The Translator in Knowledge Management for Innovation – towards Industry Commons

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Executive Summary

We introduce a new role in the field of semantic knowledge management which we call Translator in Knowledge Management for Innovation. Our interest is in the role helping to shape purposeful and traceable communication in materials and manufacturing industries and, thus, to make knowledge become managed knowledge that is actionable for innovation. We envisage that such communication will lead to harmonisation across the boundaries of the wide range individual domains and disciplines interacting in these fields. Current divisions and silos mean that there is a huge untapped value not just in terms of 'lost' data but also stakeholder knowledge, which currently is not well captured. The Knowledge Management Translator will work with materials and manufacturing domain experts as well as data scientists and knowledge engineers to shape data in order to express knowledge. The job of the Knowledge Management Translator is to bring together and orchestrate people, tools, and processes to achieve this.

To define this new role, we build on existing Technology Translator roles such as the Materials Modelling Translator and the Analytics Translator. We also tap into the professional experience of all the authors who are actively researching, practising, or working with ontologies, materials modelling, and data sciences. Therefrom we create an ideal persona and assign a variety of tasks and required skills to them.

We provide a template for a structured approach to Knowledge Management Translation, as a process broken down into six steps, adapted from the Materials Modelling Translation Guide.

Given the wide range of tasks and skills required, hardly any person today will be able to fulfil all of these on their own. Hence, Translators will work in teams, also including some client-internal and third-party consultants. This sounds prohibitively expensive but may become reality once the clients create more and more data management roles, and once universities train data management skills, and once management of data related to materials and manufacturing will facilitate systematic sustainability assessment. Having the economic viability in mind, we suggest some early paths to success that do not require the full range of experts. We also highlight that clients need to have a certain maturity level regarding data readiness to enable a fruitful interaction, and with increasing data and knowledge management maturity clients will profit from implementing the role in their company.

We discuss some current gaps and challenges for this new role and outline the next steps to make the Knowledge Management Translator role a reality. We aim to consolidate expert knowledge and further develop the role in the context of the H2020 OntoCommons project, to offer budding Knowledge Management Translators continuous professional development opportunities.

Table of Contents

1. Motivation for the new role of Knowledge Management Translator

Applying sustainability as a paradigm for thinking[1] to balance energy and mass flows and to achieve a turnaround in global warming and unequal distribution of material wealth is a major task in the 21st century. The present generations are implementing sustainable development profiting from the fifth industrial revolution (Breque, De Nul, & Petridis, 2021) that builds on digitalisation and comprises human-centric processes to achieve the timely required resilient solutions. Strategic decision making in materials development and manufacturing significantly contributes to creating value for the generations to come, relying on the availability of existing knowledge and rapid access to missing data. Understanding worldwide needs in regionally specific contexts requires efficient and effective communication to achieve the right results the right way. The needs expressed and launched by future users of manufactured material products constitute innovation challenges and are of relevance to the entire product lifecycle in the global ecosystem. Sustainable product management requires to respect the permeable interface between techno sphere and biosphere, understand potential interactions and adhere to planetary guard rails (Steinhäuser & Große Ophoff, 2022) for realising value with innovation.[2]

Common industry approaches based on jointly exploiting complex knowledge for tackling the historically unparalleled duties require activities by expert teams, and in this contribution, we suggest involving a new role we call Knowledge Management (KM) Translator to help shape purposeful and traceable communication. We envisage that such inter-organisation communication and planning processes profit from multi-perspective harmonisation beyond the boundaries of individual domains or disciplines. Finally, for pragmatically solving the challenges of the future in the framework of a knowledge-based society progress (Steilemann, 2022) may be promoted by a greater openness of science and organisations achieving substantial social support in fact-based dialogues and constructive cooperation. Forward-looking and interactive Knowledge Management thus will greatly foster innovation and advance knowledge-intensive enterprises acting purposefully and co-creating the future in quadruple helix environments. (Del Giudice, Carayannis, & Maggioni, 2017)

As outlined by Pellegrini et al. (Pellegrini, Auer, Schaffert, & Tochtermann, 2009) when referring to "networked knowledge" or Schmidt et al. (Schmidt, et al., 2009) when proposing a "knowledge maturing process model", there are several important facets of knowledge:

- "Knowledge needs to be **connected** in order to generate new knowledge or innovation"
- "Knowledge also needs to be **shared** among people in order to be used effectively, and much of this sharing is based on collaboration, social software, and social networks"
- "Knowledge is never isolated but always **embedded in a context**, connected with other information"

[1] https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd
[2] ISO 9000:2015(en) Quality management systems — Fundamentals and vocabulary: https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en

- It is essential to "understand the **flow** of knowledge and its **barriers** within and across organisations from a macroscopic point of view."

We suggest that these facets shall catalyse activities by KM Translators in human-centric processes because they strongly relate to interaction, communication, collaboration and understanding in teams and networks.

Currently, it is widely discussed and accepted that organisations and whole domains such as materials and manufacturing need to improve the handling of product-related data and knowledge. The aim is to generate not only meaningful data, but also context-enriched information readily available at the point of need, i.e., whenever insights are required, and not only operative but strategic decisions need to be taken. The latter could be research directions, process optimisation or product formulations, to name but a few. There are interconnected issues around **data and knowledge management**.

There is a huge **untapped value** in **data**, which currently is lost or insufficiently valorised (PwC EU Services, 2018) due to a lack of compliance with what is termed FAIR (Wilkinson & al., 2016) data principles[3]. The F (Findable), I (Interoperable) and R (Reusable) aspects of FAIR in particular overlap with issues regarding semantics. Without the correct and meaningful documentation of data, they will be harder to find for others and interoperability will be limited to specific formats (syntax) and reusability hindered due to a lack of understanding of context. Using a richer, ontology-based data documentation approach contributes to addressing these points and building an integrated ecosystem of tools. Especially, human actors could harness the full value of data and create shared value in their respective networks, be it by cooperatively spotting and gathering potentially missing data or by conjointly making meaningful data available. Most importantly, ontology-based data documentation unearths implicit expert knowledge about data and formally details it in ways that makes it machine actionable.

Knowledge management (KM) "*is the collection of methods relating to creating, sharing, using and managing the knowledge and information of an organization. It refers to a multidisciplinary approach to achieve organisational objectives by making the best use of knowledge." It also "enables individuals, teams and entire organisations as well as networks, regions and nations to collectively and systematically create, share and apply knowledge to achieve their strategic and operational objectives. Knowledge management contributes to increase the efficiency and effectiveness of operations on the one hand and to change the quality of competition (innovation) on the other by developing a learning organisation.* "(North & Kumta, 2018)

Regarding Knowledge Management, the current aim is for building the knowledge structures that better support decision making and that feed an Artificial Intelligence (AI) system (Earley, 2017). It is well understood that well-structured information is needed to make AI work correctly and as intended, and that information must be based on meaningful data (DIN EN ISO 9000)[4]. An internet

[3] FAIR Principles: Findability, Accessibility, Interoperability and Re-Usability https://www.go-fair.org/fair-principles/

[4] ISO 9000:2015(en) Quality management systems — Fundamentals and vocabulary: https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en

meme showing Chihuahuas and muffins (Yao, 2017) was used to show how AI can misinterpret by not differing pictures of dogs from those of bakery produce. This is a good example to show the limitations of AI – no matter how good the data is. In the example described above, AI was good at detecting some characteristics about the data (i.e., three black spots), but those were not enough to detect which end-object (dog vs. muffin) was in the picture. The Humans-in-the-loop will be important; hence, computer vision and image recognition APIs written by human experts using their knowledge can make AI procedures work correctly. AI requires a solid Information Architecture (IA) to be of use. (Earley, 2016). The necessary architecture is often depicted as a ladder (Thomas, 2019) showing how businesses can transform to successfully use AI. (Figure 1)

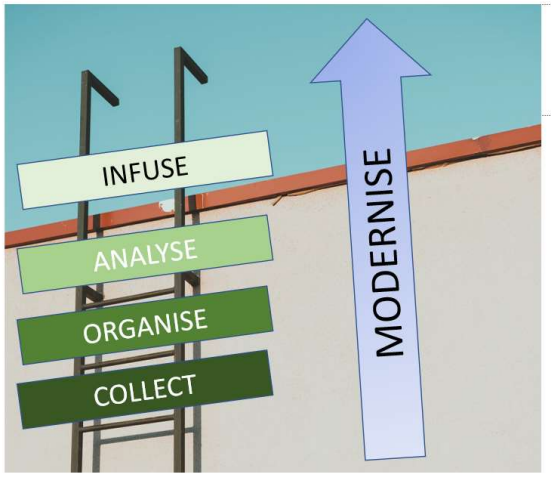

Figure 1: The AI Ladder, a guiding strategy for connecting data and AI, adapted from (Thomas, 2019)

For a materials and/or manufacturing organisation we expect them to **collect** materials data and **organise** them to get information, as depicted in Figure 2. Our newly proposed part is to **add ontologies**, as their use is crucial for knowledge management, as has been discussed widely since the start of the semantic web. (Crowder, 2015) (Fensel D. , 2004) (Fensel D. , 2002) (Fensel, van Harmelen, Horrocks, McGuinness, & Patel-Schneider, 2001) An organisation can then analyse its data to gain knowledge and know-how which then can be **infused** to competence. Hence, profiting from managed knowledge and internal consent organisations move from "data-ready" to modernised. At the same time, an enterprise and (another) organisation may consent in exchanging a part of their knowledge, i.e., some FAIR information or more than just data. We envisage them not to completely exchange their competences as fair competition of ideas shall prevail. This exchange could be enabled and promoted by two KM Translators working together.

