Internet of Production Alliance

Open Know-Where Specification

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1. Introduction

This standard was initiated by the [Internet of Production Alliance](#) and developed by an open-membership working group. It is designed to create a consistent way of documenting and sharing information about manufacturing capabilities to make it easier for people to identify where hardware can be made locally or anywhere in the world.

This specification is designed to be adopted by anyone who collects or shares data about manufacturing capabilities, including governments, non-government organisations (NGOs), aid agencies, mapping communities, makers and platforms. The standard defines data that meets the needs of a broad range of use cases and purposes.

We call this "Open Know-Where".

Adopting the Open Know-Where standard will:

- Improve the discovery of manufacturing facilities and equipment within the manufacturing industry and maker communities.
- Enable someone who wants to access a manufacturing facility to discover who they should be contacting.
- Improve relationships and collaboration between users and networks.
- Make data about the location of manufacturing capabilities more easily discoverable and accessible when needed.
- Enable better curation and management of data, so it can be collated, organised, queried and filtered.
- Enable the curation of tools to extract the maximum value from the data.

Overall, the more universal the standard is, the more useful it will be. The principle is that it is an open standard, whether or not the data it is used to describe is released openly.

The standard covers five concepts (classes) that mapping initatives typically describe. For each concept, we have aimed to standardise the properties to an appropriate level of granularity, which is helping someone to find out where something can be made.

The five classes are:

- Manufacturing Facility
- Agent (Persons and Organisation)

- Location
- Equipment
- Materials

Several aspects of the classes can be standardised through classification and dictionaries. Using this approach means initiatives and manufacturing facilities can more easily share, compare and aggregate data. This is important, as currently there is no way to do this without duplication of field names and data. The ability to easily share data encourages the building of relationships and collaboration between users and networks. This will lead to improved documentation, networking, and discovery of mapping initiatives, manufacturing facilities and equipment within the manufacturing sectors and maker communities.

The intention is for data published under Open Know-Where, to be helpful and informative, rather than authorative. We assume that any procurement resulting from data published under this standard will still involve direct or mediated interaction between the user/buyer and the facility. Future versions of the specification will move towards more rigorous approaches to defining information to enable distributed procurement systems.

The project follows on from the success of the [Open Know-How](#) documentation standard, released in September 2019.

1.1. Scope

This specification defines a standard that provides a mechanism for the discovery and exchange of the location of manufacturing capabilities and where to get something made. This reflects the goal established by the Internet of Production Alliance whose aim is to develop the enabling technologies and infrastructures to support a global move to distributed and local manufacturing.

More information about the Internet of Production Alliance can be found here: https://global.us17.list-manage.com/subscribe?u=9ef0e368cc373faed18dbfc77&id=1e6d61b540

The Open Know-Where specification defines a data model to:

- Document the location of manufacturing capabilities globally.
- Share information about manufacturing facilities and the manufacturing capabilities.
- Improve networking within the manufacturing industry and maker communities.

The Open Know-Where specification provides the level of detail needed for quick and simple documentation of manufacturing capbilites and manufacuting facilities.

Although designed to be used by all, the intended audience is:

- Mappers
- Maker communities
- Governments
- Non-Government Organisations
- Aid Agencies
- Platforms listing local manufacturing capabilities

The standard does not specify a data format or exchange protocols, instead it aims to support the wide range of use cases from spreadsheet-based datasets through to web-based platforms.

1.2. Structure of this Document

This specification is divided into eight main sections:

1. **Introduction** – provides a broad overview of the background, scope and aim of this standard.
2. **Data Model Diagram** – provides an overall view of the Open Know-Where Data Model
3. **Using the Data Model** – provides guidance about how to use the data model, with answers to our most frequently asked questions.
4. **Manufacturing Facility** – defines properties relating to the manufacturing facility. Recommended classifications and formats are also provided for consistency.
5. **Agent** – defines properties relating to people and organisations. Recommended classifications and formats are also provided for consistency.
6. **Location** – defines properties relating to locations. Recommended classifications and formats are also provided for consistency.
7. **Equipment** – defines properties relating to equipment. Recommended classifications and formats are also provided for consistency.
8. **Materials** – defines properties relating to materials. Recommended classifications and formats are also provided for consistency.
9. **Record Data** – defines properties relating to record data. Recommended formats are also provided for consistency.

1.3. Technical Authoring

Technical authoring for version 1.0 has been undertaken by [Barbal Limited](#).

The standard has been developed under the guidance of the Open Know-Where working group following a series of qualitative interviews with members of NGOs, aid agencies, mapping communities, makers and platforms, and analysis into datasets shared by mapping initiatives and organisations. From this initial research, a conceptual data model was developed and circulated to stakeholders for comment. This document is the formalisation of that data model and includes descriptions of each aspect and guidance for how mapping initiatives can adopt the standardised approach it prescribes.

1.4. Working Group Members

The following have contributed directly towards the development of this specification.

Name	Organisation
Andrés Barreiro	Wikifactory
Charles Barrete	Field Ready
Pierre-Alexis Ciavaldini	Makernet
Liz Corbin	Metabolic
Guillaume Coulombe	Fab Labs Québec / Procédurable
Marc-Olivier Duchame	Fab Labs Nation
Andrew Lamb	Field Ready / Internet of Production Alliance
Anna Sera Lowe	Manufacturing Change / Internet of Production Alliance
Bryn John	Field Ready
Ben Oldfrey	UCL
Nathan Parker	MakerNet.work
James Ochuka	Juakali Smart

|	
Alessandra Schmidt	Make Works
Hannah Stewart	RCA / Dark Matter Labs
Aziz Wadi	Field Ready
Anna Waldman-Brown	MIT

More people than those listed here have been consulted, and we still welcome any additional input from anyone who wants to get involved with Open Know-Where.

2. Data Model Diagram

This diagram illustrates the classes, properties and relationships that are introduced in the following main sections.

Whilst the model represents a relational schema between concepts, it is not anticipated that all initiatives would use the whole model. The schema is designed so that individual initiatives can focus only on certain aspects and then data can be aggregated between data sets to create richer, more powerful insight.

For example an initiative to create an open database of equipment capabilities by make and model could be combined with a mapping initiative of maker spaces in a region which lists the make and model of the equipment available to help someone work out where the specific manufacturing processes they need can be accessed.

