The Radiological Society of North America

The American College of Radiology

3D Printing Registry

Data Dictionary

July 22, 2020

Revisions

Date	Description of Revisions
June 23, 2020	Original issue
July 13, 2020	Printer technology changes on Formiga P 110 Velocis, P 396
July 22, 2020	Added field 103.1 “Case Year”

Contents

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1. Case Identifiers

101 NRDR facility ID

This is a code which uniquely identifies the facility uploading the given case. These codes are assigned by ACR at the time of facility registration.

Usage: Auto-generated by NRDR.

Permitted values: Not applicable.

102 NRDR case ID

This field is populated by the NRDR portal.

Usage: Auto-generated by NRDR.

Permitted values: Not applicable.

103 Institution case identifier

This is a unique identifier for the given case, and is to be generated by the contributing facility (and institutional IRB, if applicable). Protected Health Information (including actual or hashed Medical Record Number, Social Security Number, etc.) should not be used to construct the case identifier. Each facility is responsible for keeping its own local, secure record of the mapping from the submitted case identifier to the local identifier(s).

Usage: Required.

Permitted values: any alphanumeric string as described under “Institution case identifier” above, up to 255 characters in length.

103.1 Case Year

The calendar year of the given case. This is defined as the calendar year during which the first 3D print job for the case was started.

Usage: Required.

Permitted values: A single year, ranging from 2015 through the current year.

104 Sex

Usage: Required.

Permitted values: Select one:

- Male
- Female
- Other
- Unknown

1. Case Identifiers

105 For pediatric: <36 weeks gestation

For pediatric patients, this field is used to indicate whether the patient was <36 weeks gestation at birth (in which case the field should be specified as True) or not (in which case, the field should be specified as False). For non-pediatric patients, this field is not applicable.

Usage: Optional.

Permitted values: Select one:

- No
- Yes
- Not applicable
- Unknown

2. Imaging description and indication(s)

Imaging Exams (Data elements 201-209): One or more imaging exams (up to a maximum of 5) may be used to create virtual models.

This section describes the fields used to specify the imaging exam(s) used for this 3D printing case. One or more imaging exams may be specified, up to 5 exams. For each exam, certain fields are used to describe the anatomic area imaged. These anatomic descriptors (i.e. body region, subregion, structure) are described below. For example, a "CT of the chest, abdomen and pelvis with IV contrast" images three body regions: "chest," "abdomen" and "pelvis." As a second example, an "MRI of the upper extremity (elbow) without IV contrast" images the subregion "elbow" in the body region "upper extremity." As a third example, an "MRI of the pelvis (prostate) with IV contrast" images the structure "prostate" in the body region "pelvis."

Note that these anatomic descriptors appear again later in the data dictionary, with regard to the specific parts of a printed model. The same system of three fields (i.e. body region, subregion, structure) is referenced again to describe printed parts. However, for a given case, those fields do not necessarily have the same values as those used here to describe imaging exams. That is, the anatomic parts printed may not be exactly the same as the anatomic area imaged. For example, whereas the imaging exam "CT of the abdomen and pelvis with IV contrast" scans the body regions "abdomen" and "pelvis", this exam could be used to create a printed representation of the liver (body region "abdomen" and structure "liver").

201 Patient age at exam

The patient's age at the time of the imaging exam, using an integer number of years and disregarding any period since the last birthday. For a pediatric patient 23 months old, indicate age 1. For a pediatric patient less than 1 year old, indicate age 0. If the patient's age is 90 years or greater, or if the patient's age is unknown, indicate Null and refer to field 202 (Patient age not reported).

Usage: Required if Patient age not reported (202) = Null; not applicable otherwise.

Permitted values: an integer between 0 and 89.

202 Patient age not reported

Usage: Required if Patient Age (201) = Null; not applicable otherwise.

Permitted values: Select one:

- 1 = Patient's age is 90 or above
- 2 = Patient's age is unknown

203 Modality

Usage: Required.

Permitted values: Select one:

- CT
- MRI
- NM
- SS (surface scanning)
- US
- rXA (rotational angiography)
- Other

2. Imaging description and indication(s)

Imaging Exams (Data elements 201-209): One or more imaging exams (up to a maximum of 5) may be used to create virtual models.

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204 Modality, other, specify

Usage: Required if "other" is selected for Modality (203); not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

2. Order: Consists of imaging exams(s) and indication(s)

Body area (Data elements 205-207): Consists of region, subregion and specific anatomic structures; one or more contiguous regions with optional subregions (up to a maximum of 5 region / subregion combinations) may be provided.

205 Region – Order

Region is intended to serve as a broad indicator of body area, similar to the terms used at many institutions for the area imaged by a particular imaging exam. The list of regions is constrained to the following nine terms: head, neck, chest, abdomen, pelvis, spine, breast, upper extremity, lower extremity.

Usage: Required.

Permitted values: See Appendix A, Anatomy

206 Subregion - Order

Subregion applies to selected regions only, and serves to provide greater anatomic specificity with regard to the area of interest. For example, the region “upper extremity” is associated with the following subregion options: shoulder, upper arm, elbow, forearm, wrist, hand. As another example, the region “head” is associated with the following subregion options: orbit, face, skull base, craniofacial, brain. As a third example, the region “spine” is associated with the following subregion options: cervical, thoracic, lumbar, sacrococcygeal.

Usage: Optional.

Permitted values: See Appendix A, Anatomy

207 Structure

Structure may be relevant for an imaging exam, such as when a particular protocol focuses on a specific anatomic structure. For example, a renal protocol CT could be specified using the value "Kidney" for this field.

Usage: Optional.

Permitted values: Select one from Appendix A, Anatomy.

208 Intravenous contrast

Usage: Optional.

Permitted values: Select one:

- With contrast
- Without contrast
- With and without contrast

2. Order: Consists of imaging exam(s) and indication(s)

Indication(s) (Data elements 210-214): The indication or diagnosis which constitutes the most significant reason for creating this 3D printed model. One or more (up to a maximum of 5) indications may be provided.

209 Oral contrast

Usage: Optional.

Permitted values: Select one:
- With contrast
- Without contrast

210 System

Usage: Required.

Permitted values: See the column labeled “System” in Appendix B, Diagnosis

211 System, other, specify

Usage: Required if “other” is selected for System (210); not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

212 Diagnosis

In some cases, more specific terms as well as more generic terms will be available (e.g., "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

Usage: Required

Permitted values: See the column labeled “Diagnosis” in Appendix B, Diagnosis

213 Diagnosis, other, specify

Usage: Required if “other” is selected for Diagnosis (212); not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

214 Primary diagnosis

Usage: Optional.

Permitted values: Select one. Only one diagnosis can be selected as primary:
- Yes
- No

3. Digital Modeling (i.e. surface mesh modeling)

Section 3 may be considered in two portions. First, fields 301 to 312 capture information about the type and purpose of the 3D printed object, what clinical service ordered the object, and how the digital modeling was performed. Second, fields 313 through 320 are used to describe the part(s) that make up the object. Regarding these parts, for anatomic models the relevant fields are 313 to 316, plus 319 to 320. For anatomic guides, the relevant fields are 317 to 320. See below, and the description for field 301, for more detail about anatomic models and anatomic guides.

Anatomic model: The part(s) are specified using fields 313 to 316, plus 319 to 320. Note that fields 317 to 318 are not applicable for anatomic models. At least one part must be provided, with a maximum of 20. In models with multiple parts, the dominant part must be listed first. Each part is specified using a system of attributes (i.e. region, subregion, structure, laterality, comment) and as enumerated in Appendix A. In general, a part will be specified using a combination of region, subregion and structure terms. For example, a model of the bony skull base would be described with region “Head”, subregion “Skull base” and (generic) structure “Bone”. However, subregion is often not used. For example, a model of the prostate would be described with region “Pelvis” and structure “Prostate”.