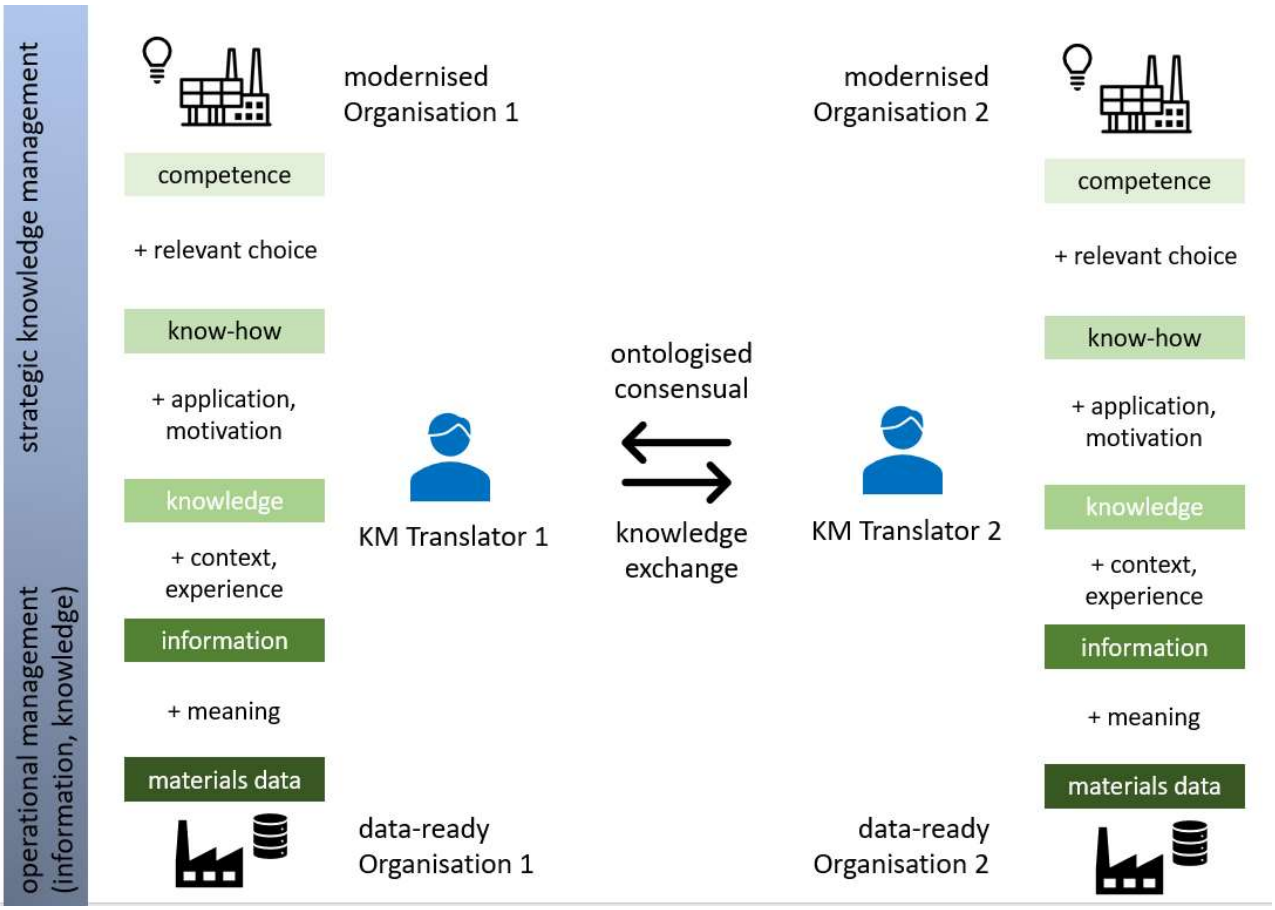

Figure 2: The AI ladder modified for materials data to competence in two organisations planning to exchange some knowledge based on consensus

In response to these requirements and objectives, organisations need to face the challenge of starting to collect data and making it FAIR. The data needs to be curated and organised using ontology-based data management (Lenzerini, 2011) while taking care that its governance is well defined. Following such a Knowledge Engineering (KE) approach ensures data are meaningful, can support decision making and can be analysed by trusted, transparent and explainable AI. Once these rungs are climbed, knowledge-based decision making and AI can infuse and thus become operational throughout an organisation. Positioning oneself at the summit of the ladder even allows for a glance on surrounding organisations behind the wall.

OntoCommons[5] is a H2020 CSA project dedicated to the development of a common, ontology-based data documentation practice across all domains related to materials and manufacturing. In particular, OntoCommons coordinates efforts by domain experts and ontology specialists into how data can be made interoperable, linked, harmonised (Zeb, Soininen, & Sozer, 2021) [6] through ontologies and how the ontologies and their terminologies that are used to describe the data can be widely agreed, and

[5] https://www.ontocommons.eu/; https://cordis.europa.eu/project/id/958371
[6] "Data harmonisation means reconciling various types, levels and sources of data in formats that are compatible and comparable, and thus useful for better decision making." (Zeb, Soininen, & Sozer, 2021)

ideally standardised [7]. OntoCommons partners involve numerous stakeholders worldwide to gather best practises and develop the Ontology Commons Eco-System (OCES) – a set of ontologies, methods, and tools – which implements practical and user-friendly mechanisms of intra- and cross-domain interoperability focusing on materials and manufacturing domains.

Delivering on the potential benefits of ontology-based data documentation and management requires significant investment not just in infrastructure but also in understanding and supporting change processes and novel ways of working in order to reap the benefits. As pointed out by Earley (Earley, 2020), finding the right people to enable a "staffing up for ontology development" can be a major barrier and prevent successful adoption.

Adopting an ontology-based data documentation approach requires coaching as well as technical work by individuals and teams with a range of skills. The **role and team** that supports industry adoption and utilising the OCES tools and recommendations for maximum impact is termed "Knowledge Management Translator" (KM Translator) whose goal is to support the deployment of Industry Commons (Magas & Kiritsis, 2022). By Industry Commons, we refer to an ecosystem in which the same data can support the development of numerous new products, services, or manufacturing processes. Hence, any business or public entity can engage with the same data in different data-sharing collaborations to accelerate data-driven innovation and the data can thus spill over into new areas of the economy.[8]

Industry Commons related developments include ontology-based data documentation coordinated and supported by OntoCommons, as well as the creation of an open marketplace as a common information system that allows data sharing in particular business-to-business. The latter is being developed by DOME 4.0[9] which envisages itself as a "marketplace of marketplaces" and will hence target the linking up of marketplaces. Some of them are already digital but might not be using semantic interoperability and could use the services of DOME 4.0 in this domain. Other marketplaces might be served with DOME 4.0 capabilities of bringing their information and services into the digital interoperable world. Altogether, this will stimulate the Industry Commons of shared knowledge.

In order to complement these technology solutions, the KM Translator provides a focus on the human aspect and roles required to make the Industry Commons ecosystem work.

Similar "Translator" roles have emerged in other fields, where there is also a gap between complex technology potential and industrial impact. Broadly speaking, "Technology Translators" are essential for increasing the adoption of digital technology in industry as they not only help in identifying the business case, the required strategy and execution route, but also interpret the results to information that is understandable, reliable, and usable by the client for making critical decisions.

For example, the Materials Modelling Communities closely linked to the European Materials Modelling Council (EMMC)[10], defined the role of a Materials Modelling Translator (Hristova-Bogaerds, et al., 2019) (Klein, et al., 2021) as having the ability to "translate" industrial problems into

[7] https://www.bdva.eu/ec-standardisation-strategy-sets-support-data-spaces-priority
[8] Horizon 2020 - Work Programme 2018-2020 Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing
[9] https://cordis.europa.eu/project/id/953163; https://dome40.eu/
[10] https://www.emmc.eu

project-specific cases to be simulated for gathering missing information for industry clients. Their role was assigned to close the "knowledge gap" between industrial stakeholders and materials modellers, thus promoting mutual understanding. As a result of EMMC activities, the role of the Materials Modelling Translator has been defined and is now widely recognised in their community. However, despite the availability of the Translators Guide (Hristova-Bogaerds, et al., 2019) and a selection of success stories (Pezzotta, et al., 2021) (Laspalas, 2016) and several demonstrations as part of the OntoTrans[11] project, a comprehensive business model for translation needs yet to be fully established. Moreover, the role of the Translators needs to be positioned within a well-defined socio-legal-technological framework for them to be able to guide the organisations based on concrete solutions as has been described by Klein et al. (Klein, et al., 2021). Following first outcomes of OntoTrans, it is expected that combining translation with ontologisation will facilitate a highly dynamic re-use of translation procedures and an accelerated iterative refining and advancement of innovation challenges based on successively gathered modelling results (Noeske, Ghedini, & Friis, 2021).