Open Know-Where data model
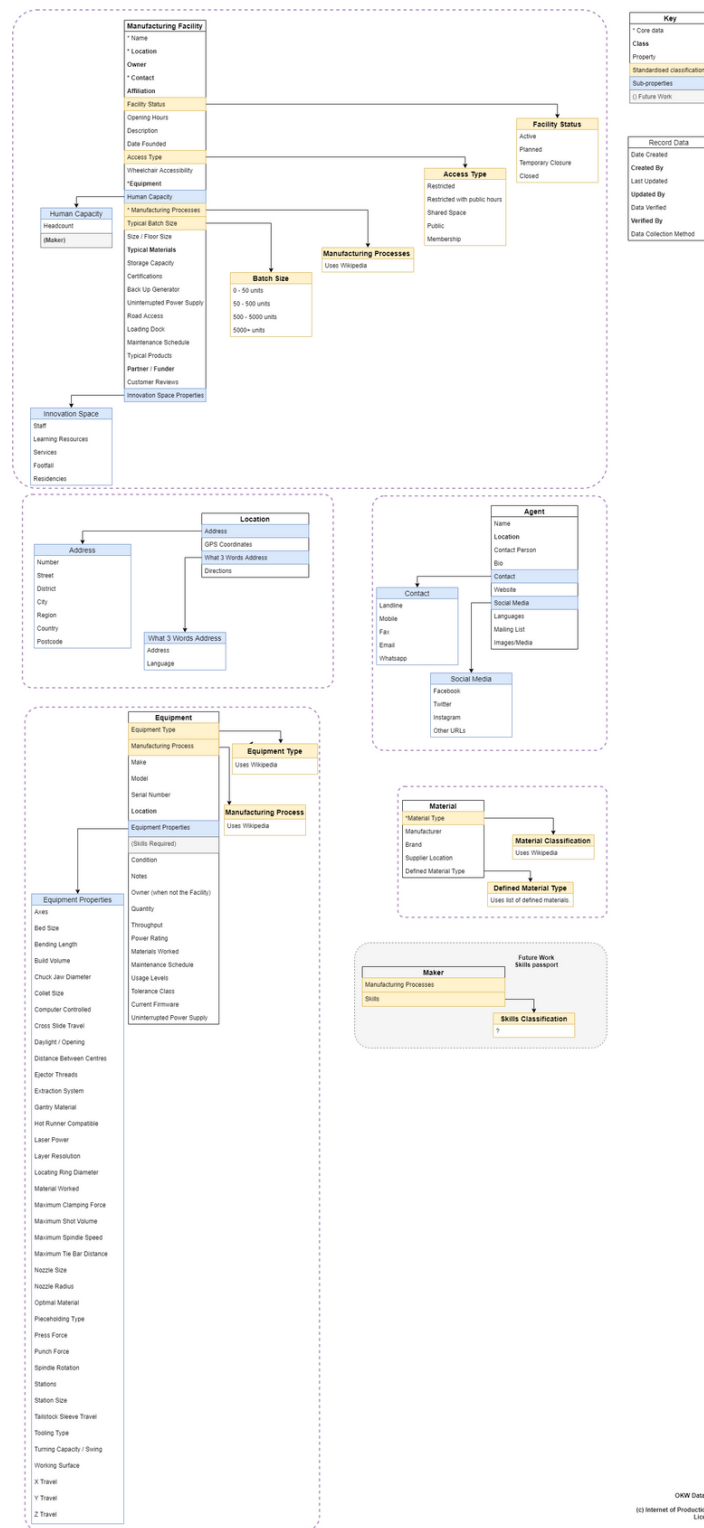
3. Using Open Know-Where

3.1. Can anyone use Open Know-Where?

Anyone can adopt the data model. It has been designed to be applied across a variety of use cases, and provides a level of detail needed for quick and simple mapping and recording of manufacturing capabilities and manufacturing facilities. It can be used by formal and informal organisations, and anyone who is mapping manufacturing capbabilities and manufacturing facilities.

3.2. My resources are only available to members, will I have to give access for free?

No, this standard does not change your access models to your content.

3.3. Is this all about publishing data online?

Not necessarily. The primary purpose of Open Know-Where is to make it easier to share information between mapping initiatives and other entities who can make use of the data. We do not anticipate that many data initiatives will choose to publish all the information openly online and advise mapping initiatives to consider the privacy and security of facilities, organisations and individuals and the permissions (implied or explicit) they have for using the information they have collected or recieved. In some cases it will be prudent to redact information to make is suitable for publishing online, e.g. state the city and not a full address, or provide a login wall to access contact information.

3.4. How is Classification Achieved?

[Naming conventions](#) allow useful information to be deduced from regularity, will prevent confusion among others who are collecting the same or similar data, and make it easier for others to interpret your data.

By using a naming convention such as Wikipedia, the classification simply provides a relevant Wikipedia URL and references the corresponding Wikipedia article to the concept being described. For example, through this way of classification, you can use the corresponding Wikipedia article for a manufacturing process, to define the process capability of a facility. The same can be applied for equipment and materials. This manner of classification makes manufacturing processes, equipment and materials easy to navigate and provides consistency across the classification.

For example, for the metal-joining process of Brazing:

Wikipedia article: https://en.wikipedia.org/wiki/Brazing

3.5. How do I use the classification system?

To aid consistency, Open Know-Where recommends using an existing classification system for Equipment, Manufacturing Processes and Materials. This being Wikipedia.

To classify equipment:

To reference a facility has a piece of equipment, for example a soldering iron, you would simply copy and paste the Wikipedia URL for a soldering iron into the relevant field.

Wikipedia article: https://en.wikipedia.org/wiki/Soldering_iron

To classify a manufacturing process:

To classify a manufacturing process, for example soldering, you would simply copy and paste the relevant Wikipedia URL for soldering into the relevant field.

Wikipedia article: https://en.wikipedia.org/wiki/Soldering

To classify a material:

To reference a material, for example aluminium, you would simply copy and paste the relevant Wikipedia URL for aluminium into the relevant field.

Wikipedia article: https://en.wikipedia.org/wiki/Aluminium

3.6. What data format is the data model designed to support?

The scheme is designed to support any structured data format. There is no recommendation for how the data is stored or transferred.

3.7. Which standards does the specification use?

Rather than creating classifications for Equipment, Manufacturing Processes and Materials we have used Wikipedia as reference.