Laterality is always relevant for structures in the extremity or breast, and sometimes relevant in other regions. For example, a model of the right humerus would be described with region “Upper extremity”, subregion "Upper arm", structure “Bone” and laterality “Right”. A model of a tumor in the left breast would be described with region “Breast”, structure “Tumor” and laterality “Left”.

In cases where the field descriptors do not uniquely distinguish structures, the comment field (field 320) is used to further clarify. For example, a model of the right tibia and fibula would be described as:

a) Region “Lower extremity”, subregion “Lower leg”, structure “Bone”, laterality “Right” and comment “Tibia”
b) Region “Lower extremity”, subregion “Lower leg”, structure “Bone”, laterality “Right” and comment “Fibula”

In a few selected instances, omitting the structure term will still describe a printable part. For example, region “Chest” with subregion “Chest wall” can describe a valid part. Even though the chest wall is composed of many constituent types of tissue (e.g. ribs, muscles, nerves), taken as a whole the chest wall is a segmentable structure that may correlate with a single surface mesh. In such cases, at least a subregion is required. Only subregions “Heart”, “Chest wall” and “Brain” may be used in this way. In these cases, a specific structure is not necessarily required, and the region and subregion may suffice.

Anatomic guide: The part(s) are specified using fields 317 to 320. Note that fields 313 to 316 are not applicable for anatomic guides. At least one part must be provided, with a maximum of 15. Because guides do not represent anatomic structures directly, but rather represent pieces designed to fit against anatomic structures, the method of specifying parts is different than that for anatomic models. Guide parts are selected from a relatively short list (as shown in field 317). While these terms are anatomic, they are meant to correspond to pieces designed for use in relation to the named anatomy. For example, a guide part “Fibula” indicates a part designed to fit the fibula.

Note that fields 319 (laterality) and 320 (comment) may be relevant for guide parts. A left fibular guide should be described with part “Fibula” and laterality “Left”. If a guide in a single area consists of multiple, separately engineered parts, then the comment field is used to distinguish these parts.

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

301 Type of 3D printed object

The registry is designed to collect information on 3D printed objects which may be classified as either anatomic models or anatomic guides. For the purposes of the registry, this distinction is primarily based on what is represented by the printed object, not on the usage of that object.

An anatomic model is defined as an object which reflects only or primarily the patient's anatomy. A printed object based purely on anatomic structures segmented from imaging exams is considered an anatomic model. However, minor manipulations or modifications to the patient's anatomy may not preclude the model from being considered an anatomic model. Such alterations include fracture fragment reduction, mirror imaging of anatomic structures, or alteration of a pathologic structure in order to restore a more normal appearance (sometimes referred to as "perfected anatomy"). For example, manipulation of segmented bony fragments to produce a printed representation of fracture reduction is considered an anatomic model. A printed anatomic object, even if used as part of an intervention (e.g. a mandibular model used for bending a fixation plate) is still considered an anatomic model.

In addition, certain engineered elements may also be present in an anatomic model, if used only for support or part connections. For example, a model of the bones of the foot with cylindrical connectors added between bones to maintain alignment in the printed object, would still be considered an anatomic model. In addition, a vascular model which incorporates augmentation of material at branch points for mechanical strength would be considered an anatomic model.

Anatomic guides, on the other hand, are defined as objects which include engineered features as primary design elements. These engineered features are typically created using geometric primitives, and combined with anatomic features using functions such as Boolean set operations. For example, bone drilling guides may include plates and flanges as primary design elements, and are considered anatomic guides.

Usage: Required.

Permitted values: Select one:

- Anatomic model
- Anatomic guide

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

302 Purpose of anatomic model

Usage: Required if “Type of 3D printed object” (301) = “Anatomic model”; not applicable otherwise.

Permitted values: Select all that apply:

- Planning: Use of the model for surgical planning, or planning of some other interventional procedure. Examples of such use include, but are not limited to, the following: Use of a model to confirm a surgical plan, to select a surgical approach, to optimize patient positioning, to refine a planned surgical maneuver, or to determine the extent of a surgical resection.
- Simulation: Use of the model to conduct trials of a planned intervention, such as using an in vitro setup. For example, the use of a luminal model of an aortic aneurysm as part of a benchtop setup in order to test the deployment of endovascular devices would constitute a simulation usage of the model.
- Templating: Use of the model to select the sizes or types of implants or other devices. For example, the use of a cardiac model to select the size and type of a valve prosthesis would be a templating usage of the model.
- Collaboration: Use of the model to communicate with other care providers about the patient, diagnosis or intervention. Such communication may be among the members of a single subspecialty team, or may be among members of an interdisciplinary team.
- Other

303 Purpose of anatomic model, other, specify

Usage: Required if “Purpose of anatomic model” (302) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

304 Type of anatomic guide

Usage: Required if “Type of 3D printed object” (301) = “Anatomic guide”; not applicable otherwise. Note that the pre-operative or intra-operative use of a printed anatomic model does not cause it to be considered an anatomic guide. For example, the use of a printed cardiac model to select the size of a valve prosthesis does not cause the printed object to be considered an anatomic guide.

Permitted values: Select all that apply:

- Cutting guide: May include design elements such as plates, struts, slots or flanges to accommodate and guide surgical tools. May be applied to bone or other tissues. Note that drilling guides are considered a subtype of cutting guides. Examples of cutting guides include: osteotomy guide, pedicle drilling guide, incision guide, organ cutting guide.
- Positioning guide: Designed for alignment of structures such as anatomic fragments, cut segments of anatomy or implant components. Examples include: trauma reduction guide, acetabular cup placement guide, mandibular segment alignment guide.
- Contour guide: When a normalized or mirror-imaged anatomic structure has been used to create an external reference, framework or template for the reconstruction of an organ of interest, this is considered a contour guide. These guides are used to permit fitting to a surface or filling a defect. For example, at breast reconstruction, a mirror image of the normal contralateral breast could be used to create a reference geometry for symmetric reconstruction of the ipsilateral breast. Note that such mirror imaging in itself would not constitute a guide, but rather it is the addition of engineered features (such as flanges, plates, struts or latticework) to the mirrored anatomy that makes this a contour guide.
- Hardware bending guide: A hardware bending guide is a representation of the hardware itself, not simply an anatomic surface to which to bend the hardware. A model of the mandible, to which a fixation plate is bent, would be considered by the registry to be an anatomic model not a guide. However, a 3D printed model of the bent plate itself would be considered a hardware bending guide.
- Trajectory guide: May include design elements such as plates, struts, flanges, latticework, clips or receptacles to accommodate tools or devices. Examples include: biopsy guide, probe placement guide, deep brain stimulator electrode placement guide (including 3D printed stereotactic head frames for such electrode placement).
- Other: Guide not listed above.

305 Type of anatomic guide, other, specify

Usage: Required if “Type of anatomic guide” (304) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

306 Was the underlying anatomy used to create this guide also printed as an anatomic model?

Usage: Required if “Type of 3D printed object” (301) = “Anatomic guide”; not applicable otherwise.

Permitted values: Select one:

- No
- Yes

307 Ordering service

The clinical service which requested this 3D printed model. One or more (up to a maximum of five) ordering service / ordering service sub-category combinations must be provided.

Usage: Required.

Permitted values: Select one or more (up to five) from Appendix C, Ordering Services. The same ordering service may be selected more than once, with different ordering service sub-categories (308).

308 Ordering service sub-category

Usage: Required.