A report from McKinsey (Henke, Levine, & McInerney, 2018) introduced the "Analytics Translator" as a new must-have role for organisations who want to make the most of their data and Artificial Intelligence (AI). It is clearly understood that a holistic team comprising data engineers, data architects, data-visualisation experts, and Translators will be required to make AI based techniques a success. In other words, business has become data-driven and innovation is expected to become AI-driven (Gartner, 2021). The role of an Analytics Translator is to link the technical expertise of data engineers and data scientists with the operational expertise of marketing, supply chain, manufacturing, risk, and other frontline managers, i.e., to close the "knowledge gap" between industrial stakeholders and data experts. AIANDUS[12] praises Analytics Translators as the new sexiest jobs of the 21st century and attempts to build a community around persons who can aid with building Data Science solutions to getting business value.

2. Knowledge Management Translation: a structured approach

Knowledge Management Translation involves a wide range of business, technical and communication tasks which may vary in practice case by case. A structured approach helps breaking the overall translation effort down into a sequence of six steps, some more business and some more technology oriented, that are performed first successively and then in cyclic iterations. Here we follow an established and expandable approach elaborated for the Materials Modelling Translator Process. The six steps are depicted in Figure 3 below:

[11] https://cordis.europa.eu/project/id/862136; https://www.ontotrans.eu
[12] https://www.aiandus.com/ats/

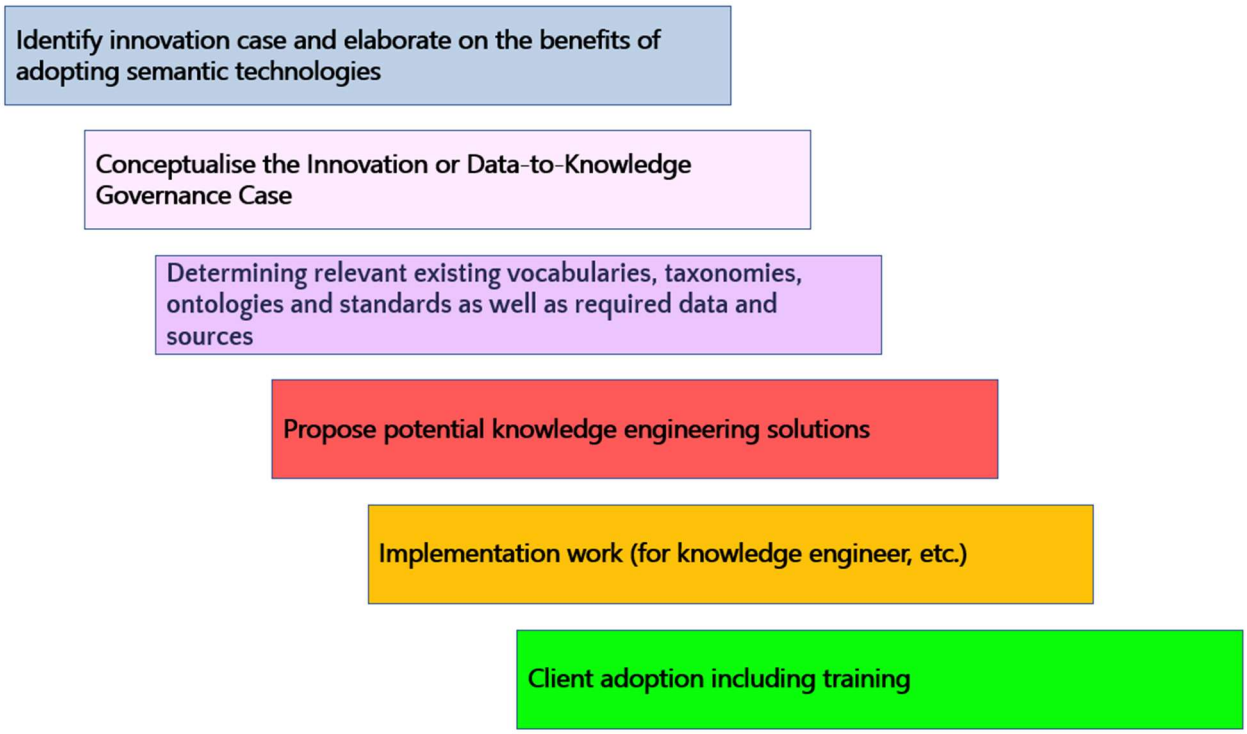

Figure 3: The six steps of KM Translation

Prior to the six steps, various types of readiness regarding data, semantics, ontologies and the availability of expertise need to have been assessed, as depicted in Figure 4 below. Their non-existence will not prohibit an organisation from working with a KM Translator; on the contrary, the Translator can also be deployed to create an environment to make working with semantics possible at all.

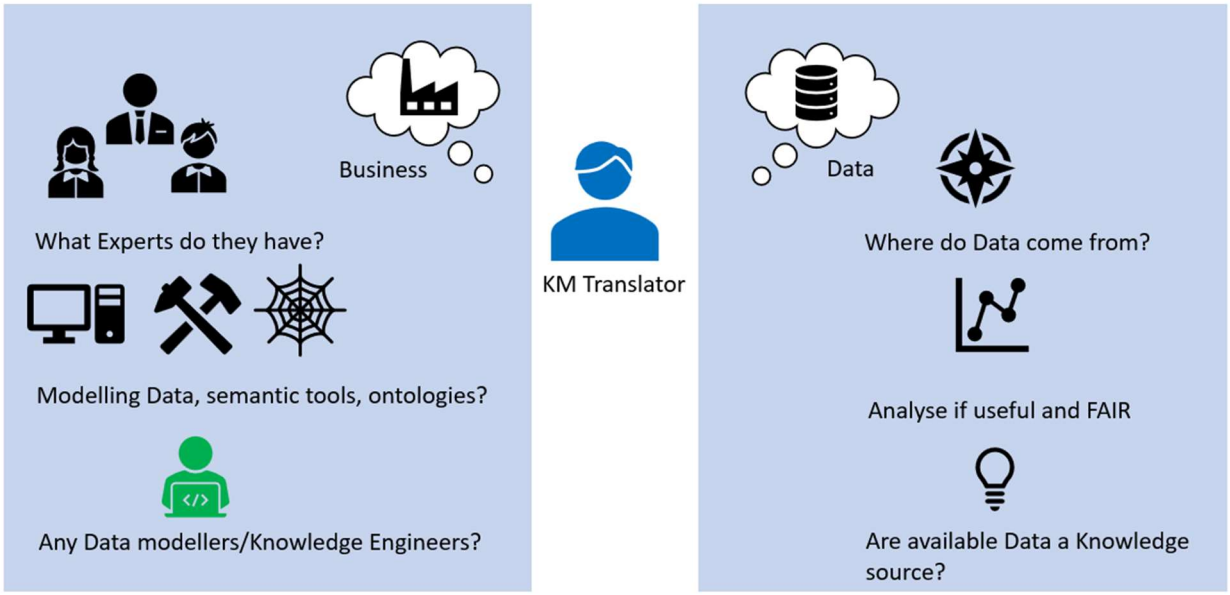

Figure 4: Step 0 – Readiness assessment by the Knowledge Management (KM) Translator with respect to human resource, tools, ontologies, and data maturity

Six Steps of Knowledge Management Translation

Step 1: Identify innovation case and elaborate on the benefits of adopting semantic technologies

Here, the KM Translator will convert the Innovation Challenge into an innovation Case, as pictured in Figure 5. Defining the benefits of adopting an ontology requires the KM Translator to "understand the business," value generation by solving/identifying "a set of innovation challenges", define a set of "B2B constellations", or "the ecosystem", etc. The benefits of adopting an ontology-based knowledge management approach should be investigated cooperatively and the Translator should spot "semantic" opportunities for a business case. This means addressing all layers of management in the company and it requires an understanding of both long-term and short-term business views spanning several product lifecycles. Without a vision for both these business time-scales, the funding for a particular project may be cut before any tangible benefit is achieved due to shifting markets and business priorities. The outcome of this step should be (i) an agreed general benefits analysis and (ii) identification of a specific case where value can be demonstrated relatively short term (the 'innovation case').