The specification also references ISO 8601, the format YYYY-MM-DD for date, and ISO 639-2 or ISO 639-3, for example "en-gb", to record Languages.

3.8. Is Open Know-Where compatible with Open Know-How?

Open Know-Where is more detailed than Open Know-How version 1, which only extends as far a signposting the documentation for making things. We anticipate that later versions of Open Know-How will apply the same approach as Open Know-Where for classifying equipment, materials and processes so that the two standards will be fully interoperable.

3.9. What do the properties and sub-properties mean?

This section defines the layout used for defining properties. The list of properties are laid out in sections four, five, six, seven and eight. Each of these sections are navigated by the label assigned to each individual field.

Sub-properties are used to group properties that relate to a specific concept and that might be applicable in specific circumstance (e.g. educational aspects of an innovation space).

For each property, the following specification is given where applicable.

Label	The human readable name assigned to the term.
Fieldname	The standardised computer readable fieldname. Typically this is the label expressed in camel case.
Definition	A statement which represents the concept of the term.
Format	The recommended practice for the field.
Note	Additional points of note.
Example	An illustration of how the term can be used.

3.10. Is the entire specification mandatory?

No aspect of the specification is mandatory. However the more rigourously the specification is followed, the more useful the data will be to others when shared.

The Open Know-Where working group intends to develop implementation guides for specific use cases which may make certain aspects mandatory in certain situations,

e.g. Humanitarian applications may specify that certain formats are used for fields or the Humanitarian Exchange Language (HXL) is used for location.

3.11. Some of my data is sensitive and I don't want to share it.

That's fine. You should make a decision as to whether the information you share will comprimise the trust, privacy or security of the facilities or individuals the information relates to and apply a risk based approach when deciding how you share data and who with.

3.12. Can I use Open Know-Where with spreadsheets?

Absolutely, the standard is designed to work with any structured data format. The design is such that we expect that you will use separate sheets within a workbook for each of the five classes and then use a primary key or other spreadsheet functionality to link between them.

3.13. Which data serialisation format should I use?

Open Know-Where is compatible with any data serialisation format, for example, XML, JSON, and YAML. It may be helpful to speak with who you are exchanging data with to find out which format is most appropriate.

3.14. How does Open Know-Where deal with linked data across datasets?

We have not made any recommendation for how to link related data between datasets, however each class has fields (or combination of fields) which can be used as unique references.

3.15. Will it be a lot of work to revise my existing datasets to be compatible with Open Know-Where?

Possibly. The data model doesn't require you to capture new data, as it is not mandatory to use all the properties, but you may have to restructure your data. The amount of work will be dependent on the size of your datasets.

### 3.16. What if I want to capture information that isn't covered by Open Know-Where?

You are free to extend the fields you use in your own datasets, they just might not be recognised by others. If you think your properties would be a useful addition to the Open Know-Where specification itself for others to use, contact the working group and recommend the additions.

4. Manufacturing Facility Properties

This class incorporates the important properties relating to 'Manufacturing Facility'. By facility we mean the workspace used for manufacturing.

There are many different types of workspaces, ranging from industrial facilities such as factories, to small scale production facilities such as workshops, to makerspaces, even individual craftspeople working from home. The aim of Open Know-Where is to incorporate and capture the properties that are common to all of them, and also to define important fields that are only applicable to certain types of manufacturing facilities. For example, for innovation type spaces we have included sub-properties such as Learning Resources, which is not relevant to all manufacturing facilities but important to those within maker communities.

Where properties are logically grouped, such as 'Human Capacity' and 'Innovation Space Properties', they are presented as collections of sub-properties.
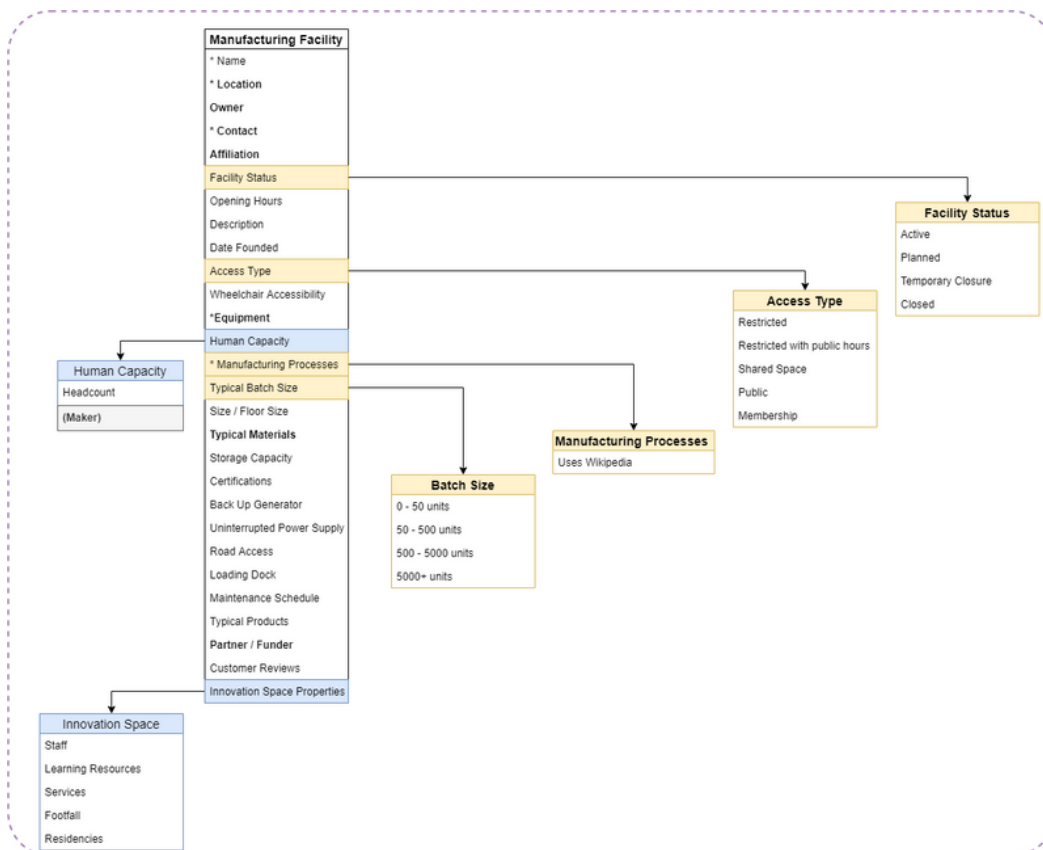
Manufacturing Facility data model

4.1. Name

Definition: Name of the facility.

