surface_sequence;

— non-sequential_path_range;

— multiplicity;

— number_of_change_positions;

— multi-configuration.

4.3.8.2 coordinate_system

The coordinate_system specifies a coordinate system in which to express an optical surface form.

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4.3.8.3 optical_axis

The optical_axis specifies an axis in a coordinate system that acts as the optical axis for expressing an optical surface form.

4.3.8.4 meridional_plane

The meridional_plane specifies the plane defined by the optical axis and another axis of the coordinates.

4.3.8.5 surface_sequence

The surface_sequence specifies the order of optical surfaces in the ray-tracing sequence. The surface_sequence is a list of surface_interface data (see 4.3.9).

4.3.8.6 non-sequential_path_range

The non-sequential_path_range designates the range of non-sequential path elements. It is composed of the following detailed data:

— non-sequential_path_entrance;

— non-sequential_path_exit.

NOTE A sequential path is a ray-tracing path in which rays travel through surfaces in the same sequential order as the optical surfaces are input into an optical CAD. A non-sequential path is a ray-tracing path that specifies the order in which the rays actually encounter the optical surfaces; this is not the sequential order in which the surfaces are input into an optical CAD. Examples of non-sequential path elements are multi-reflective optical elements, e.g. rod lenses or indecisive reflective optical elements such as corner cube prisms and pentagonal roof prisms, and cases in ghost images generated by optical surfaces.

4.3.8.7 non-sequential_path_entrance

The non-sequential_path_entrance designates the entrance optical surface in a non-sequential path element.

4.3.8.8 non-sequential_path_exit

The non-sequential_path_exit designates the exit optical surface in a non-sequential path element.

4.3.8.9 multiplicity

The multiplicity specifies the maximum configuration number of multiple configurations in an optical system that has dynamic blocks. Typical dynamic blocks are zoom blocks and focusing blocks. The multiplicity of an optical system without a dynamic block is unity.

4.3.8.10 number_of_change_positions

The number_of_change_positions specifies the number of dynamic blocks in an optical system.

4.3.8.11 multi-configuration

The multi-configuration specifies the information of multiple configurations in an optical system. It is composed of the following detailed data:

— multi-configuration_comment;

— change_position.

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4.3.8.12 multi-configuration_comment

A multi-configuration_comment represents the supplementary explanation of a configuration.

EXAMPLE Infrared focusing position, image stabilization, collapse (in a collapsible lens), wide position, intermediate position, telephoto position and closest position.

4.3.8.13 change_position

4.3.8.13.1 General

The change_position specifies the arrangement of dynamic blocks in an optical system. It is composed of the following detailed data:

— surface_interface_change_designator;

— applied_surface_position.

4.3.8.13.2 surface_interface_change_designator

The surface_interface_change_designator designates the first surface of a dynamic block.

4.3.8.13.3 applied_surface_position

The applied_surface_position specifies a surface_position (see 4.3.10) of a dynamic block after a position change, which includes the surface distance or local coordinate for a designated surface.

4.3.9 surface_interface

4.3.9.1 General

A surface_interface represents the information necessary for ray-tracing at each interface. The data associated with a surface_interface include the following:

— optical_surface_identification;

— preceding_material;

— following_material;

— transit_mode;

— transit_direction;

— effective diameter.

4.3.9.2 optical_surface_identification

The optical_surface_identification represents the identifier of an optical surface used to link an optical_surface_description (see 4.3.11) and a surface_position (see 4.3.10).

4.3.9.3 preceding_material

The preceding_material designates the material traced by ray on the incident side on an optical surface.

4.3.9.4 following_material

The following_material designates the material traced by ray outgoing from an optical surface. An exit side material is designated in the case of a transmitting ray.

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4.3.9.5 transit_mode

The transit_mode specifies the behaviour of a ray on a surface, i.e. refraction, reflection, or total reflection. The default of transit_mode is refraction.

4.3.9.6 transit_direction

The transit_direction specifies the direction of exit rays on a surface, i.e. forward or backward. The default of transit_direction is forward.

4.3.9.7 effective_diameter

The effective_diameter specifies the optically effective diameter, expressed in millimetres, on an optical surface based on a zone (see 4.3.19).

4.3.10 Surface_position

4.3.10.1 General

A surface_position indicates the position of an optical surface defined by the surface distance or local coordinate. The data associated with a surface_position are the following:

— surface_distance;

— local_coordinate_transformation.

4.3.10.2 surface_distance

The surface_distance specifies the distance, expressed in millimetres, between an optical surface designated by an optical_surface_identification and the surface which precedes it.

4.3.10.3 local_coordinate_transformation

4.3.10.3.1 General

The local_coordinate_transformation specifies the origin of the local coordinate system and coordinate transformation to locate an optical surface. It is composed of the following detailed data:

— local_coordinate_system_origin;

— coordinate_transformation.

4.3.10.3.2 local_coordinate_system_origin

The local_coordinate_system_origin specifies the origin of the coordinate system for locating an optical surface as an absolute coordinate system or a local coordinate system based on the preceding surface of the designated surface.

4.3.10.3.3 coordinate_transformation

The coordinate_transformation specifies the three-dimensional vector as a coordinate transformation based on the local coordinate system.

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4.3.11 optical_surface_description

4.3.11.1 General

An optical_surface_description is the mathematical expression of an optical surface form. Optical surfaces include an object surface and an image surface. The data associated with an optical_surface_description are the following:

— surface_type;

— surface_expression_parameter.

4.3.11.2 surface_type

4.3.11.2.1 General

The surface_type specifies a type of optical surface form. It is composed of the following detailed data:

— spherical_surface;

— plane_surface;

— general_aspheric_surface;

— conical_surface_with_power_series;

— cylindrical_surface_with_power_series;

— surface_of_revolution;

— user-defined_surface.