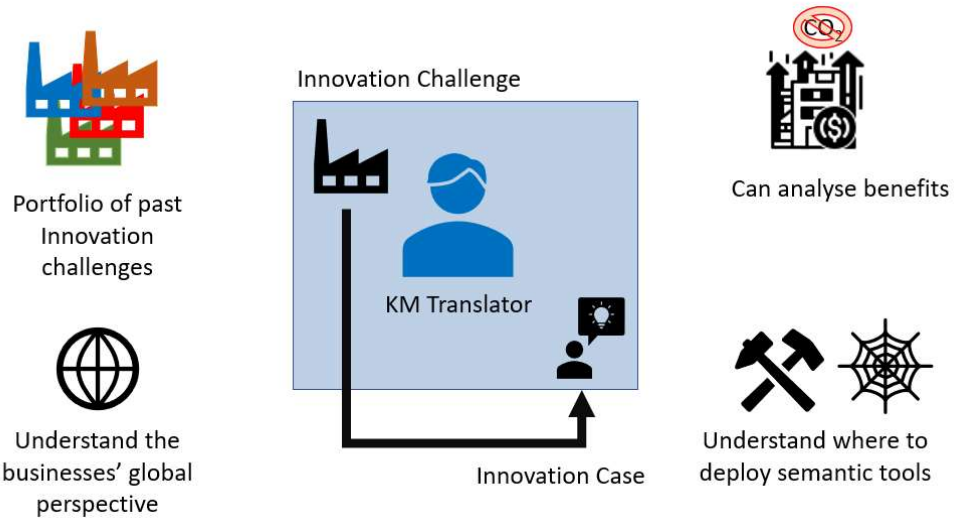

Figure 5: Step 1 – Identify innovation case starting from an Innovation Challenge and elaborate on the benefits of adopting semantic technologies. The pictograms surrounding the blue cube highlight the To-Do's for the KM translators encountered in this step.

As such KM Translator-guided benefits analysis is case-specific and well-documented a valuable agreement will be achieved on whether involving semantic technologies in a project will comply with productivity expectations - or not. For a KM Translator developing a seminal innovation case with a new customer may be more challenging, so they shall offer a portfolio of reference cases to reassure their clients.

Step 2: Conceptualise the Innovation or Data-to-Knowledge Governance Case

For the agreed innovation case, the Translator needs to guide conceptualisation, i.e., work with the relevant domain experts to capture and elucidate all relevant case entities (e.g., objects, processes, properties etc.) that play a role as well as their relationships (object properties), as outlined in Figure 6.

In this step, it can be helpful to use graphical representations and tools profiting from natural language rather than going straight to formal languages.

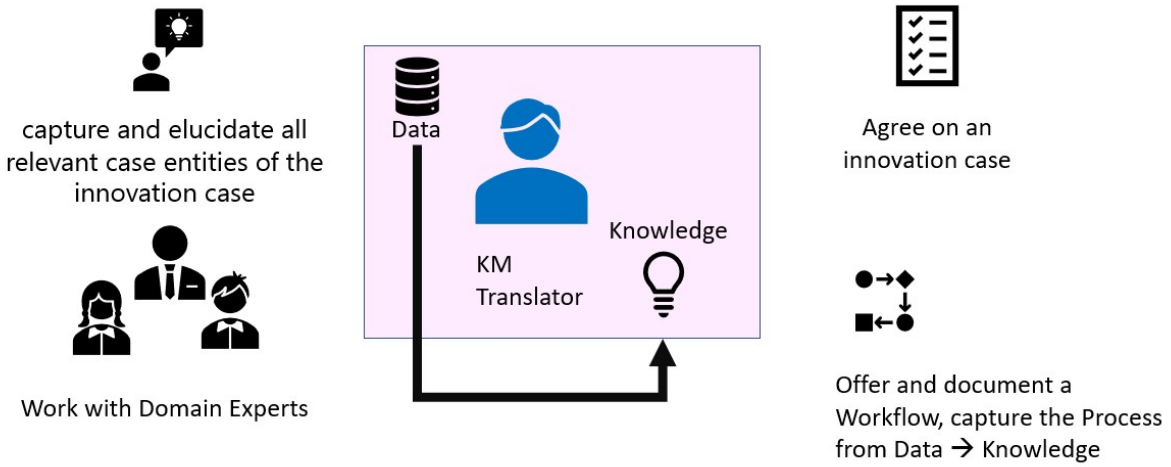

Figure 6: Step 2 - Conceptualise the Innovation or Data-to-Knowledge Governance Case. The pictograms surrounding the pink cube highlight the To-Do's for the KM translators encountered in this step.

At this stage, if ontologies rather than some semantic aspects are required to fully gain knowledge, the KM Translators may select a suitable ontology and may go through the following checklist, assembled from Neuhaus et al.: (Neuhaus, et al., 2013):

- Are all relevant terms from the use/innovation cases documented?
- Are all entities within the scope of the chosen ontology captured?
- Do the domain experts agree with the ontological analysis?
- Is the documentation sufficiently unambiguous to enable a consistent use of the terminology?

Furthermore, at this step, the innovation cases should be clearly defined and agreed upon and the ontology scope captured based on competency questions, i.e., questions based on the assumption that past successful or unsuccessful deployments of ontologies provide evidence of compatibility with a particular innovation case. It is advantageous and greatly promoted by ontologies to squarely face the activities both for assessing the missing conceptualisation required in the particular innovation case and to facilitate their potential re-use by implementing missing ontology modules for tackling future innovation cases related to the same business. In this way, knowledge-based innovation is performed. Figure 7, reflecting current discussions in progress in working groups of the Industrial Ontologies Foundry[13], outlines how the KM Translator can tackle this in an iterative way. They will have to get involved by managers responsible for strategic KM, become part of a little team comprising a few experts and potential end-users based at the organisation's site and then guide KM-related team decisions. This team defines the Innovation case with respect to its purpose, scope, and goals. Therefrom they deduct the needed requirements and define user stories around them. Thereafter, they may scrutinise their construct with compliancy questions, and if they are answered

[13] https://www.industrialontologies.org/history-of-the-iof/

with nays they need to revise. Once the questions result in positive answers, then they may start with identifying terms.

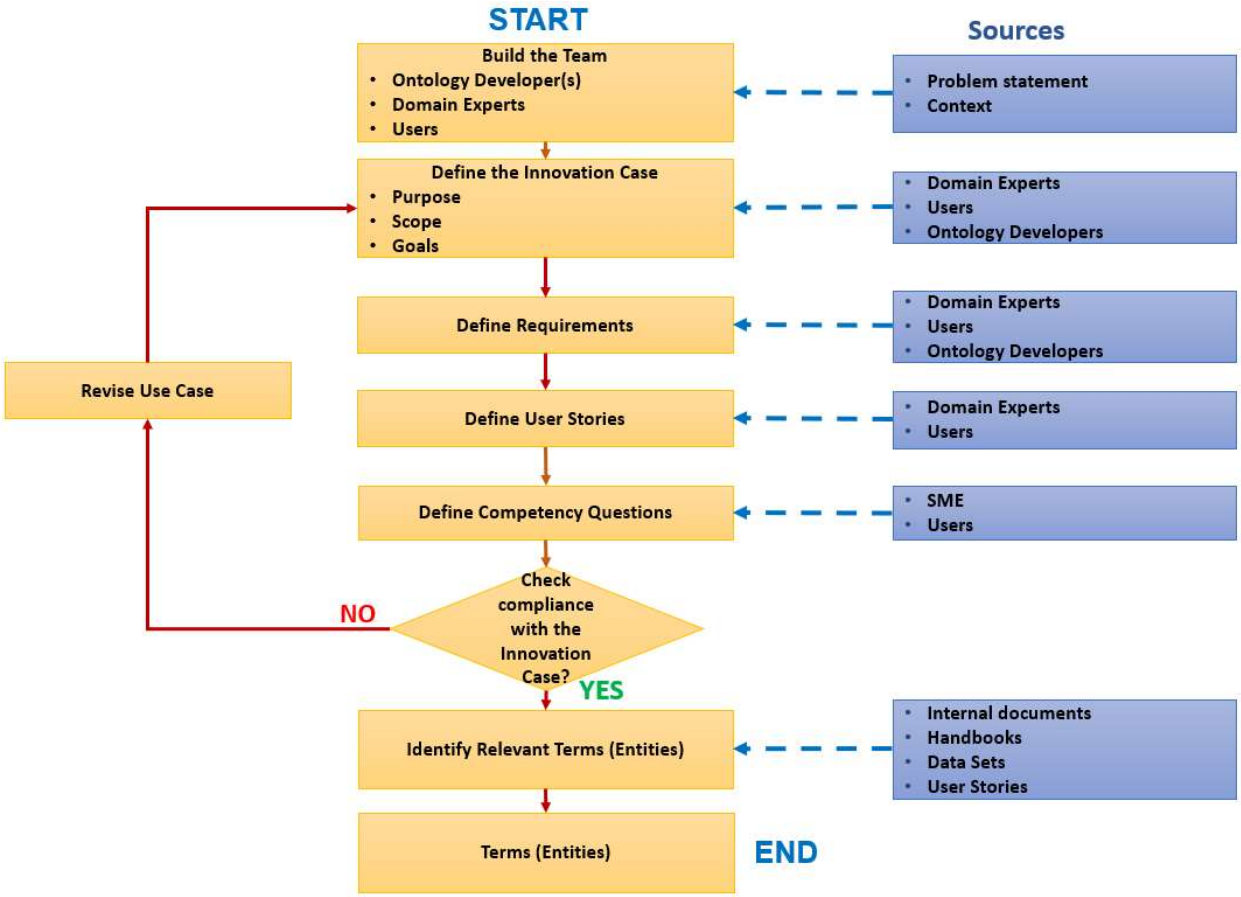

Figure 7: How to start an Ontology module development project

Step 3: Determining relevant existing vocabularies, taxonomies, ontologies, and standards as well as required data and sources

As depicted in Figure 8, in this step the translator works with the organisation to determine existing semantic assets (vocabularies, taxonomies, and ontologies) that are relevant or already in use in the organisation as well as relevant external sources such as domain ontologies but also standards that include specific definitions for relevant terms (e.g., product, process, etc.) related to materials and procedures. The translator should advise on but not develop solution such as ontology modules by themselves, i.e., a Knowledge Management Translator role is clearly delineated from that of e.g., the Knowledge Engineer.