Format: Provide the name of the facility.

4.2. Location

Definition: Location of the facility.

Format: Uses the Location class.

4.3. Owner

Definition: An Agent who owns or manages the facility.

Format: Uses the Agent class.

4.4. Contact

Definition: An Agent who is the contact for enquiries about making.

Format: Uses the Agent class.

4.5. Affiliation

Definition: The Agent(s) who the manufacturing facility is affiliated with.

Format: Uses the Agent class.

Note: An affiliation can be used to define the facility type, for example an affiliation with FabLabs.org implies that the facility is a FabLab.

4.6. Facility Status

Definition: Status of the facility.

Format: Use of one the following:

- Active
- Planned
- Temporary Closure
- Closed

4.7. Opening Hours

Definition: Hours in which the facility operates.

Format: Free text.

4.8. Description

Definition: Description of the facility.

Format: Free text.

4.9. Date Founded

Definition: Date the facility was founded.

Format: Recommended practice is to use [ISO 8601](#), i.e. the format YYYY-MM-DD.

Note: It is acceptable to include only the Year (YYYY) or year and month (YYYY-MM).

4.10. Access Type

Definition: How the manufacturing equipment is accessed.

Format: Use one of the following:

- Restricted (only certain people (e.g. staff members) can use the equipment)
- Restricted with public hours (the equipment can be used by the public during limited hours)
- Shared space (the facility is a shared workspace where access is by qualifying criteria (e.g. rental of a desk or workspace))
- Public (anyone may use the equipment (e.g. training may be required and other restrictions may apply))
- Membership (access requires membership, which is available to the public or a certain demographic)

Note: For facilities, use this field on a general-terms basis (i.e. if most equipment is available to members, but certain equipment requires staff to operate use Membership). This field can also be used as a property of individual equipment where a facility has different aspect types for different equipment.

4.11. Wheelchair Accessibility

Definition: Whether the manufacturing facility is wheelchair accessible.

Format: Free text.

4.12. Equipment

Definition: The equipment available for use at the manufacturing facility.

Format: List the equipment available using the Equipment **class.**

4.13. Manufacturing Processes

Definition: Typical manufacturing processes undertaken at the facility.

Format: Reference the relevant Wikipedia article.

Note: For instructions how to do this, please see section 3.5.

4.14. Typical Batch Size

Definition: Typical batch size output.

Format: Use one of the following:

- 0 – 50 units
- 50 – 500 units
- 500 – 5000 units
- 5000 + units

4.15. Size / Floor Size

Definition: The size or floor size of a manufacturing facility.

Format: Integer. Unit: square metres (sqm).

Note: This helps a prospective user gauge the scale of a manufacturing facility.

4.16. Storage Capacity

Definition: Storage Capacity of the manufacturing facility.

Format: Free text.

Note: This helps a prospective user gauge how much storage capacity a manufacturing facility has for producing and storing stock.

4.17. Typical Materials

Definition: Typical materials used by the facility.

Format: Uses the Materials **class.**

4.18. Certifications

Definition: Certifications obtained by the facility.

Format: List the certifications.

Note: Knowledge of these is imperative informal manufacturing and procurement. For example, aid agencies would be able to see which manufacturing facilities have particular manufacturing licenses, such as medical manufacturing.

4.19. Backup Generator

Definition: Whether a manufacturing facility has a backup generator.

Format: TRUE / FALSE

Note: Knowledge of this is particiularly useful in places where there are frequent power outages.

4.20. Uninterrupted Power Supply

Definition: Whether a manufacturing facility has an uninterrupted power supply.

Format: TRUE / FALSE

4.21. Road Access

Definition: Whether a manufacturing facility has road access.

Format: TRUE / FALSE

4.22. Loading Dock

Definition: Whether a manufacturing facility has a loading dock.

Format: TRUE / FALSE

4.23. Maintenance Schedule

Definition: The maintenance schedule of a manufacturing facility.

Format: Free text.

4.24. Typical Products

Definition: Typical products produced by the facility.

Format: List the typical products produced.

4.25. Partner / Funder

Definition: The [Agent](#) which partners or funds the facility.

Format: Uses the [Agent](#) class.

4.26. Customer Reviews

Definition: Customer reviews of the facility.

Format: Free text.

4.27. Circular Economy sub-properties

This section relates to Circular Economy. The definition of Circular Economy used can be found [here](#).

4.27.1. Circular Economy

Definition: Whether a manufacturing facility applies Circular Economy principles.

Format: TRUE / FALSE

4.27.2. Description

Definition: Definition of how Circular Economy principles are applied.

Format: Free text.

4.27.3. By-products

Definition: List of the by-products produced.

Format: Uses the [Materials](#) class.

4.28. Human Capacity sub-properties

Definition: The human capacity of the facility sub-properties.

4.28.1. Headcount

Definition: The headcount of the facility in FTE, using definition provided [here](#).

Format: Integer.

Note: It is useful for a user / NGO / aid agency to determine the scale of the facility.

4.28.2. Maker

Note: Identified as future work.

4.29. Innovation Space sub-properties

Definition: The innovation space sub-properties.

4.29.1. Staff

Definition: Number of staff supporting the innovation and educational aspects of the facility.

Format: Integer.

Note: It is useful to help determine the scale of the facility.

4.29.2. Learning Resources

Definition: The learning resources available at the facility.

Format: List the learning resources.

Note: It is useful for a user to be aware of any learning resources – courses, educational classes etc., a manufacturing facility may have / run.

4.29.3. Services

Definition: The services provided by a manufacturing facility.

Format: List the services provided.

4.29.4. Footfall

Definition: The footfall at a manufacturing facility.

Format: Integer.

Note: It is useful to help determine the scale of the manufacturing facility.

4.29.5. Residencies

**Definition:** Where residencies are available at a manufacturing facility.

Format: TRUE / FALSE

5. Agent Properties

This class incorporates properties relating to 'Agent'. Mapping initiatives capture different relationships, ranging from owners, managers, funders, contact, people, members, and so on. In order to categorise this, we have standardised the properties of people and organisations, or 'agent' as an umbrella term. We have decided to keep people and organisations combined in a single class because they are often interchangeable. For example, an owner could be a person or an organisation.