Permitted values: Select one sub-category of the selected ordering service (307). Refer to Appendix C, Ordering Services.

309 Segmentation software

Usage: Optional.

Permitted values: Select one or more (up to five) from Appendix D, Digital Modeling Software.

310 Segmentation software, other, specify

Usage: Required if “Segmentation software” (309) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

311 CAD modeling software

The software application(s) used to create this virtual model. One or more applications may be specified using a drop down menu, including "Other" in which case the name of the application may be entered as free text.

Usage: Optional

Permitted values: Select one or more (up to five) from Appendix D, Digital Modeling Software.

312 CAD modeling software, other, specify

Usage: Required if “CAD modeling software” (311) = “Other”; not applicable otherwise

Permitted values: Text, up to 255 characters in length.

313 Region – Anatomic model

Region is intended to serve as a broad indicator of body area, similar to the terms used at many institutions for the area imaged by a particular imaging exam. The list of regions is constrained to the following 9 terms: head, neck, chest, abdomen, pelvis, spine, breast, upper extremity, lower extremity. If multiple body regions are specified, they must be contiguous.

Usage: Required if “Type of 3D printed object” (301) = “Anatomic model”; not applicable otherwise

Permitted values: Select one from Appendix A, Anatomy.

314 Subregion – Anatomic model

Subregion serves to identify a more specific anatomic area within a given region. Not all regions have subregions, and not all structures fall within a subregion. However, subregions can be used to improve the specificity of the part. For example, a bony model of the skull base would specify region “head” subregion “skull base” and structure “bone.”

Usage: Optional if “Type of 3D printed object” (301) = “Anatomic model”; not applicable otherwise

Permitted values: Select one from Appendix A, Anatomy.

3. Digital Modeling (i.e. surface mesh modeling)

Refer to page 11 for further explanation of the data elements on this page.

315 Structure

Each structure selected for a given case indicates a particular part in the 3D printed model. Some structure terms are region and subregion independent (e.g., artery, vein, bone). Other structure terms are relevant for multiple regions or subregions, though not all (e.g., aorta). Still other structure terms are relevant for only a single particular region or subregion (e.g., left ventricle).

Usage: Required if “Type of 3D printed object” (301) = “Anatomic model”; not applicable otherwise.

Permitted values: Select one from Appendix A, Anatomy.

316 Structure, Other

This field should only be used if Appendix A does not list terms that can be used to describe the part in question. Note that parts with detailed anatomic names (e.g. subclavian artery, or scaphoid bone, or ulnar nerve, or hepatocellular carcinoma) do not qualify for use of this field. These parts should be identified using the terms “artery”, “bone”, “nerve” and “tumor” respectively in field 315.

One example which would require use of this field is a part which represents an existing implanted device. For example, a part which represents a metal fixation rod in the lumbar spine could be described using the region “Spine” in field 313, the subregion “Lumbar” in field 314, the value “Other” in field 315, and the value “Metal rod” in field 316. Note that this example refers to an implant already in place. This does not refer to parts that are 3D printed during this episode of clinical care which are meant to be implanted within the patient. The registry does not at present collect information about 3D printed parts intended for implantation.

Usage: Required if “Structure” (315) = “Other”; not applicable otherwise

Permitted values: Text, up to 255 characters in length.

3. Digital Modeling (Computational or surface mesh model)

Refer to page 11 for further explanation of the data elements on this page.

317 Guide part

Usage: Required if “Type of 3D printed object” (301) = “Anatomic guide”; not applicable otherwise.

Permitted values: Select as many as apply (up to 15 parts):

- Aorta
- Arteries
- Cardiac Valves
- Cervical Spine
- Dental
- Femur
- Fibula
- Foot
- Hand/Carpus
- Heart
- Humerus
- Lumbosacral Spine
- Mandible
- Maxillae
- Mouth/Soft Palate
- Orbits
- Pelvis
- Radius
- Scapula
- Skull
- Thoracic Spine
- Tibia
- Trachea
- Ulna
- Veins
- Other

318 Guide part, other specify

Usage: Required if “Part” (317) = “Other”.

Permitted values: Text, up to 255 characters in length.

3. Digital Modeling (Computational or surface mesh model)

Refer to page 11 for further explanation of the data elements on this page.

319 Anatomic part – Laterality

Laterality is relevant for any structure in an extremity or breast, as well as selected other regions or subregions.

Usage: Required.

Permitted values: Select one:

- Left
- Right
- Bilateral
- Left side mirror imaged to right
- Right side mirror imaged to left
- Not applicable

320 Anatomic part - Comment

A comment field may be used on a per-part basis to clarify the part in question. This is especially important, and thereby required, when the attributes used for two or more parts are indistinguishable. For example, consider an object which includes separately segmented models of the right radius and ulna. Each could be indicated by the attribute values: {Region: upper extremity; Subregion: forearm; Structure: bone; Laterality: right}. A comment on each part is then used to clarify, leading to the following part specifiers:

{Region: upper extremity; Subregion: forearm; Structure: bone; Laterality: right; Comment: Radius}
{Region: upper extremity; Subregion: forearm; Structure: bone; Laterality: right; Comment: Ulna}

Usage: Required if 2 or more anatomic parts are entered with identical attributes; optional otherwise.

Permitted values: Text, up to 255 characters in length.

4. Printer

Each site uses the data fields in this Section to build a library of on-site 3D printers. This will generally be done once at the time of initial enrollment in the registry. This list may subsequently be expanded if new printers are installed. Note that these fields are not specified with each registry case submission. Rather, each case refers to one or more printers using the Label associated with each machine.

These fields define a single printer, corresponding to a specific physical device. If a facility operates multiple machines of the same make and model, then each machine is specified separately, each with a Label unique within the site. Note that while these labels can be descriptive of the specific machine, they should not include any indicator of the site itself. For example, suppose a facility operates three machines, all of the same make and model. These might be assigned Label's such as "Make-Model-1", "Make-Model-2" and "Make-Model-3". However, a Label such as "St-Elsewhere-Make-Model-1" should not be used. The only mechanism for facility identification is the (anonymized) NRDR facility ID.

The printers listed in Appendix E are provided as predefined options for users to select when adding to the facility's printer library. If the printer in question has its manufacturer listed in Appendix E, but not its model, then use field 402 to select the manufacturer, specify "other" in field 404, and use field 405 to enter the model name. If the printer manufacturer in question is not listed here, then specify "other" in field 402, use field 403 to enter the manufacturer name, specify "other" in field 404 and use field 405 to enter the model name.

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401 Label

A name defined by the user. Must uniquely identify a printer.

Usage: Required.

Permitted values: Text, up to 255 characters in length.

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402 Manufacturer

Usage: Required.

Permitted values: Select one from Appendix E, Printer Manufacturers.

---

403 Manufacturer, other, specify

Usage: Required if "Manufacturer" (402) = "Other"; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

---

404 Model

Usage: Required.

Permitted values: Select one from Appendix E, Printer Manufacturers.

4. Printer

Refer to page 19 for further explanation of the data elements on this page.

405 Model, other, specify

Usage: Required if “Model” (404) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

406 Technology

Usage: Required.

Permitted values: Select one:

- Material extrusion
- Vat photopolymerization
- Material jetting
- Powder bed fusion
- Sheet lamination
- Binder Jetting
- Directed energy deposition
- Other

407 Technology, other, specify

It is expected that this field should be needed very rarely, if ever. In general, it is expected that the technology type of a given printer should be one of the seven standard terms (not “other”) listed for field 406.

Usage: Required if “Technology” (406) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

501 Anatomic parts

A model consists of some subset of the parts created in Section 3, Digital Modeling.

Usage: Required.