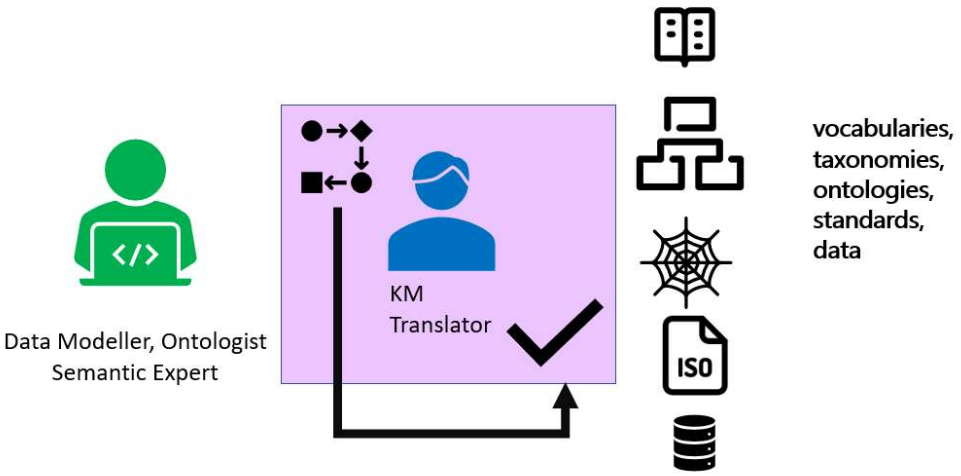

Figure 8: Step 3 – Determining relevant existing vocabularies, taxonomies, ontologies, and standards as well as required data and sources

Step 4: Propose potential knowledge engineering solutions.

This step consists of recommendations towards an organisation for adopting an ontology-based knowledge management approach (Figure 9), taking steps to move existing solutions on a more fundamental, sustainable, and value-generating footing. Key considerations include the use of top and middle level ontology framework and/or the OCES Top Reference Ontology which would be a longer-term investment. Similarly, domain ontologies are useful as a more general approach but to create one from scratch or adapt one would need to be carefully justified.

Also, in the innovation case, a balance between new modular application ontology developments and the use of existing ontologies and ontology design patterns needs to be discussed, e.g., as part of a corporate ontology lifecycle management (Neuhaus, et al., 2013) since "The ontology has to evolve parallel to the progress of the company" (Luczak-Rösch & Heese, 2009)

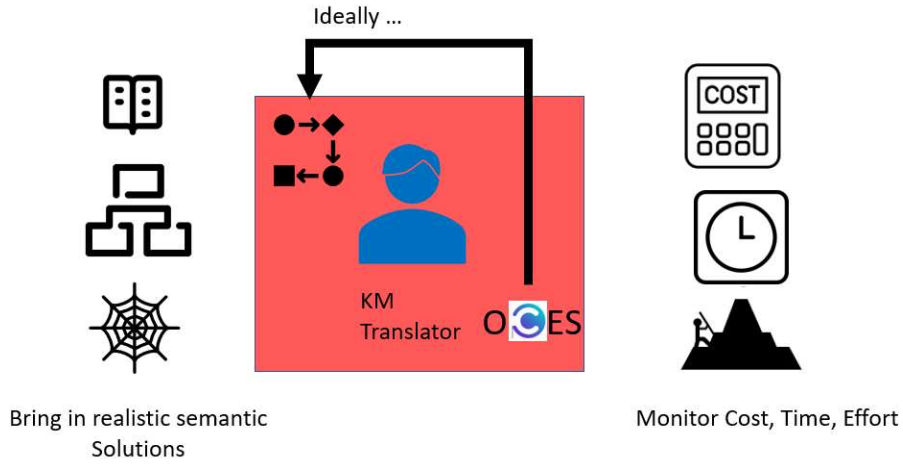

Figure 9: Step 4 – Propose potential knowledge engineering solutions. The pictograms surrounding the red cube highlight the To-Do's for the KM translators encountered in this step.

Further choices include knowledge representation formalisms and their semantics, reasoning approaches, implementations, and algorithm, and generally considering the trade-offs between using particular technologies in terms of effort, value and cost. This will be described in depth in Chapter 3. The analysis will lead to a comparison of the use of different semantic technologies as a decision guide for the customer when organising and directing the data workflow.

Step 5: Implementation work (for knowledge engineer, etc.)

Based on the implementation solution selected by the KM Translator together with the Client in Step 4, Step 5 involves the technical implementation of both the relevant ontologies or ontology modules and the tool-based knowledge engineering solution.

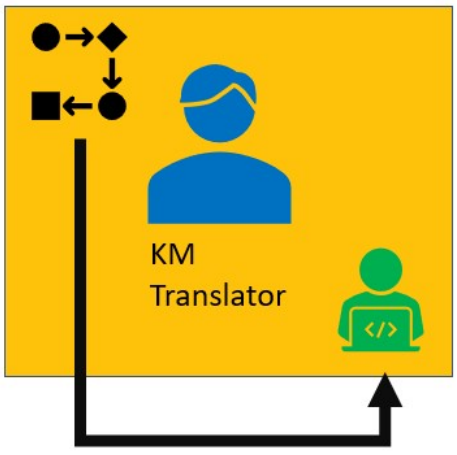

Figure 10: Step 5 – Implementation work (for knowledge engineer, etc.)

The Translator hands their engineering solution over for actual implementation, depicted by the green person pictogram in Figure 10. The implementation work typically requires a team of people including domain experts, data scientists and knowledge engineers. The result should be both a solution to the specific case and a contribution to moving the organisation forward to a higher maturity level of knowledge management, e.g., by implementing ontology maintenance solutions that will be key to keeping the specific solution relevant and up to date, as well as providing the opportunity for building on the initial success to other areas.

Step 6: Client adoption including training

In the final step, the Translator needs to ensure adoption, working with different stakeholders during demonstrating the functionality and potential extensibility, and supporting the organisation in training and CPD to move towards a knowledge engineering culture. The Take-over by the stakeholder (adoption) means most likely that a team of people will have to be assigned to make sure the semantic technologies are then applied. The maintenance of the new framework or work style will need monitoring and fine-tuning (at best) to make sure all operates as expected. They KM Translators may want to suggest corporate wikis, blogs or websites that may be used (Luczak-Rösch & Heese, 2009) to communicate the achieved modular ontology progress in order to boost its re-use for solving future innovation cases.

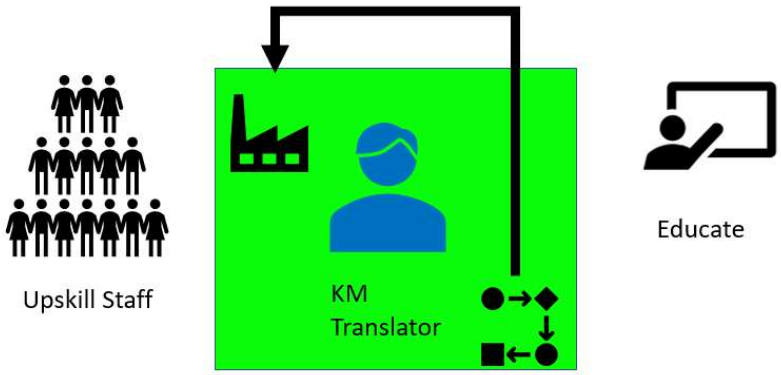

Figure 11: Step 6 – Client adoption including training

3. The requirements for a Knowledge Management Translator

3.1 The ideal Knowledge Management Translator Persona

In general, a KM Translator requires a complex range of skills based on expertise spanning across the Information and Communication Technologies (ICT), analytical philosophy, logic and science/engineering domains. Their competence will enable them to advise on the benefits of applying ontologies, selection of existing ontologies to employ, to develop tailored domain ontologies, and to translate business challenges into (potential or actual) solutions based on ontologies and related systems. As solving superordinate business challenges in this way encompasses the configuration of numerous business cases, well-networked translators are pivotal for successful data-driven business. In this section, we will elaborate on the ideal translator persona (Figure 12) in more detail.