Some properties such as 'Contact' and 'Social Media', have been developed further to include important sub-properties. For example, the inclusion of 'Social Media' sub-properties was incorporated as many mapped Fab Labs did not have their own URL website, but used Facebook to promote their facility, projects and capabilities.

Where properties are logically grouped, they are presented as collections of sub-properties.

Agent data model
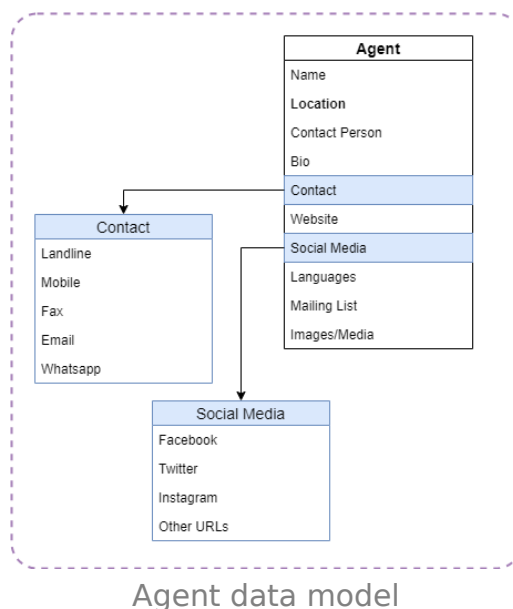
5.1. Name

Definition: The name of the Agent.

Note: This could be a name of a person or an organisation.

5.2. Location

Definition: A Location.

Format: Uses the [Location](#) class.

5.3. Contact Person

Definition: An [Agent](#) who is the key point of contact for a manufacturing facility or organisation.

Format: Provide the name of the [Agent](#).

5.4. Bio

Description: A description of a person or an organisation.

Format: Free text.

5.5. Website

Definition: Website address.

Format: Provide the relevant URL.

5.6. Languages

Definition: Languages used by a person or an organisation.

Format: [ISO 639-2](#) or [ISO 639-3](#), for example "en-gb".

Note: Often manufacturing facilities may be able to provide services dealing in more than one language.

5.7. Mailing List

Definition: Mailing list for an organisation.

5.8. Images / Media

Definition: Images / Media of a person, an organisation, or relating to the manufacturing facility.

5.9. Contact sub-properties

Description: Defined contact information.

5.9.1. Landline

Definition: A landline telephone number to contact the facility, person or organisation.

Format: Provide the telephone number.

5.9.2. Mobile

Definition: A mobile telephone number to contact the facility, person or organisation.

Format: Provide the telephone number.

5.9.3. Fax

Definition: A fax number to contact the facility, person or organisation.

Format: Provide the fax number.

5.9.4. Email

Definition: An email address to contact the facility, person or organisation.

Format: Provide the email address.

5.9.5. WhatsApp

Definition: A WhatsApp number to contact the facility, person or organisation.

Format: Provide the telephone number.

Note: In some instances, users contact the manufacturers through WhatsApp.

5.10. Social Media sub-properties

Description: Defined social media information.

5.10.1. Facebook

Definition: Facebook page URL.

Format: Provide the relevant URL.

Note: Facebook is an important platform for contacting Fablabs / other manufacturing facilities. For example, in the Philippines, a Facebook group has been created for all Fablabs to interact through.

5.10.2. Twitter

Definition: Twitter page URL.

Format: Provide the relevant URL.

Note: Manufacturing facilities often promote themselves, their activities and projects on Twitter.

5.10.3 Instagram

Definition: Instagram page handle.

Format: Provide the relevant Instagram handle.

Note: Manufacturing facilities often promote themselves, their activities and projects on Instagram.

5.10.4 Other URLs

Definition: Other URLs.

Format: Provide the relevant URLs.

Note: Other examples of social media associated with a manufacturing facility, organisation or person, unclassified by this standard, but can also be included. For example, fablabs.io or hackerspaces.org.

6. Location Properties

This class incorporates the important properties relating to 'Location'.

A simple standardised way of capturing geographical information is imperative – to be able to use a 'Manufacturing facility' or 'Equipment', a user needs to know its location. The properties below describe the core characteristics which are needed for data collection.

Recording a geographical location differs globally. In the developed world, an 'Address' such as a street address, is the norm for recording places of interest. Whereas, in some countries, a description of the location – i.e. 'near the school, on this corner', is an adequate description of location. When recording data, the latter qualitative data is subjective, and difficult to quantify. As such, an addressing system which is not a street address is incredibly useful. Consequently, the application of 'GPS coordinates' and 'What 3 Words' have been integrated into the Open Know-Where data model. Both 'GPS coordinates' and 'What 3 Words' are already in use by many NGOs and Aid Agencies when recording the 'Location' of manufacturing facilities and/or 'Equipment'.

For compatibility with the Humanitarian Exchange Language, use the HXL hashtag chooser.

Where properties are logically grouped, they are presented as collections of sub-properties.

Location properties data model
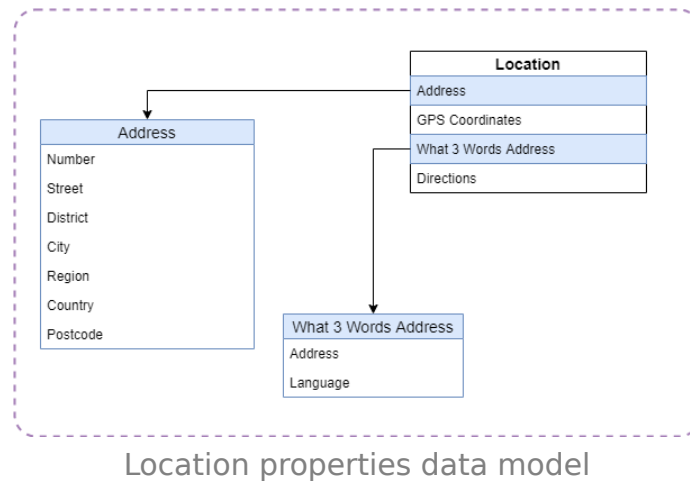
6.1. Address

Definition: Address relating to a manufacturing facility, person or organisation.

Format: Use the defined Address sub-properties:

- Number
- Street
- District
- City
- Region
- Country
- Postcode

Note: Address has been standardised to include these fields for ease of use, discoverability and merging data sets.