Permitted values: Select all that apply from the anatomic parts created in Section 3, Digital Modeling.

502 Print model scale

A floating point number which indicates the size of the model relative to true anatomic size. A value of 1 indicates true anatomic size, a value of 0.5 indicates a half-size model, and a value of 2 indicates a model which is twice the anatomic size.

Usage: Required.

Permitted values: a number between 0.1 and 9.9 in n.n format.

503 Printer

The 3D printer on which this model is printed.

Usage: Required.

Permitted values: Select one from the Printer Dictionary.

504 Primary material

The source material used to create the given print. When the model material and support material are the same, then these should all be included as “primary material.”

Usage: Required.

Permitted values: Select one from Appendix G, Material.

505 Primary material, other, specify

Specify the primary material used.

Usage: Required if “Primary material” (504) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

506 Amount of primary material used

The amount of source material used to create the given print. While a select few printers are capable of using multiple source materials simultaneously, this field is intended to capture the total, aggregate amount of source material used in mL or grams.

Usage: Required.

Permitted values: a number between 0.1 and 15,000.0 mL or 0.1 and 15,000 g in nnnnn.n format.

507 Amount of primary material used – unit of measure

Indicate whether the amount or primary material used is reported in milliliters or grams.

Usage: Required.

Permitted values: Select one:

- mL
- g

508 Was support material different from primary material?

Note that if the support material is the same as the primary material, then the amount of support material used should be included in the amount of primary material used. In such cases, no separate accounting of support material should be provided.

Usage: Required.

Permitted values:

- Yes
- No

509 Support material

Indicate the support material used.

Usage: Optional if “Was support material different from primary material?” (508) = “Yes”; not applicable otherwise.

Permitted values: Select one from Appendix G, Material.

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

510 Support material, other, specify

Specify the support material used.

Usage: Optional if “Support material” (509) = “Other”; not applicable otherwise.

Permitted values: Text, up to 255 characters in length.

511 Amount of support material used

Amount of support material used in mL or g.

Usage: Optional if “Was support material different from primary material?” (508) = “Yes”; not applicable otherwise.

Permitted values: a number between 0.1 and 15000.0 in nnnnn.n format.

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

Fields 512 through 518 ask about the physical properties of the 3D printed object, not about the capabilities of a given printer. For example, consider field 512 regarding optical properties. If a printer capable of creating transparent models is used to create an opaque object, then the response for field 512 should be opaque.

512 Optical

Usage: Required.

Permitted values: Select one:

- Transparent
- Opaque
- Semi transparent
- Unknown

513 Stiffness

Usage: Required.

Permitted values: Select one:

- Soft
- Medium
- Rigid
- Unknown

514 Multi-color

Usage: Required.

Permitted values: Select one:

- No
- Limited discrete palette
- Full color
- Unknown

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

Fields 512 through 518 ask about the physical properties of the 3D printed object, not about the capabilities of a given printer. For example, consider field 512 regarding optical properties. If a printer capable of creating transparent models is used to create an opaque object, then the response for field 512 should be opaque.

515 Multi-material

Note that "Yes" values are intended to refer specifically to printers capable of printing in multiple materials based on a limited set of source materials, and where this capability has been used for the given model. If a single-source-material printer is used, and the source material is changed during the printing process, then the response to this field should be "No".

Usage: Required.

Permitted values: Select one:

- No
- Yes
- Unknown

516 Metal

Indicates whether this object was printed using a metallic material.

Usage: Required.

Permitted values: Select one:

- No
- Yes
- Unknown

517 Biocompatible

While biocompatibility may carry different levels of meaning (e.g., safe for limited temporary patient contact, versus safe for long-term implantation), here these levels are grouped together. A value of "yes" should be used whenever a model is created from materials deemed safe for some level of patient contact, and the model is intended for such contact.

Usage: Required.

Permitted values: Select one:

- No
- Yes
- Unknown

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

Fields 512 through 518 ask about the physical properties of the 3D printed object, not about the capabilities of a given printer. For example, consider field 512 regarding optical properties. If a printer capable of creating transparent models is used to create an opaque object, then the response for field 512 should be opaque.

518 Sterilized

Indicates whether this 3D printed object is intended for sterilization before use.

Usage: Required.

Permitted values: Select one:

- No
- Yes
- Unknown

5. 3D Printed Model

In many cases, only a single model will be specified, consisting of all of the created parts. In other cases, however, different models containing different subsets of parts may be printed. The registry supports up to a maximum of 5 models per case.

519 Print time - hours

The time of the 3D printer run(s) required to create this model.

Usage: Required.

Permitted values: an integer between 0 and 99.

520 Print time - minutes

The time of the 3D printer run(s) required to create this model.

Usage: Required.

Permitted values: an integer between 0 and 59.

521 Number of copies

Copies indicates the number of instances of the given model created using the printer and materials described by the preceding attributes. If a given model is printed again using a different printer, then a new line in the 3D Printed Model section should be created.

Usage: Required.

Permitted values: an integer between 1 and 10.

6. Procedure

If the 3D printed object is used either in preparation for, or as part of, a surgical procedure or some other interventional procedure, then fields 601 through 603 are used to specify information about that procedure.

601 Type of procedure

Indicates the type of intervention for which the object is intended to assist, if applicable.

Usage: Required if “Type of 3D printed object” (301) = “Anatomic guide”, or if “Type of 3D printed object” (301) = “Anatomic model” AND “Purpose of Anatomic Model” (302) = “Planning”, “Simulation” or “Templating”; optional otherwise.

Permitted values: Select one or more (up to 5) from Appendix F, Procedure Types.

602 Patient age at procedure

The patient’s age at the time of the procedure, using an integer number of years and disregarding any period since the last birthday. For a pediatric patient 23 months old, indicate age 1. For a pediatric patient less than 1 year old, indicate age 0. If the patient’s age is 90 years or greater, or if the patient’s age is unknown, indicate Null and refer to field 603 (Patient age at procedure not reported).

Usage: Required if “Type of Procedure” (601) is selected AND “Patient age at procedure not reported” (603) is not selected; not applicable otherwise.

Permitted values: an integer between 0 and 89.

603 Patient age at procedure not reported

Usage: Required if “Type of Procedure” (601) is selected AND “Patient age at procedure” (602) is not entered; not applicable otherwise.

Permitted values: Select one:

- 1 = Patient’s age is 90 or above
- 2 = Patient’s age is unknown

7. Effort

Fields 701 through 724 capture information about the effort spent on the current 3D printing case. There are four categories of effort (i.e., consultation, segmentation, CAD, and prep/post-processing). Furthermore, for each of these four categories, effort may be expended by either clinicians or non-clinicians. Note that for the purposes of this registry, "clinician" includes individuals with any of the following degrees (MD, DO, DDS, DMD, DPM, OD [doctor of optometry], DC [chiropractor]) as well as other practitioners (i.e., physician assistant, nurse practitioner, clinical nurse specialist, certified registered nurse anesthetist, certified nurse-midwife). This group of "clinicians" is meant to encompass qualified health care providers. On the other hand, the group "non-clinicians" is meant to include staff such as engineers, medical physicists, other scientists, and technologists.

With four categories of effort, and two categories of individuals, this leads to a total of eight kinds of time:

1. Clinician consultation
2. Clinician segmentation
3. Clinician CAD
4. Clinician prep/post-processing
5. Non-clinician consultation
6. Non-clinician segmentation
7. Non-clinician CAD
8. Non-clinician prep/post-processing

Note that each of these kinds of time is specified using a set of 3 data fields: one for hours, one for minutes, and one if the amount of time is unknown. That leads to a total of 24 data fields in this section of the registry.