4.3.11.2.2 spherical_surface

The spherical_surface specifies a spherical optical surface that is parameterized by the curvature or the radius of curvature.

4.3.11.2.3 plane_surface

The plane_surface specifies an optical surface whose radius of curvature is infinity.

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4.3.11.2.4 general_aspheric_surface

The general_aspheric_surface specifies an optical surface based on Formula (1), given in ISO 10110-12:2007, Annex A.

$$z = \frac{\dfrac{x^2}{R_x} + \dfrac{y^2}{R_y}}{1 + \sqrt{1 - (1+\kappa_x)\left(\dfrac{x}{R_x}\right)^2 - (1+\kappa_y)\left(\dfrac{y}{R_y}\right)^2}} + \left(A_4 x^4 + B_4 y^4 + A_6 x^6 + B_6 y^6 + \cdots + C_3 |x|^3 + \cdots + D_3 |y|^3 + \cdots\right) \tag{1}$$

The substitutions $R = R_x = R_y$, $\kappa = \kappa_x = \kappa_y$, and $h = \sqrt{x^2 + y^2}$ give Formula (2):

$$z = \frac{h^2}{R\left[1 + \sqrt{1 - (1+\kappa)\left(\dfrac{h}{R}\right)^2}\right]} + \left(A_3 h^3 + A_4 h^4 + A_5 h^5 + \cdots\right) \tag{2}$$

Formula (3) is equivalent to Formula (2) with curvature substituted for radius.

$$z = \frac{x^2 C_x + y^2 C_y}{1 + \sqrt{1 - (1+\kappa_x)(xC_x)^2 - (1+\kappa_y)(yC_y)^2}} + \left(A_4 x^4 + B_4 y^4 + A_6 x^6 + B_6 y^6 + \cdots + C_3 |x|^3 + \cdots + D_3 |y|^3 + \cdots\right) \tag{3}$$

The substitutions $C = C_x = C_y$, $\kappa = \kappa_x = \kappa_y$ and $h = \sqrt{x^2 + y^2}$ give Formula (4):

$$z = \frac{h^2 C}{1 + \sqrt{1 - (1+\kappa) h^2 C^2}} + \left(A_3 h^3 + A_4 h^4 + A_5 h^5 + \cdots\right) \tag{4}$$

4.3.11.2.5 conical_surface_with_power_series

The conical_surface_with_power_series specifies an optical surface based on Formula (5), taken from ISO 10110-12:2007, Annex A.

$$z = c\sqrt{\frac{x^2}{a^2} + \frac{y^2}{b^2} + \left(A_4 x^4 + B_4 y^4 + A_6 x^6 + B_6 y^6 + \cdots + C_3 |x|^3 + \cdots + D_3 |y|^3 + \cdots\right)} \tag{5}$$

The substitutions $a = b$ and $h = \sqrt{x^2 + y^2}$ give Formula (6):

$$z = \frac{c}{a} h + \left(A_3 h^3 + A_4 h^4 + A_5 h^5 + \cdots\right) \tag{6}$$

4.3.11.2.6 cylindrical_surface_with_power_series

The cylindrical_surface_with_power_series specifies an optical surface based on Formula (7), specified in ISO 10110-12:2007, Annex A.

$$z = \frac{u^2}{R_u\left[1 + \sqrt{1 - (1+\kappa_u)\left(\dfrac{u}{R_u}\right)^2}\right]} + \left(A_4 u^4 + A_6 u^6 + \cdots + C_3 |u|^3 + \cdots\right) \tag{7}$$

where u represents x or y.

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Formula (8) is equivalent to Formula (7) with curvature substituted for radius.

$$z = \frac{u^2 C_u}{1+\sqrt{1-(1+\kappa_u)u^2 C_u^2}} + \left(A_4 u^4 + A_6 u^6 + \cdots + C_3 |u|^3 + \cdots\right) \tag{8}$$

where u represents x or y.

4.3.11.2.7 surface_of_revolution

The surface_of_revolution specifies an optical surface based on Formula (9), taken from ISO 10110-12:2007, Annex A.

The surface_of_revolution is represented by Formula (9) when the defining curve lies on the xz plane and the rotating axis is parallel to the x axis.

$$z = R_y \mp \sqrt{\left[R_y - g(x)\right]^2 - y^2} \tag{9}$$

$$g(x) = \frac{x^2}{R_x\left[1+\sqrt{1-(1+\kappa_x)\left(\frac{x}{R_x}\right)^2}\right]} + \left(A_4 x^4 + A_6 x^6 + \cdots + C_3 |x|^3 + C_5 |x|^5 \cdots\right) \tag{10}$$

The surface_of_revolution is represented by Formula (11) when the defining curve lies on the yz plane and the rotating axis is parallel to the y axis.

$$z = R_x \mp \sqrt{\left[R_x - g(y)\right]^2 - x^2} \tag{11}$$

$$g(x) = \frac{y^2}{R_y\left[1+\sqrt{1-(1+\kappa_y)\left(\frac{y}{R_y}\right)^2}\right]} + \left(B_4 y^4 + B_6 y^6 + \cdots + D_3 |y|^3 + D_5 |y|^5 \cdots\right) \tag{12}$$

4.3.11.2.8 user-defined_surface

The user-defined_surface specifies an optical surface form expressed by an external definition.

4.3.11.3 surface_expression_parameter

4.3.11.3.1 General

The surface_expression_parameter specifies a parameter set for each surface type to express an optical surface form. The data are composed of the following detailed data:

— radius;

— curvature;

— x_radius;

— x_curvature;

— y_radius;

— y_curvature;

— conic_constant;

— x_conic_constant;

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