For compatibility with the Humanitarian Exchange Language, use the HXL hashtag chooser.

6.3. GPS Coordinates

Definition: The relevant GPS coordinates.

Format: Provide the relevant GPS coordinates, using Decimal Degrees.

Note: GPS coordinates are a common standardised way of detailing a location, used by many aid agencies and mapping initiatives.

6.4. Directions

Definition: Directions to manufacturing facility, person or organisation.

Format: Free text.

Note: This qualitative data field may be helpful for a difficult to find location, or in an area where the standard address format is irrelevant.

6.5. What 3 Words sub-properties

Definition: The What 3 words address for the location.

6.4.1. What 3 Words

Definition: What 3 Words phrase for location.

Format: State the What 3 Words phrase.

Note: Often informal settlements, or developing countries do not have street addresses, and communicating GPS coordinates can be tricky and error-prone. What 3 Words is an alternative geospatial address system.

Every location has been a 3m x 3m grid square with a 3 word address. Meaning you can collect, validate and provide any location within a 3m x 3m radius with just 3 words. For example: Barbal's office in Bristol is recorded as '///shares.parks.alone'.

6.4.2. Language

Definition: Language What 3 Words has been recorded in.

Format: ISO 639-2 or ISO 639-3, for example "en-gb".

Note: What 3 Words is available in 43 different languages and the words for an address are not direct translations of each other.

7. Equipment Properties

This class incorporates the properties relating to Equipment. It provides a simple standardised way of capturing the manufacturing capabilities of equipment.

A key aspect which arose, is the scope, and specifically – what are we trying to capture? For example, only machines and digital equipment? Or can we capture hand tools, IT equipment, software, and so on?

Knowing that a CNC router may be important may be useful in decision making for deciding where to get something made, but generic hand tools may not, but that does not preclude them from being included when documenting. This resulted in needing a simple classification system which would standardise a wide variety of Equipment.

The potential list of properties for Equipment is boundless but, Open Know-Where aims to standardise as many as possible. We expect this list to grow with time with different recommended properties for different classes of equipment/tools.

Where properties are logically grouped, they are presented as collections of sub-properties.
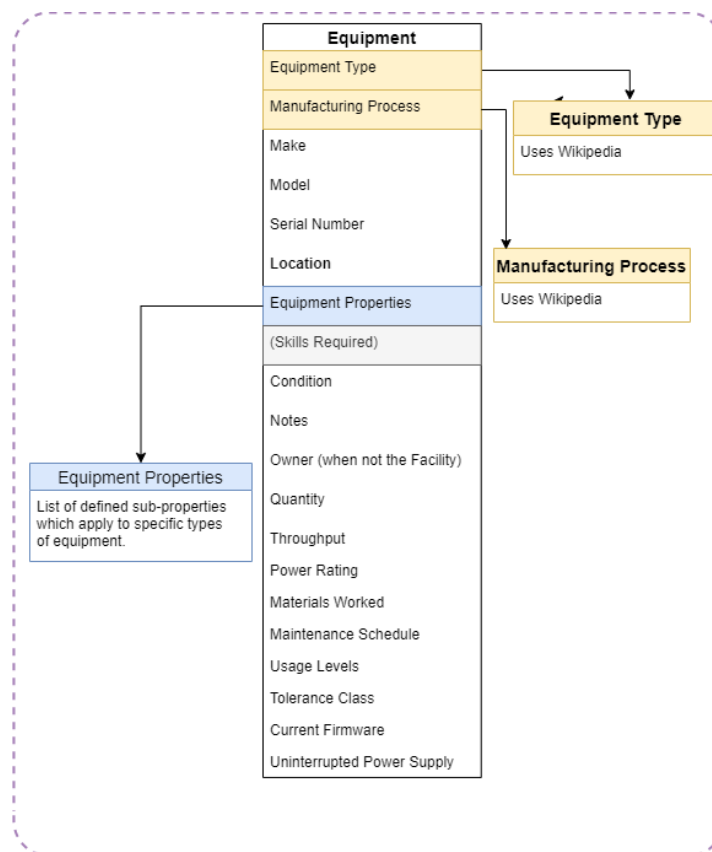
7.1. Equipment Type

Definition: Classification of Equipment.

Format: Provide the Wikipedia URL for the relevant Equipment Type.

Note: For instructions how to do this, please see [section 3.5](#).

7.2. Manufacturing Process

Definition: Manufacturing process the Equipment is capable of.

Format: Provide the Wikipedia URL for the relevant manufacturing process.

Note: For instructions how to do this, please see [section 3.5](#).

7.3. Make

Definition: Make of the piece of equipment.

Format: Provide the make of the model.

Note: Provides detailed information about a piece of equipment/tool. For example, you can design generically for a 3D printer, or you can design for a specific make or model of 3D printer.

7.4. Model

Definition: Model of the piece of Equipment.

Format: Provide the name of the model.

Note: Provides detailed information about a piece of equipment. For example, you can design generically for a 3D printer, or you can design for a specific make or model of 3D printer.

7.5. Serial Number

Definition: Serial number of the piece of Equipment.

Format: Provide the serial number of the Equipment.

7.6. Location

Definition: Location of the equipment.

Format: Uses [Location](#) class.

7.7. (Skills Required)

Identified as future work.

7.8. Condition

Definition: The condition of the piece of equipment.

Format: State the condition of the piece of equipment.

Note: This provides a user with information surrounding the quality of a piece of equipment/tool, and whether it can complete the task they need it for.

7.9. Notes

Definition: Additional information about the piece of equipment.

Format: Free text.

7.10. Owner

Definition: The owner of a piece of equipment.

Format: Uses the [Agent](#) class.

Note: To be used when the owner is not the manufacturing facility.

7.11. Quantity

Definition: Quantity of specific piece of equipment.

Format: Integer.

Note: This provides information surrounding the size and scale of a manufacturing facility and implicates batch size.

7.12. Throughput

Definition: The throughput of the piece of equipment.

Format: Free text.

7.13. Power Rating

Definition: The power rating of the piece of equipment.

Format: Integer. Unit: W.

7.14. Materials Worked

Definition: The materials that can be used with the piece of equipment.

Format: Uses the [Materials](#) Classification.

7.15. Maintenance Schedule

Definition: When the equipment was last maintained.

Format: Free text.

7.16. Usage Levels

Definition: How often the piece of equipment is used.