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

701 Clinician consultation effort - Hours

Effort spent by physicians or other qualified health care providers in consultation with referring providers. Consultation time consists of time spent discussing the model or guide. Such consultation may occur prior to 3D printing, including, for example, discussion of the appropriateness of 3D printing in the given case, or the physical requirements for the object (e.g., material properties, or the need for sterilization). This consultation may also occur after 3D printing, with regard to the completed printed object. For example, there may be a need to communicate with the referring provider about the model orientation, or limitations of the model. The consultation time fields are meant to capture all of the time spent on such discussions.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Clinician consultation effort – Unknown” (703) = False (unchecked); not applicable otherwise. If no time is spent on effort, enter 0 hours, 0 minutes.

Permitted values: Integer between 0 and 999.

702 Clinician consultation effort - Minutes

Usage: Required if “Clinician consultation effort – Unknown” (703) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

703 Clinician consultation effort – Unknown

Check this box (indicate as true) if the clinician consultation effort is unknown.

Usage: Required if “Clinician consultation effort – Hours” (701) or “Clinician consultation effort – Minutes” (702) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

704 Clinician segmentation effort - Hours

Effort spent by physicians or other qualified health care providers on segmentation. Segmentation time consists of time spent constructing a digital model from imaging data. Such time would include time spent deriving an initial surface mesh from an imaging study, as well as modifications to a surface mesh (such as hole-filling and surface smoothing) when such operations are based on the pixel data. This time should not include time for machines or processes to complete without human intervention. For example, the time required for a 3D printing job to complete without human intervention should not be included in any of these time fields. If no time is spent on effort, enter 0 hours, 0 minutes.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Clinician segmentation effort – Unknown” (706) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

705 Clinician segmentation effort - Minutes

Usage: Required if “Clinician segmentation effort – Unknown” (706) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

706 Clinician segmentation effort - Unknown

Check this box (indicate as true) if the clinician segmentation effort is unknown.

Usage: Required if “Clinician segmentation effort – Hours” (704) or “Clinician segmentation effort – Minutes” (705) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

707 Clinician CAD time - Hours

Effort spent by physicians or other qualified health care providers on CAD processing. CAD processing time consists of time spent modifying a digital model using engineering operations. CAD operations are not based directly on pixel data. For example, time spent performing Boolean operations for model trimming or model cutaways should be counted as CAD processing time. In addition, time spent using geometric primitives in conjunction with an anatomic model to produce anatomic guides should also be counted as CAD processing time. This time should not include time for machines or processes to complete without human intervention. For example, the time required for a 3D printing job to complete without human intervention should not be included in any of these time fields.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Clinician CAD time – Unknown” (709) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

708 Clinician CAD time - Minutes

Usage: Required if “Clinician CAD time – Unknown” (709) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

709 Clinician CAD time – Unknown

Check this box (indicate as true) if the clinician CAD time is unknown.

Usage: Required if “Clinician CAD time – Hours” (707) or “Clinician CAD time – Minutes” (708) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

710 Clinician prep / post processing time - Hours

Effort spent by clinicians or other qualified health care providers on print preparation and post processing. Print preparation and post-processing time consists of time spent preparing a model for 3D printing (such as with model orienting and model slicing) and time spent after printing is complete to perform operations such as support material removal, or preparing a printed object for curing. Time required for machines or processes to complete, without human intervention, should not be included in these fields.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Clinician prep /post processing time – Unknown” (712) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

711 Clinician prep / post processing time - Minutes

Usage: Required if “Clinician prep / post processing time – Unknown” (712) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

712 Clinician prep / post processing time - Unknown

Check this box (indicate as true) if the clinician prep / post processing time is unknown.

Usage: Required if “Clinician prep / post processing time – Hours” (710) or “Clinician prep /post processing time – Minutes” (711) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

713 Non-clinician consultation effort - Hours

Effort spent by non-clinicians (such as engineers, imaging scientists, and imaging technologists) on consultation with referring providers. Consultation time consists of time spent discussing the model or guide. Such consultation may occur prior to 3D printing, including, for example, discussion of the appropriateness of 3D printing in the given case, or the physical requirements for the object (e.g., material properties, or the need for sterilization). This consultation may also occur after 3D printing, with regard to the completed printed object. For example, there may be a need to communicate with the referring provider about the model orientation, or limitations of the model. The consultation time fields are meant to capture all of the time spent on such discussions.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Non-clinician consultation effort – Unknown” (715) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

714 Non-clinician consultation effort - Minutes

Usage: Required if “Non-clinician consultation effort – Unknown” (715) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

715 Non-clinician consultation effort – Unknown

Check this box (indicate as true) if the non-clinician consultation effort is unknown.

Usage: Required if “Non-clinician consultation effort – Hours” (713) or “Non-clinician consultation effort – Minutes” (714) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

716 Non-clinician segmentation effort - Hours

Effort spent by non-clinicians (such as engineers, imaging scientists, and imaging technologists) on segmentation. Segmentation time consists of time spent constructing a digital model from imaging data. Such time would include time spent deriving an initial surface mesh from an imaging study, as well as modifications to a surface mesh (such as hole-filling and surface smoothing) when such operations are based on the pixel data. This time should not include time for machines or processes to complete without human intervention. For example, the time required for a 3D printing job to complete without human intervention should not be included in any of these time fields.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Non-clinician segmentation effort – Unknown” (718) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

717 Non-clinician segmentation effort - Minutes

Usage: Required if “Non-clinician segmentation effort – Unknown” (718) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

718 Non-clinician segmentation effort - Unknown

Check this box (indicate as true) if the non-clinician segmentation effort is unknown.

Usage: Required if “Non-clinician segmentation effort – Hours” (716) or “Non-clinician segmentation effort – Minutes” (717) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

719 Non-clinician CAD time - Hours

Effort spent by non-clinicians (such as engineers, imaging scientists, and imaging technologists) on CAD processing. CAD processing time consists of time spent modifying a digital model using engineering operations. CAD operations are not based directly on pixel data. For example, time spent performing Boolean operations for model trimming or model cutaways should be counted as CAD processing time. In addition, time spent using geometric primitives in conjunction with an anatomic model to produce anatomic guides should also be counted as CAD processing time. This time spent should not include time for machines or processes to complete without human intervention. For example, the time required for a 3D printing job to complete without human intervention should not be included in any of these time fields.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minute

Usage: Required if “Non-clinician CAD time – Unknown” (721) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

720 Non-clinician CAD time - Minutes

Usage: Required if “Non-clinician CAD time – Unknown” (721) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

721 Non-clinician CAD time - Unknown

Check this box (indicate as true) if the non-clinician CAD time is unknown.

Usage: Required if “Non-clinician CAD time – Hours” (719) or “Non-clinician CAD time – Minutes” (720) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

7. Effort

Refer to page 29 for further explanation of the data elements on this page.

722 Non-clinician prep / post processing time - Hours

Effort spent by non-clinicians (such as engineers, imaging scientists, and imaging technologists) on print preparation and post processing. Print preparation and post-processing time consists of time spent preparing a model for 3D printing (such as with model orienting and model slicing) and time spent after printing is complete to perform operations such as support material removal, or preparing a printed object for curing. Time required for machines or processes to complete, without human intervention, should not be included in these fields.

For example:

- 0 hour 0 minute
- 1 hour 15 minutes
- 0 hour 30 minutes
- 2 hours 0 minutes

Usage: Required if “Non-clinician prep / post processing time – Unknown” (724) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 999.

723 Non-clinician prep / post processing time - Minutes

Usage: Required if “Non-clinician prep / post processing time – Unknown” (724) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59.