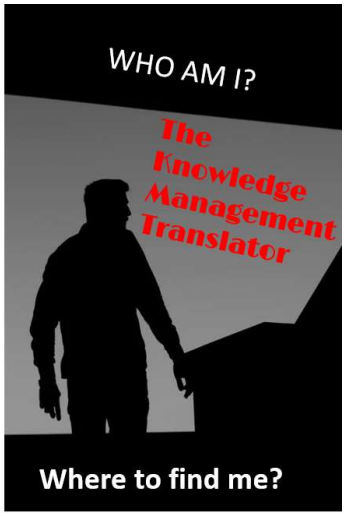

Figure 12: The new Role

We will define an exhaustive profile, and we know that at this time only a handful of persons may fit. Given that the required skill set is extensive, it is likely that in practical terms the role will be fulfilled by a team of Translators working on a case rather than a "Jack-of-all-Trades." Hence, we suggest that Translators form a team with other consultants or persons with particular skill sets within the organisation they will work for.

Figure 13: The new role will be a team effort

Figure 13 depicts somewhat an ideal scenario that may be only found in a data-driven large enterprise or a consultancy firm. However, the latter could enable SMEs to take advantage of the new role as they can hire these specialists on an as needed basis. We also may add, that not all protagonists are needed to accomplish relevant ontology driven work with data. To simplify our task at hand, we are going to define a persona and provide many facets for them to enable interested experts to identify themselves with parts of the role we are seeking. The facets we suggest to be essential, are:

A strong advocate and communicator

The ideal KM Translator can clearly communicate and promote the benefits of using an ontology-based data documentation and knowledge management approaches as essential to discover, extract and unlock the meaning of data and convert meaningful data into knowledge in general, and ideally has specific experience in the materials and manufacturing sectors, as we intend to prioritise them.

Ontologies are about the management of complex knowledge. The data and information related to this complex knowledge and their possible characterisation, contextualisation, visualisation, and transformation often reside within different groups in organisations (or even across organisations) and the benefits rely on these working together. A KM Translator therefore needs to be able to communicate well with different groups and to be able to overcome any barriers in collaborating towards a common goal following compliance, especially when these groups represent different scientific disciplines with conflicting R&D philosophies and scientific "language" barriers. The ability to gain and maintain support from management by demonstrating that the translator understands business and other societal priorities will be crucial for success.

To motivate companies to adopt semantic technologies, the Translators may want to survey stakeholders across the industry to identify the "matter-at-hand" and associated key business - and use-cases for ontologies. A portfolio of use-cases could demonstrate and quantify business values of semantic tools. The Translators may wish to detect and collect also failure cases and understand why they failed.

A good 'auditor' and benefits advisor

Identifying bottlenecks in the use of information that can be addressed with ontologies is key to demonstrating success. The Translator will need to be able to carry out audits to understand the subject matter and assess and define its context and clearly pinpoint information flow problems and how they impact the performance of an organisation.

On the other hand, it will be pertinent for them to prevent managers of organisations from misinformed decisions and letting them use ontologies only when they have thoroughly understood their framework. The Translator, thus, also needs to advise on business benefits of semantic technologies (including ontologies). The Translators need to objectively analyse the data maturity of an organisation before consulting on the application of a particular semantic technology. The Translators may want to consider an organisation's aptitude with several semantic technologies, like knowledge graphs (KGs), machine learning (ML) and artificial intelligence (AI). Sometimes, an organisation just may want to perform exploratory searches through their data to gain new knowledge or add new data, e.g., the pharma industry wants to better leverage biological assay results to support drug discovery; It is advisable to follow the quote by J. A. Hendler[14]: "A Little Semantics Goes a Long Way" and not overwhelm a marginally digitised organisation with all the newest ontologies and tools and triple stores and other whatnots. Even in SMEs with a wide product portfolio awareness may be risen that in the long term a capable ICT infrastructure complemented by taking on competitive data technologies is an enabler that uncloses automation benefits not only for data related to transport and packaging. These novel data technologies may be also related to the more diversified manufacturing and their R&D, and, thus, prospectively embracing the whole product lifecycle.

A KM Translator is expected to be well-trained and skilled for communicative exchanges that occur between human agents, between human agents and software agents, and between software agents. They target at augmenting human collaboration effectively by appropriate technologies, such as systems for ontology negotiations, for ontology-based business interactions, and for pragmatic ontology-building efforts in communities of practice. They utilise standards, but as for example, the "Pragmatic Web Manifesto" (Schoop, De Moor, & Dietz, 2006) highlights, they are aware that ontologies are not fixed, but co-evolve with their communities of use. Therefore, as these authors suggest rather than stressing formal foundations, for the KM Translator a pragmatics-based approach should be pursued, focusing on the application side towards a flexible, world-wide information exchange between entities such as human users, software agents, or computers. The KM Translators will use ontologies for semantic enrichment of their communicative exchanges, comprising pragmatic negotiations about business scenarios and, at the same time, negotiations about the semantic and pragmatic contexts remain possible.

[14] James Alexander Hendler (* April 2, 1957) is an artificial intelligence researcher at Rensselaer Polytechnic Institute (USA) and one of the originators of the Semantic Web

Technical skills in ontologies and knowledge engineering

A KM Translator needs a thorough understanding of knowledge engineering and should have profound knowledge of the trade-offs of using certain technology stacks[15], including semantic trade-offs and costs. They also should be familiar with, but not necessarily an expert, in:

- the landscape of semantic tools, including their maturity levels, and in particular the upcoming OCES (d'Aquin, 2021) including the Top Reference and Middle Level Ontologies, Ontology development and maintenance methodologies, ontology repositories etc.
- FAIR semantics to reuse and generate collaborative workflows
- knowledge representation formalisms and their semantics
- various reasoning approaches, implementations, and algorithms
- the ideas behind explainable AI and novel developments such as Neurosymbolic AI (Ananthaswamy, 2020), and how it relates to KE

As a result of an ongoing harmonisation and the integration of more and more industrial sectors and domains into a FAIR international translation ecosystem, it may be anticipated that both the tools and the procedures applying them are constantly developed further. This requires translators to keep their technical skills up to date and makes their expertise highly topical. It is foreseen that both the readiness to provide and to accept regular advanced training is a key aspect of the respective personas' skill-based facet and allows for implementing enhanced comprehensive knowledge about translation into specific translation tasks ("top-down" conceptualisation).

It is also important to note that there is no stereotypical profile for a Translator. The technical competencies required for a certain Translator's job will greatly depend on the type and level of translation, that the job at hand requires them to perform. For example, the skillset for Translators, responsible for recommending the best possible knowledge model or service as solutions for a particular business need is different from the skills needed for being able to model the data using those services or interpreting the results of these services for aiding effective decision-making. In terms of different levels of work, Translators working closely with the technical team members (e.g., data scientists, analysts, application engineers) may need different technical skills than the Translators working with the sales and marketing departments, which requires broader perspectives on customers, vendors, suppliers, market, and supply chains. Furthermore, translators working with government policymakers, technology alliances, investors, and entrepreneurs may even need to have exposure to the interrelation and impact of technology on politics, economy, society, legality, and the environment.

Relevant domain expertise

The aim of the KM Translator in the framework of the OntoCommons project is to support data sharing among materials and manufacturing companies and communities. They should be able to map science and engineering aspects to a wide range of semantic technologies and knowledge/data.

[15] "A technology stack, also called a solutions stack, technology infrastructure, or a data ecosystem, is a list of all the technology services used to build and run one single application." (Booth, 2021)

Specific translation tasks require insight in specific science and engineering domains. Hence the Translator role involves working with the respective domain experts in "bottom-up" conceptualisation and the organisation of knowledge which requires at least an appreciation and, in some cases, a good understanding of the respective materials and manufacturing domains, i.e., the "matter" in this case.

For generating value, based on the knowledge of the organisation, the Translator may be required to draw a fine balance between the technological rigours and domain-specific needs. Whereas theories and best practices for knowledge engineering (including data modelling, ontologisation, and transformation) ensures the correctness of the result, the expectations of the clients are paramount in the success of the result as the 'right solution is not always the best solution'.

While analysing the domain requirements for their respective industry, the translators must pay close attention to the interrelations and cross-functional impacts of different areas of the business. For example, a design decision may have a tremendous impact on the sourcing of material, a process plan may influence the assets, logistics and human resource needs. In this regard, the translators need to adopt "system thinking" to help in decision-making from a holistic perspective.

Unbiased Project management

In carrying out translation and overseeing a project, a Translator needs to ensure that technical and business objectives are met in the project of building knowledge engineering solutions. The Translator may have particular areas of knowledge and preferred choices but always needs to build awareness of their own as well as internal organisational technology biases.