Format: Free text.

7.17. Tolerance Class

Definition: The tolerance class of the piece of equipment.

Format: In accordance with [ISO 2768](#).

7.18. Current Firmware

Definition: The current firmware used by the piece of equipment.

Format: Free text.

7.19. Uninterrupted Power Supply

Defintion: Whether the piece of equipment has an uninterrupted power supply.

Format: TRUE / FALSE

7.20. Defined sub-properties

These are specialised properties that only apply to specific types of equipment. In this section th**e list of Equipment Properties provided is extensible, and hasn't attempted to be exhaustive. The Equipment sub-properties provided represent a significant proportion of equipment used in manufacturing facilities. The below list of defined sub-properties has been provided in alphabetical order for ease of use and reference.**

7.20.1. Axes

Definition: The number of axes.

Format: Integer.

7.20.2. Bed Size

Definition: The bed size of a piece of equipment.

Format: Integer. Unit: mm.

7.20.3. Bending Length

Definition: Length of bending.

Format: Integer. Unit: mm.

7.20.4.Build Volume

Definition: The dimensions of the build.

Format: Integer. Unit: mm^3.

7.20.5. Chuck Jaw Diameter

Definition: The diameter of the chuck jaw.

Format: Integer. Unit: mm.

7.20.6. Collet Size

Defintion: The size of the collet.

Format: Integer. Unit: mm.

7.20.7. Computer Controlled

Definition: Whether the equipment is computer controlled.

Format: TRUE / FALSE

7.20.8. Cross Slide Travel

Definition: Distance of Cross Slide Travel.

Format: Integer. Unit: mm.

7.20.9. Daylight / Opening

Definition: Daylight / Opening size.

Format: Integer. Unit: mm.

7.20.10. Distance Between Centres

Definition: The distance between a centre in the headstock and a centre in the tailstock.

Format: Integer. Unit: mm.

7.20.11. Ejector Threads

Definition: Ejector Thread Size.

Format: Integer. Unit: mm.

7.20.12. Extraction System

Definition: Is there an extraction system?

Format: TRUE / FALSE

7.20.13. Gantry Material

Definition: The material the gantry is made out of.

Format: Uses Material class.

7.20.14. Hot Runner Compatible

Definition: Whether the equipment is hot runner compatible.

Format: TRUE / FALSE

7.20.15. Laser Power

Definition: Power consumption used.

Format: Integer. Unit: W.

7.20.16. Layer Resolution

Definition: Thickness of layer.

Format: Integer. Unit: mm.

7.20.17. Locating Ring Diameter

Definition: Diameter of the locating ring.

Format: Integer. Unit: mm.

7.20.18. Material Worked

Definition: The type of material worked on the equipment.

Format: METAL / NON-METAL

7.20.19. Maximum Clamping Force

Definition: The maximum clamping force of the equipment.

Format: Integer. Unit: t.

7.20.20. Maximum Shot Volume

Definition: The maximum shot volume.

Format: Integer. Unit: mm^3.

7.20.21. Maximum Spindle Speed

Definition: The maximum spindle speed.

Format: Integer. Unit: rpm.

7.20.22. Maximum Tie Bar Distance

Definition: The maximum tie bar distance.

Format: Integer. Unit: mm.

7.20.23. Nozzle Size

Definition: Size of nozzle.

Format: Integer. Unit: mm.

7.20.24. Nozzle Radius

Definition: Radius of the nozzle.

Format: Integer. Unit: mm.

7.20.25. Optimal Material

Definition: The optimal material for use with a piece of equipment.

Format: Uses [Material] class.

7.20.26. Pieceholding Type

Definition: How the part is fixed.

Format: Free text.

7.20.27. Press Force

Definition: The press force.

Format: Integer. Unit: kN.

7.20.28. Punch Force

Definition: The punch force.

Format: Integer. Unit: kN.

7.20.29. Spindle Rotation

Defintion: The spindle rotation.

Format: Integer. Unit: Deg.

7.20.30. Stations

Definition: The number of stations.

Format: Integer.

7.20.31. Station size

Definition: The size of the station.

Format: Integer. Unit: mm.

7.20.32. Tailstock Sleeve Travel

Definition: Distance of tailstock sleeve travel.

Format: Integer. Unit: mm.

7.20.33. Tooling Type

Definition: The tooling type.

Format: Free text.

Example: Forming, Piercing.

7.20.34. Turning Capacity / Swing

Definition: The turning capacity / swing of a piece of equipment.

Format: Integer. Unit: mm.

7.20.35. Working Surface

Definition: The working surface of a piece of equipment.

Format: Integer. Unit: mm.

7.20.36. X Travel

Definition: Distance of X travel.

Format: Integer. Unit: mm.

7.20.37. Y Travel

Definition: Distance of Y travel.

Format: Integer. Unit: mm.

7.20.38. Z Travel

Definition: Distance of Z travel.

Format: Integer. Unit: mm.

7.21. Equipment Sub-properties by Type

In this following section there is a mapping of sub-properties to type.

TYPE	PROPERTIES / CAPABILITIES
CNC Router	Bed Size Chuck Jaw Diameter Collet Size Extraction System Gantry Material Pieceholding Type

CNC Milling	Axes
	Bed Size
	Chuck Jaw Diameter
	Collet Size
	Gantry Material
	Material Worked
CNC Punching	Bed Size
	Punch Force
	Stations
	Station Size
	Tooling Type
Press Brake	Bed Size
	Bending Length
	Computer Controlled
	Daylight / Opening
	Press Force
Laser Cutter	Bed Size
	Extraction System
	Laser Power
3D Printer – FDM	Build Volume
	Layer Resolution
	Nozzle Size(s)
	Optimal Material

|	
3D Printer – SLA	Build Volume Layer Resolution Material Worked
3D Printer – SLS	Build Volume Layer Resolution Material Worked
Vinyl Cutter	Bed Size
Plasma Cutter	Computer Controlled Power Rating
Injection Molding	Ejector Threads Hot Runner Compatible Locating Ring Diameter Maximum Clamping Force Maximum Shot Volume Maximum Tie Bar Distance Nozzle Radius
Mill	Maximum Spindle Speed Spindle Rotation Working Surface X Travel Y Travel Z Travel

Lathe	Chuck Jaw Diameter
	Cross Slide Travel
	Distance Between Centres
	Maximum Spindle Speed
	Tailstock Sleeve Travel
	Turning Capacity / Swing
Overlock Sewing Machine	[In development with the Equipment Sub-group]
Embroidery Machine	[In development with the Equipment Sub-group]
Standard Sewing Machine	[In development with the Equipment Sub-group]

8. Materials Properties

This class incorporates properties relating to materials. In general, materials are outside of the scope for Open Know-Where, however a simple standardised way of capturing materials is important. For instance, to be able to use a manufacturing facility, a user needs to be aware of what materials are available or commonly used at a specific location, or to use a piece of equipment, a user will need to know what material the machine is callibrated for. Materials are decisive facet of whether something can be made at a specific manufacturing facility.