724 Non-clinician prep / post processing time - Unknown

Check this box (indicate as true) if the non-clinician prep / post processing time is unknown.

Usage: Required if “Non-clinician prep / post processing time – Hours” (722) or “Non-clinician prep / post processing time – Minutes” (723) not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

8. User Assessment

The optional assessment questions listed below are intended for clinical users of the 3D printed model or guide. Respondents should answer these questions using the following prompt: "To what extent do you agree or disagree with the following statements about the 3D printed model or guide?"

801 Status of respondent

Usage: Required if any assessment questions (804-811) are answered; optional otherwise.

Permitted values: Select one:

- 1=Attending
- 2=Trainee

802 Trainee PGY year

Usage: Required if "Status of respondent" = "Trainee"; not applicable otherwise.

Permitted values: Integer between 1 and 15.

803 Respondent's clinical service

Usage: Required if any assessment questions (804-811) are answered; optional otherwise.

Permitted values: Select one from Appendix C, Ordering Services.

804 The 3D printed model or guide was easy for me to use.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

8. User Assessment

The optional assessment questions listed below are intended for clinical users of the 3D printed model or guide. Respondents should answer these questions using the following prompt: "To what extent do you agree or disagree with the following statements about the 3D printed model or guide?"

805 Before using the 3D printed model, I was confident in the treatment plan.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

806 After using the 3D printed model, I was confident in the treatment plan.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

807 As a result of using the 3D printed model, the treatment plan was altered or refined.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

8. User Assessment

The optional assessment questions listed below are intended for clinical users of the 3D printed model or guide. Respondents should answer these questions using the following prompt: "To what extent do you agree or disagree with the following statements about the 3D printed model or guide?"

808 Use of the 3D printed model or guide was important in this case.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

809 The quality of the 3D printed model or guide was adequate.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

810 Use of the 3D printed model or guide was compatible with other aspects of my approach to this case.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

8. User Assessment

The optional assessment questions listed below are intended for clinical users of the 3D printed model or guide. Respondents should answer these questions using the following prompt: "To what extent do you agree or disagree with the following statements about the 3D printed model or guide?"

811 Use of the 3D printed model or guide saved me time.

Usage: Optional.

Permitted values: Select one:

- 1=strongly disagree
- 2=disagree
- 3=neutral
- 4=agree
- 5=strongly agree

812 What would you have changed about the model?

Usage: Optional.

Permitted values: Text, up to 1000 characters in length.

813 In my experience, the 3D model or guide saved (number) minutes in the location (operating room, cath lab, etc.)

Usage: Optional.

Permitted values: integers between 0 and 500.

814 In my experience, the 3D model or guide saved (number) minutes in radiation exposure (for interventional patients)

Usage: Optional.

Permitted values: an integer between 0 and 500.

9. Outcome

901 Operative / procedural time - Hours

Operative or procedural time in hours and minutes. For example:

- 1 hour 15 minutes
- 0 hours 30 minutes
- 2 hours 0 minutes

Usage: Required if Operative / procedural time – Unknown (903) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 24. Either Operative / procedural time – Hours (901) or “Operative / procedural time – Minutes” (902) must be greater than 0 if “Operative / procedural time – Unknown” (903) = False.

---

902 Operative / procedural time - Minutes

Usage: Required if “Operative / procedural time – Unknown” (903) = False (unchecked); not applicable otherwise.

Permitted values: Integer between 0 and 59. Either “Operative / procedural time - Hours” (901) or “Operative / procedural time – Minutes” (902) must be greater than 0 if “Operative / procedural time – Unknown” (903) = False.

---

903 Operative / procedural time - Unknown

Check this box (indicate as true) if the operative / procedural time is unknown.

Usage: Required if “Operative / procedural time – Hours” (901) or “Operative / procedural time – Minutes” (902) is not reported; not applicable otherwise.

Permitted values: Checked (true) or unchecked (false).

---

904 Fluoroscopy time

Fluoroscopy time in minutes.

Usage: Optional.

Permitted values: Number between 0 and 100.0 in nnn.n format.

---

905 Blood loss (mL)

Usage: Optional.

Permitted values: Integer between 0 and 5000.

9. Outcome

906 Surgery margin status

Usage: Optional.

Permitted values: Select one:

- Negative margins
- Positive margins
- Indeterminate
- Unknown

Appendix A, Anatomy

NOTES:

1. If multiple body regions are specified, they must be contiguous.
2. For any model which relates to the upper extremity, lower extremity or breast, a laterality specifier (Right or Left) must be specified.

Region	Subregion	Structure
Head		
		Skull
	Orbit	
	Face	
	Skull base	
	Craniofacial	
	Brain	
		White matter
		Gray matter
		Cerebellum
		Ventricles
		Corpus callosum
		Amygdala
		Hippocampus
Neck		
		Thyroid
Chest		
		Lung
		Airway
	Heart	
		Coronary arteries
		Coronary sinus and cardiac veins
		Left atrium (incl. pulmonary veins)
		Left side of hear: LA+LV
		Left ventricle
		Right atrium (incl. vena cavae)
		Right side of heart: RA+RV
		Right ventricle
		Pulmonary arteries
		Ventricular myocardium
		Valves
		Surgical conduit, graft or device
	Chest wall	
Abdomen		
		Liver

Appendix A, Anatomy		
Region	**Subregion**	**Structure**
		Biliary tree
		Portal vein
		Gallbladder
		Adrenal gland
		Kidney
		Ureter
		Pancreas
		Spleen
Pelvis		
		Prostate
		Seminal vesicle
		Uterus
		Cervix
		Ovary
		Testicle
		Bladder
		Urethra
		Vagina
		Penis
Upper extremity		
	Shoulder	
	Upper arm	
	Elbow	
	Forearm	
	Wrist	
	Hand	
Lower extremity		
	Hip	
	Thigh	
	Knee	
	Lower leg	
	Ankle	
	Foot	
Spine		
	Cervical	
	Thoracic	
	Lumbar	

Appendix A, Anatomy		
Region	**Subregion**	**Structure**
	Sacrococcygeal	
Breast		

Region-agnostic (generic) structures
Aorta (Chest, Abdomen, Pelvis only)
Artery
Vein
Collateral vessel
Bone
Nerve
Spinal cord (Neck, Chest, Abdomen, Pelvis only)
Lymphatic
Aerodigestive tract (Head, Neck only)
GI tract (Chest, Abdomen, Pelvis only)
Muscle/tendon
Ligament
Cartilage
Tumor
Skin surface
Soft tissue
Other

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

System	Diagnosis
Neuro/HN/Craniofacial	Skull fracture
	Facial fracture
	Mandibular fracture
	Congenital malformation of skull and facial bones
	Cleft lip and palate
	Ear malformation
	Osteochondroma
	Orbit fracture
	Orbit tumor
	Orbit maxillofacial plating array
	Venous anatomy
	Arterial anatomy, AVM, aneurysm, AVF
	Skull base tumor, pterygopalatine fossa
	Osteochondroplasia
	Dentofacial anomalies including malocclusion
	Other diseases of jaws, mandibular dental tumors
	Temporomandibular joint disorders
	Craniofacial syndrome
	Craniofacial reconstruction
	Benign neoplasm (bone)
	Benign neoplasm (soft tissue)
	Malignant neoplasm (bone)
	Malignant neoplasm (brain)
	Malignant neoplasm (soft tissue)
	Carotid stenosis, bypass, ECA to ICA planning
	Vertebral stenosis, dissection, pseudoaneurysm
	Ventricular anatomy,pathology, procedural simulation
	Dural based masses, resection planning
	Dural venous sinus
	Cavernous sinus, trigmeninal cave, IAC, Jugular foramen
	Parotid mass
	Squamous cell carcinoma Head and Neck
	Larynx and Thyroid
	Craniocervical injury, invagination, settling, cervical fractures, subluxation
	Cord tumors
	Intradural extramedullary spine tumors
	Spine hardware surgical planning, scoliosis, ALIF, TLIF, PLIF, SI fusion
	Tethered cord, syringohydromyelia
	Chiari malformation