Projects often involve working with science and engineering teams, data scientists/ontologists as well as business managers to ensure that the right KE approach is applied to the right business problem. In order to ensure success, the Translator also needs to support building a Knowledge Engineering culture in the organisation, which will be discussed in more depth below.

In a nutshell, we are aware that translation is predicated on communication and, thus, on dynamic dialogue comprising several dimensions. Harmonised translation procedures facilitating teamwork both among Translators themselves and between Translators and their industry clients will greatly be promoted by digital tools relying on machine-readable and ontology-based FAIR guidance and documentation. In this way, a persona acting as KM Translator is predestined to promote Industry 5.0 impulses in industrial materials innovation.

Whatever the current maturity level of an organisation may be, a Translator needs to support them to generate strategies for approaching and moving towards their desired maturity level. The starting point for the transformational journey is the evaluation of the current level of an organisation and then focusing on concrete plans of action during the transformation project. The evaluation needs to include at least six dimensions in the analysis: Products, Process, Platform, People, Partnership and Performance. These pillars can be clustered into two categories: Technical Pillars and Socio-Business Pillars, focusing on technical competency and process maturity, respectively. The Translators are responsible for designing the metrics for each dimension in such a way that the evaluation not only provides the AS-IS maturity level of the company but also lets them compare it with the desired one (TO-BE maturity).

3.2 Training and Continuous Continuing Professional Development

There are no colleges or universities offering courses to become a KM Translator. Hence, we suggest upskilling of either technical staff with semantic knowledge or knowledge engineers with technical knowledge.

In addition to these technical skills the Translator should be able to advise on business advantages of employing semantic technologies. The Translator should thus acquire deep understanding/knowledge of:

- Business goals and the industry interrelationships with their providers and customers related to business
- Value processes creating value, e.g., in economic, ecologic, and societal dimensions contributing to sustainability
- Performing a hands-on conception with industry clients for relating business decisions and value generation

By trying to fulfil all this these demands, Translators are endangered to become a jack of all trades, which will broaden their knowledge but flatten their expertise. The availability of profound expertise is essential for an organisation aspiring to provide a valuable translation service rather than a sales talk for a software product. To avoid this, a Translator will require a network of experts and be able to bring them in when required, i.e., to delegate tasks to other experts. It is unlikely that the KM Translator role will be a permanent position within even a larger organisation just as yet. We envisage freelance consultants or staff of consulting companies taking on the role when required by a customer. They will have to gain the trust of the established staff and be supported by an organisations' management to conduct their work. This is however an advantage for SMEs as they can hire a consultant when and if needed. Within large enterprises we expect over time that established staff undergo upskilling to be able to form an internal Knowledge Management task force. Senior technical staff can become Translators as a secondary role, to start with. They often already possess the flattened expertise profile required, understand the business goals of the organisation, work closely with managers, and have extensive networks of internal and external experts. Their ability to assess a wide range of projects within a larger business is ideal for developing interdisciplinary collaborations and spotting opportunities to employ semantic technologies.

3.3 Translator tools

KM Translators will need to be familiar with the use of a range of semantic tools and come equipped with methodologies of working with clients in a wide range of corporate scenarios. (Luczak-Rösch & Heese, 2009) Further development of the OCES (d'Aquin, 2021) will be key to lowering technical barriers. These developments include providing a more integrated and harmonised system of Top-

and Middle-Level Ontologies (TLOs and MLOs) as well as related, widely agreed domain ontologies in a framework that supports a pluralistic view of the world, making it more easily adaptable to the end user requirements.

OntoCommons delivered a report (Slaughter & Otten, 2022) that summarises the existing TLOs and MLOs used in our domains of interest, i.e., those showing potential for implementation within the NMBP (Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing) application domains. This report is useful for KM Translators to check if an ontology is actually used in relevant NMBP domains, if it is actively developed and maintained, if it can provide additional resources (other than OntoCommons) for its further development, and finally, if it is supported by strong communities that can facilitate stakeholder engagement.

Another useful report (Le Franc, 2022) sheds light onto the domain ontology landscape of manufacturing and materials. A dataset of 130 ontologies has been created based on expert inputs collected during workshops and surveys. This report may be useful to the KM Translator to uncover existing domain ontologies and preventing them from developing one from scratch.

OntoCommons also held a focused workshop aimed at the definition, extent, characteristics, and components of an ontology ecosystem toolkit and comprised their findings in a report. (d'Aquin, 2021). The toolkit should cover components classified under the four steps of the ontology engineering process, i.e., Ontology requirements specification, Ontology implementation, Ontology publication, and Ontology maintenance.

Ontology engineering requires some software tools/systems and also these have been listed in a report. (Skjæveland, Slaughter, & Kindermann, 2022) The authors collected software systems which are evidently used in practice and made a dossier comprising information about their homepage, documentation, and other publicly available materials.

In addition, they will require tools that support their interaction with domain experts. These range from graphical tools to tools that support a wide range of experts to agree on terminologies. Also, further tool development that lowers the technical training requirements for KM Translators will be required, for example better/easier User Interfaces to semantic/KE tools. It goes without saying that FAIR semantics (Le Franc, Bonino, Koivula, Parland-von Essen, & Pergl, 2022), i.e., making semantic artefacts such as ontologies FAIR, is of key importance to the work of KM Translators.

3.4 Organisational Readiness

Not all organisations are open as yet to work with a KM Translator; as a minimum requirement they will have to aspire to be a data-driven organisation that actively aims to convert data into knowledge.

Organisations need to offer a certain operational capacity, a good readiness level regarding data and be perceptive of ontologies and knowledge engineering. Pragmatically, applying outcomes of the early industrial revolutions based on mechanisation and automation showed to be much more remunerative for fixing thousands of screws per day than for loosening and fixing five screws when exchanging one car tyre which may straightforwardly be performed manually. Similarly, the ongoing industrial revolutions allow for profitability when data and information are to be re-used or shared. While there is a minimum maturity requirement that is to be met before the semantic technology is

adopted, most organisations have some level of data organisation and the Translator's role is to work with the organisation to point them in the direction that complies best with their requirements. As pointed out by Earley (Earley, 2020), most companies already have some sort of knowledge management in place which can be built upon. Nevertheless, some organisations may need to invest more in the process of capturing knowledge, to accommodate for the new developments in the Knowledge Engineering domain, and involving their experts to carry out conceptualisation as a key step in employing ontologies. Examples are questions such as "How you measure this temperature?", "What do you exactly mean by *product*?". A Translator can suggest neither a taxonomy nor an ontology without this "pre-ontology maturity" which is, to a great extent, based on an established taxonomy as a framework for the respective industry's language. In simple terms, the rough-and-ready-rule "one can't use what one can't interpret" holds true both for translators and for industry experts.

An organisation seeking to employ the services of a KM Translator must also achieve a minimum level of technical readiness. Those that rely on external consultants, licensed technology, standardised testing (i.e., ASTM[16]), or black box workflows for process development and manufacturing will need to ensure there is sufficient internal expertise to interpret all of their data. If the Translator (or team thereof) is an internal resource, they may be called upon to provide or achieve this level of readiness for a project. The technology stack needed is expensive, and once a project fails (which it inevitably will without a proper KM Translator), a client may likely shy away from investing again and tell their peers how bad ontologies are.

3.5 KM Translator Entry Points to Success

While a certain organisational readiness is important as discussed above, KM Translators, on the other hand, should be able to demonstrate the strength of KM methodologies based on a strong portfolio of successful use cases. These will be important in communications with target communities including Business Process Automation, where KM frees up time of knowledge workers to do intelligent things, Data Governance where KM ensures correct application of data and analytics, and R&D departments driven by innovation where KM supports future competitiveness and a shorter time to market.

KM Translators can offer to explain the organisations' relevant data and what the difference between data and knowledge is. They should take time to explain how Ontologies can help, where they fit in straight away, and what it is a business should be using them for.

The KM Translators should not make the mistake to define ontologies, schemas, workflows, etc. upfront but rather take the more natural middle approach of "define a little bit," then apply, then define some more (Agile Development). The latter approach lets the clients follow up how the imposed changes can bring benefits to their organisation. The translator should also be honest and tell a business when not to invest. Investing in semantic technologies blindly is the biggest reason why one can fail to ensure sustained industry interest.

[16] formerly known as American Society for Testing and Materials

One of the enablers for industries to reap the value of ontologies may be the application of just-in-time (JIT) methods and Lean practices. JIT methods apply efficient organisational practices substituting overly committed management processes and protocols that add cost to the customer, supplier, and the environment. In terms of ontology, organisations need to adopt trusted sources for ontologies so that they can be provisioned as on-demand. Ontology repositories (e.g., Industrial Ontologies[17], MatPortal[18]) or enterprise ontology banks hosted in the cloud are some great examples of such sources. However, organisations need to establish a support system for their employees to access and deploy ontologies in their data modelling, transformation, and integration jobs. Furthermore, organisations need to invest in understanding their business needs and pertinent domains and subject areas for curating and preparing their stock of ontologies for cutting down on time-consuming search and evaluation. All these strategies should also embed quality assurance within them instead of an ad-hoc concern. In terms of ontology selection, data-based modelling and annotation, the organisation should adopt a standardised approach for quality evaluation, preferably automatic or semi-automatic for increasing confidence in their decisions.