Consequently, a simple standardised way of capturing materials is provided by Open Know-Where, but future work to fully standardise material classifications may be needed, and is currently being investigated by the Internet of Production Alliance.

Where properties are logically grouped, they are presented as collections of sub-properties.
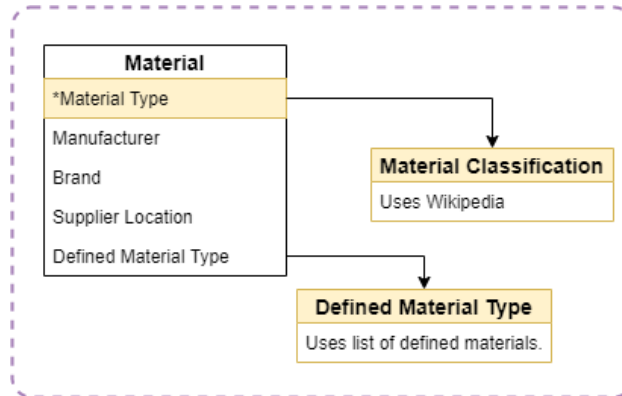
8.1. Manufacturer

Definition: The manufacturer of the material type.

Format: Free text.

8.2. Brand

Definition: The brand of the material type.

Format: Free text.

8.3. Supplier Location

Definition: Place of immediate supply to the facility.

Format: Use Location class.

Note: This is not to be used for the location of the manufacturer of the material, but where the facility gets the material from.

8.4. Material Type

Definition: Type of material.

Format: Provide the Wikiepedia URL for the relevant material type.

Note: For instructions how to do this, please see section 3.5.

8.5. Defined Material Types

In order to support interoperability across datasets, this section sets out a standardised list of material types used in manufacturing.The list is not intended to be exhaustive, but extensive enough to capture the most common types of materials.

In compiling the list, the level of specificity was deemed important. If the list is too high-level, it would not help a buyer or maker determine if a facility is appropriate for their specific needs. If it is too detailed a search could exclude equipment that could easily be applied to similar materials. The figure below provides examples of the level of specificity for different material types, which was used to guide decision making in producing this list.
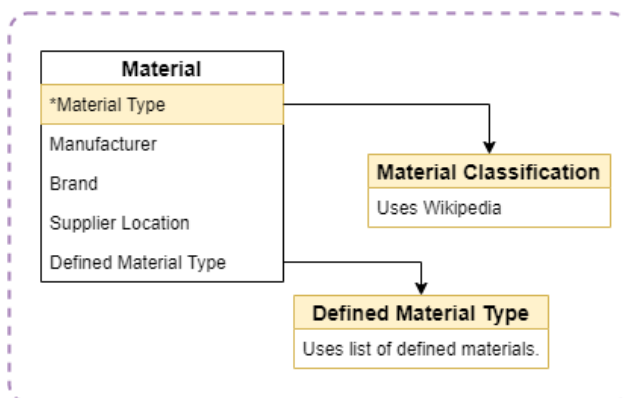
Headings are included in the list to aid navigation by users of the standard, but do not form part of the classification scheme and should not be used in Open Know-Where datasets.

8.5.1. Plastics

HDPE

PLA

ABS

PET

Acetate

PVC

Nylon

Polycarbonate

Polypropylene

Acrylic

8.5.2. Metals

[Iron](#)

[Steel](#)

[Stainless Steel](#)

[Mild Steel](#)

[Galvanised Steel](#)

[Aluminium](#)

[Copper](#)

[Zinc](#)

8.5.3. Wood Products

[Softwood](#)

[Hardwood](#)

[MDF](#)

8.5.4. Elastomers

[Natural Rubber](#)

[TPU](#)

[Silicone](#)

8.5.5. Ceramics

[Geopolymers](#)

[Ceramics](#)

[Clay](#)

8.5.6. Electronics

[PCBs](#)

[Electronic Components](#)

8.5.7. Others

Textiles

Leather

Concrete

Rock

Soil

Composite Materials

Food

Compost

Resin

Glass

Carbon Fiber

Cardboard

Paper

9. Record Data Properties

This class incorporates properties relating to record data. By "record data" we mean information about who created the data and how up to date it is. In highly dynamic environments, datasets can quickly become obsolete and so it can be helpful to share information about the provenance of the data.

```
┌─────────────────────────────┐
│        Record Data          │
├─────────────────────────────┤
│ Date Created                │
│ Created By                  │
│ Last Updated                │
│ Updated By                  │
│ Data Verified               │
│ Verified By                 │
│ Data Collection Method      │
└─────────────────────────────┘
```

9.1. Date Created

Defintion: Date record was created.

Format: Recommended practice is to use [ISO 8601](#), i.e the format `YYYY-MM-DD` .

9.2. Created By

Definition:[Agent](#) who created the resource.

Format: Use [Agent](#) class.

9.3. Last Updated

Definition: Date the record was updated.

Format: Recommended practice is to use [ISO 8601](#), i.e the format `YYYY-MM-DD` .

9.4. Updated By

Defintion: The Agent who updated the record.

Format: Use the [Agent](#) class.

9.5. Date Verified

Definition: Date the data in the record was verified.

Format: Recommended practice is to use [ISO 8601](#), i.e. the format `YYYY-MM-DD` .

9.6. Verified By

Defintion: The agent who verified the data in the record.

Format: Use the [Agent](#) class.

9.7. Data Collection Method

Definition: Method of data collection.

Format: Free text.

Example: Interview, Survey, Field Visit, and so on.

10. Governance of this specification

The Open Know-Where specification is governed by the Open Know-Where working group.

Changes to the specification are proposed in StandardsRepo.

Changes are voted on during meetings of the Open Know-Where working group.

11. Acknowledgements