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

Cardiac	Atrial septal defect
	Ventricular septal defect
	Atrioventricular canal
	Aortopulmonary window
	Truncus arteriosus
	Partial anomalous pulmonary venous return (PAPVR)
	Total anomalous pulmonary venous return (TAPVR)
	Cor triatriatum
	Pulmonary venous stenosis
	Tetralogy of Fallot
	Tricuspid valve disease and Ebstein's anomaly
	RVOT obstruction and/or pulmonary stenosis
	Hypoplastic left heart syndrome
	Shone's syndrome
	Double inlet left ventricle
	Double inlet right ventricle
	Mitral atresia
	Tricuspid atresia
	Unbalanced AV canal
	Single ventricle
	Congenitally corrected TGA (levo-TGA)
	Transposition of the great arteries (dextro-TGA)
	Double outlet right ventricle
	Double outlet left ventricle
	Cardiac mass
	Ectopia cordis
	Cardiomyopathy
	Coronary arterial anomaly
	Fontan revision
Chest (Non-cardiac)	Lung cancer
	Esophageal neoplasm
	Esophageal atresia
	Tracheobronchial narrowing
	Tracheal atresia
	Bronchoscopy planning
	Mediastinal lesion
	Chest wall reconstruction

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

GI	Liver mass
	Liver transplant
	Biliary stenosis
	Biliary atresia
	Choledocholithiasis
	Choledochal cyst
	Pancreatic mass
	Pancreatitis
	Abdominal hernia
	Duplication cyst
	Inflammatory bowel disease
	Gastric mass
	Small bowel mass
	Colorectal mass
	Mesenteric mass
	Perianal fistula
GU	Urolithiasis
	Renal cancer
	Renal cyst
	Pyelonephritis
	Perinephric abscess
	Lower tract tumors (bladder and urethra)
	Upper tract tumors (pyelocalyceal cavities and ureter)
	Kidney transplant
	Adrenal disease
	Penile cancer
	Testicular cancer
	Prostate cancer
	Ovarian disease
	Uterine and cervical disease
	Vaginal cancer
	Retroperitoneal mass
Breast	Benign breast lesion
	High-risk breast lesion
	Breast cancer

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

MSK	Fracture
	Fracture, chest wall
	Fracture, acute complex long bone
	Fracture, acute complex intra-articular
	Fracture, complex acetabular
	Fracture, complex pelvic
	Fracture, vertebral, non-pathological
	Fracture, vertebral, pathological
	Fracture malunion
	Fracture nonunion
	Heterotopic ossification
	Ligamentous injury
	Hip dysplasia
	Bone/soft tissue neoplasm, with joint and neurovascular involvement
	Bone/soft tissue neoplasm, without joint and neurovascular involvement
	Arthritis
	Scoliosis
	Scoliosis, secondary to congenital vertebral anomaly
	Scoliosis, severe/marked
	Scoliosis, thoracic kyphosis
	Avascular necrosis
	Osteomyelitis

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

Peds	Congenital Airway Malformation
	Congenital Lobar Hyperinflation
	Pulmonary sequestration
	Bronchopulmonary foregut malformation
	Diaphragmatic hernia
	Tracheal anomalies
	Mediastinal mass(anterior, middle and posterior)
	Bronchiectasis
	Mediastinal Vascular ring
	Pulmonary vascular malformation
	Tracheal esophageal fistula
	Duodenal atresia/stenosis/web
	Small bowel/colonic atresia
	Anal atresia
	Biliary atresia
	Choledochal cyst
	GI duplication cyst
	Bowel malrotation
	Hirschsprung's disease
	Cloacal extrophy - including pubic diastasis
	Uterine and vaginal anomalies
	Renal duplication with or without obstruction
	Cystic kidney disease(MCDK, ADPKD, ARPKD)
	Bladder and urethral anomlies
	Renal masses - malignant(Wilms, rhabdoid, clear cell)
	Renal masses - benign
	Neuroblastoma
	Pancreatic anomalies
	Pancreatic mass
	Liver mass - malignant
	Liver mass - benign
	Liver vascular anomaly
	Abdominal pelvic vascular anomalies-congenital and acquired
	Inherited skeletal dysplasia including storage disease
	Non-inherited congenital bony anomaly
	Post traumatic boney deformity(acute and chronic)
	Hip dysplasia/dislocation
	Spinal dysraphism/dysplasia
	Slipped capital femoral epiphysis
	Osteochondritis dissecans
	Metabolic bone disease
	Arthropathies including JRA and hemophilia
	Bone tumors- benign
	Bone tumors - malignant

Appendix B, Diagnoses

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Peds (continued)	Osteomyelitis - acute and chronic
	Brachial plexus and lumbar sacral plexus
	Branchial cleft cyst
	Cleft palate/lip
	Cystic hygroma
	Soft tissue hemangioma
	Retropharyngeal mass including abscess
	Choanal atresia
Vascular	Aortic dissection
	Aortic aneurysm
	Design of patient-specific aortic stent
	Aortic pseudoaneurysm
	Aortic coarctation
	Peripheral aneurysm
	Stenosis
	Vascular malformation
	Varices
	Carotid stenosis
	Carotid dissection
	Carotid pseudoaneurysm
	Carotid post-endarterectomy
	Intracranial stenosis
	Intracranial aneurysm
	Intracranial dural arteriovenous fistula
	Intracranial arteriovenous malformation
	Lymphangioma
	Hemangioma
	Aneurysm
	Dissection
	Stenosis
	Vascular ring
	Kawasaki's disease
	Henoch-Schonlein purpura
	Septic emboli
Obstetrics	

Appendix B, Diagnoses

In some cases, more specific terms as well as more generic terms will be available (e.g. "orbit fracture" vs. "fracture", or "testicular cancer" vs. "malignancy" vs. "mass", or "dissection" vs. "aortic dissection"). Only the most specific applicable term should be selected.

Multisystem	Mass
	Trauma
	Lymphoma
	Sarcoma
	Benign neoplasm
	Malignancy
	Metastatic disease
	Inflammation / infection
	Abscess
	Hematoma

Appendix C, Ordering Services

Medical specialty

Cardiology
Endocrinology
Gastroenterology
Infectious diseases
Internal medicine
Medical oncology
Nephrology
Neurology
Nuclear medicine
Pediatrics
Physical medicine and rehabilitation
Podiatry
Pulmonary medicine
Rheumatology

Surgical speciality

Breast surgery
Cardiothoracic surgery
Colorectal surgery
Dermatology
ENT
General surgery
Hepatobiliary and pancreatic surgery
Neurosurgery
Ophthalmology
Orthopedic surgery
Oral surgery
Pain management
Plastic surgery
Surgical oncology
Transplantation surgery
Trauma surgery
Upper gastrointestinal surgery
Urology
Vascular surgery

Other

Anesthesiology
Dentistry
Interventional radiology
Radiation oncology
Obstetrics and gynecology

Appendix D, Digital Modeling Software

Segmentation Software	CAD Modeling Software
3D Slicer	3D Sprint
4 DICOM	3Ds Max
Amira	3-matic
Brain Lab	Biomesh3D
D2P	Cura
GE Advanced Workstation	Dolphin
iNtuition	Freeform
itk-SNAP	Fusion 360
Mimics Innovation Suite	Magics
Mimics Inprint	Meshlab
OsiriX MD	Meshmixer
Philips Intellispace Portal	Mimics Inprint
Seg3D/	Netfab
Vitrea	Onshape
Other	Proplan
	Rhinoceros
	Simplify 3D
	Solidworks
	TinkerCAD
	Other

Appendix E, Printer Manufacturers

Selected 3D printer manufacturers and models are listed here, along with the corresponding type of 3D printing technology (see also Appendix G). Each participating facility maintains a library of its own printers, using the data fields described in Section 4.

Manufacturer	Model	Technology
3D Systems	ProJet MJP 5600	Material Jetting
	ProJet MJP 2500	Material Jetting
	ProJet MJP 2500 Plus	Material Jetting
	ProJet MJP 2500 IC	Material Jetting
	ProJet MJP 2500W	Material Jetting
	ProJet MJP 3600	Material Jetting
	ProX SLS 6100	Powder Bed Fusion
	sPro 60 HD-HS	Powder Bed Fusion
	sPro 140	Powder Bed Fusion
	sPro 230	Powder Bed Fusion
	ProJet 6000 HD	Vat Photopolymerization
	ProJet 7000 HD	Vat Photopolymerization
	ProX 800	Vat Photopolymerization
	ProX 950	Vat Photopolymerization
	ProJet CJP 860Pro	Binder Jetting
	ProJet CJP 660Pro	Binder Jetting
	ProJet CJP 460Plus	Binder Jetting
	ProJet CJP 360	Binder Jetting
	ProJet CJP 260Plus	Binder Jetting
Carbon	L1	Vat Photopolymerization
	M2	Vat Photopolymerization
	M2d	Vat Photopolymerization
EnvisionTEC	Vida	Vat Photopolymerization
	P4K	Vat Photopolymerization
	3SP	Vat Photopolymerization
	CDLM	Vat Photopolymerization
	3D-Bioplotter	Material Extrusion
	SLCOM	Sheet Lamination
	Viridis3D	Binder Jetting
EOS	Formiga P 110 Velocis	Powder Bed Fusion
	P 396	Powder Bed Fusion
	P 500	Powder Bed Fusion
	P 770	Powder Bed Fusion
	P 800	Powder Bed Fusion
	P 810	Powder Bed Fusion

Appendix E, Printer Manufacturers

Manufacturer	Model	Technology
EOS (continued)	M 100	Powder Bed Fusion
	M 290	Powder Bed Fusion
	M 300-4	Powder Bed Fusion
	M 400	Powder Bed Fusion
	M 400-4	Powder Bed Fusion
	Precious M 080	Powder Bed Fusion
ExOne	Innovent+	Binder Jetting
	X1 25PRO	Binder Jetting
	M-Flex	Binder Jetting
	M-Print	Binder Jetting
	S-MAX Pro	Binder Jetting
	S-Print	Binder Jetting
	S-MAX	Binder Jetting
Formlabs	Form 2	Vat Photopolymerization
	Form 3	Vat Photopolymerization
	Form 3B	Vat Photopolymerization
	Form 3L	Vat Photopolymerization
	Fuse 1	Powder Bed Fusion
HP	Jet Fusion 5200	Powder Bed Fusion
	Jet Fusion 4200	Powder Bed Fusion
	Jet Fusion 540	Powder Bed Fusion
	Jet Fusion 580	Powder Bed Fusion
	Jet Fusion 340	Powder Bed Fusion
	Jet Fusion 380	Powder Bed Fusion
	Metal Jet	Powder Bed Fusion
Makerbot	Method	Material Extrusion
	Replicator+	Material Extrusion
	Replicator Z18	Material Extrusion
Markforged	X3	Material Extrusion
	X5	Material Extrusion
	X7	Material Extrusion
	Onyx One	Material Extrusion
	Onyx Pro	Material Extrusion
	Mark Two	Material Extrusion
	Metal X	Material Extrusion

Appendix E, Printer Manufacturers

Manufacturer	Model	Technology
Mimaki	3DUJ-553	Material Jetting
Raise3D	Pro2	Material Extrusion
	Pro2 Plus	Material Extrusion
Stratasys	F120	Material Extrusion
	F170	Material Extrusion
	F270	Material Extrusion
	F370	Material Extrusion
	F900	Material Extrusion
	Fortus 380 Carbon Fiber Edition	Material Extrusion
	Fortus 380mc	Material Extrusion
	Fortus 450mc	Material Extrusion
	Connex 1 Objet260	Material Jetting
	Connex 1 Objet500	Material Jetting
	Connex 3 Objet260	Material Jetting
	Connex 3 Objet350	Material Jetting
	Connex 3 Objet500	Material Jetting
	J700 Dental	Material Jetting
	J720 Dental	Material Jetting
	Objet1000 Plus	Material Jetting
	Objet260 Dental	Material Jetting
	Objet260 Dental Selection	Material Jetting
	Objet500 Dental Selection	Material Jetting
	Objet30 Dental Prime	Material Jetting
	Objet30 Prime	Material Jetting
	Objet30 Pro	Material Jetting
	J55	Material Jetting
	J750	Material Jetting
	J826	Material Jetting
	J835	Material Jetting
	J850	Material Jetting
	V650 Flex	Vat Photopolymerization
	uPrint SE Plus	Material Extrusion
	Mojo	Material Extrusion
Ultimaker	Ultimaker 2	Material Extrusion
	Ultimaker 2+	Material Extrusion
	Ultimaker 3	Material Extrusion
	Ultimaker S3	Material Extrusion
	Ultimaker S5	Material Extrusion

Appendix E, Printer Manufacturers

Manufacturer	Model	Technology
Other		

Appendix F, Procedure Types

Surgical Procedures for Maternity Care and Delivery
Surgical Procedures on the Auditory System
Surgical Procedures on the Cardiovascular System
Surgical Procedures on the Digestive System
Surgical Procedures on the Endocrine System
Surgical Procedures on the Eye and Ocular Adnexa
Surgical Procedures on the Female Genital System
Surgical Procedures on the Hemic and Lymphatic Systems
Surgical Procedures on the Integumentary System
Surgical Procedures on the Male Genital System
Surgical Procedures on the Mediastinum and Diaphragm
Surgical Procedures on the Musculoskeletal System
Surgical Procedures on the Nervous System
Surgical Procedures on the Respiratory System
Surgical Procedures on the Urinary System

Appendix G, 3D Printing Technologies and Materials

HP's Multi Jet Fusion technology is classified as Powder Bed Fusion for the purpose of this registry.

Technology	Material
Binder Jetting	Gypsum Silicon sand PMMA particle material Stainless steel Ceramics Cobalt-chrome Tungsen-carbide Other
Directed Energy Deposition	Titanium Stainless steel Aluminum Copper Nickel Steel Other
Material Extrusion	Polylactic Acid (PLA) Acrylonitrile Butadiene Styrene (ABS) Nylon Flexible Other
Material Jetting	Rigid Transparent Stainless steel Ceramics Wax Other
Powder Bed Fusion	Nylon Alumide Peek TPU Aluminum Stainless steel Nickel alloys Cobalt-chrome Other
Sheet Lamination	Aluminum Paper Other
Vat Photopolymerization	Standard resin Tough resin Flexible resin Transparent resin Castable Resin Other
Other	Other

Glossary

ACR	American College of Radiology
CT	Computed Tomography
e.g.	For example
HN	Head / neck
i.e.	That is
MRI	Magnetic resonance imaging
NM	Nuclear medicine
NRDR	National Radiology Data Registry
PGY	Post-graduate year
RSNA	Radiological Society of North America
US	Ultrasound