3.6 With whom they will work

Ideally, the KM Translator enters the company as a consultant but does feature in their management process as a person and not as a service. This means foremost, that Translators have to be hired on a contractors' basis and organisations are advised to consider our job spec (Appendix) in their recruiting strategy.

If Translators enter as contractors they will have to be assigned to a manager and/or project manager. Ideally, they should be woven into the Data Engineering division of a company. This is where some of the more difficult work needs to happen, like semantics (i.e., ingesting data into a semantic form) and API development (i.e., providing semantic data for downstream use).

If this does not exist within an organisation, Data & Analytics focused divisions could be an option as the staff there understand the technical side well enough to work on ontologies. However, there may be some preconceived opinions with regards to black box machine learning/data science and the nature of semantic tools in the first place. Therefore, the KM Translator has to have diplomacy skills to engage people in different ways of thinking.

As colleagues for the KM Translator, we envisage ontology curators, ontology engineers, DevOps experts and data engineers to coordinate solutions. As there are not many companies around that can offer this, these colleagues may have to be brought in as 3rd party experts when and if needed. Hence, if these roles needed cannot be covered by internal staff, we would strongly advice to form a team of mostly external consultants (with a couple of internal experts) for the pilot/demonstrator phase. To lower the barriers of working as consultants and subcontractors, Translators will need strong legal frameworks in place.

[17] https://www.industrialontologies.org/
[18] https://matportal.org/

Once success is evident, the clients can start to upskill or even hire staff to replace the consultants. A good overview of roles can be found with The Open Biological and Biomedical Ontology (OBO)[19] Foundry[20] which illustrates the very clear distinction between an ontology curator (domain expert) and engineer (logic/pattern expert). The ontology should not be put into the hands of a domain expert; we would like to stress to use the domain experts for the terminological curation and the engineers for the logical modelling (logic expert). We further suggest an ontology curator to work with Translators and domain experts. Ideally, a member of staff needs to be volunteered for this role, and the Translators can be their mentors; this "volunteered person" will ensure the adoption of the solution and its continuation in the organisation beyond the Translator engagement.

We also would like to stress the importance of the business site; Translators need to be able to work closely with the business team to map out the innovation case. According to Nonaka (Nonaka, 2007), "*As team leaders, middle managers are at the intersection of the vertical and horizontal flows of information in the company. They serve as a bridge between the visionary ideals of the top and the often chaotic market reality of those on the front line of the business. By creating midlevel business and product concepts, middle managers mediate between "what is" and "what should be." They remake reality according to the company's vision*." Hence, these middle managers should be a point of interaction. The KM translators need to understand that inside out before they can work with the engineering team on a solution. Thus, Translators should be located at the interface between engineering (data, ontology engineering) and the business team.

For many SMEs and organisations with a non-established data division of some sort, the manager taking on the Translator would be the head of R&D. However, having established, that an engineering team can come in as consultants for a short-term project, this is not prohibitive at all.

3.7 How the Translator can enable changes within an organisation to pave the way for adopting ontologies

For the KM Translators, it is important to remember that the adoption of sophisticated data and knowledge modelling techniques, including ontology, is always a means to an end. The level of semantic rigour is specific to the job, i.e., organisations interested in integrating data from multiple sources for market or supply-chain analysis may need geospatial tagging whereas organisations interested in predictive maintenance based on machine-monitoring data may require event-based semantics and high-performance inference. There is no requirement for upper-level (top-level or mid-level ontology) semantics for a company which has no scenario for cross-discipline or cross-domain data interoperability. On the other hand, policy institutes, industrial R&D, and product research assessing social trends, human behaviour, and historical records may require a diverse set of ontologies aligned by a set of generic vocabulary and rich semantics. Such requirements are common in modern-day e-commerce, healthcare, and transport industries. The bottom line is that the translators should bring the right amount of semantic interoperability as justified by the organisational need, return-on-investment (ROI) and Key Performance Indicators (KPIs). However,

[19] https://obofoundry.org/
[20] https://oboacademy.github.io/obook/getting-started/#the-different-roles-of-obo-semantic-engineering

knowledge and know-how additions (both about data and processes) in an organisation are not always captured by the organisation's knowledge management tools, so the KM Translator may want to suggest KPIs than can be realised by existing data. Such KPIs could be:

- Code maintenance cost (cost of changing business logic)
- Cost of losing domain/business experts (a thriving knowledge culture is key)
- Value added for end-clients
- Interoperability of existing data silos (%)

KM Translators are envisaged to be consultants, who should also advice a client when not to use ontologies. One can build trust by empowering a client to make informed decisions and not blindly adopt the wrong solutions. If ontologies are used for the "correct" innovation challenges, and, thus, accelerate new products or patents, a client can see their value and will consider them for further engineering work, new materials and manufacturing processes that work.

It is recommended that the KM Translator remains involved in the entire R&D workflow and reports whenever semantics and ontology are the reason for success, otherwise all will be just attributed to the usual R&D advancements.

3.8 Ethics

The workflows converting data into knowledge have the potential to be abused. Even within organisation there maybe rules that data (e.g., person-related data) cannot be easily shared, and building up a knowledge layer must comprise regulations on what knowledge should be available at which point to whom for which purpose, and what shall be done after the purpose has timed out.

The European Commission provides rules and actions (European Commission, 2021) for excellence and trust in Artificial Intelligence to still able AI to be used to its best potential but also protect EU citizens.

The power of such workflows lies in that cross-domain data can be brought in, linked and new knowledge can be created. Each domain comes with certain regulations, such as data who identify living persons must be General Data Protection Regulation (GDPR) compliant. Sensitive contents regarding politics, race, religion, and ethnicity generated from different sources need to be moderated. Potentially, workflows could be used to monitor the workforce engaging with them. The access to such features should be disabled by default.

Trusted Data Sharing (TDS) and Trusted Data Access (TDA) must be respected by KM Translators as part of data protection concerns. The enablement of TDS/TDA in every facet of knowledge management is facilitated by technical documentation, a standardised identification scheme, and traceability of provenance. Apart from TDS and TDA, various data governance techniques such as FAIRification[21] and JUST (Judicious, Unbiased, Safe and Transparent) data annotation are concepts, that are developed by the European Open Science Cloud (EOSC)[22], and have received overwhelming support from industry stakeholders in a recent EOSC study. (Magas & Dubber, 2020) They ensure

[21] https://www.go-fair.org/fair-principles/fairification-process/
[22] https://www.eosc.eu/

that reliability and accountability are embedded in workflows affecting environmental sustainability, and support CARE (collective benefit, authority to control, responsibility, ethics) principles[23] of data equity.

4. The challenges of the role, of the work, current gaps, and possible solutions to support the role of a Knowledge Management Translator

The challenges and gaps will become evident when the KM Translators engages with their clients. In the following section, we will prepare them with possible questions they may face and provide some state-of-the-art answers.

Why to invest in Ontologies at all?

Organisations will have to carry the costs but will need good incentives why to do this; the Translator will need to convince managers and show the added value. The OntoCommons Demonstrators will be useful to show to clients that the investment is worthwhile. However, building and maintaining ontologies is expensive, hence show cases with high impact will be important. Once successful, the client can use that fact that they are working with ontologies as PR for their company, and raise its profile; this is certainly an early win.

To keep costs down, the KM Translator will aim to re-use previous ontologies, KGs, etc. However, ontologies and KGs are often created for a specific Use Case and a reuse in the future, i.e., knowledge transfer and interoperability, is forgotten about, or ignored because of lack of resources or long-term planning. The KM translator will work with a kind of check-list that can be used during ontology creation for abstracting out processes, or "linking" to existing work.

We as an SME cannot afford to take part, can we?

Translators will need a wider system including infrastructures and digital marketplaces (e.g., DOME 4.0) to 'drive' the ontology-based data documentation and support SMEs to take part.

What is your CV like, and can you really help us?

There is no certified KM Translator service, hence, OntoCommons needs to collate existing Training Materials/resources from distinguished sources and to provide a training portfolio.

How long will you take?

Large ontology modules can take years of development. The Translator may want to take two to three weeks to capture data, check if the organisation does have some governance and some data

[23] https://www.adalovelaceinstitute.org/blog/care-principles-operationalising-indigenous-data-governance/

maturity. Instead of developing an ontology module from scratch Translators will check the landscape for similar ontologies and use the OntoCommons resources. The best way forward is to start with small pilot projects with simple ontologies or existing ones to deliver tangible results quickly.

Do you have all tools you need?

OCES will collate all existing tools which will include excellent Translator resources. We expect the Translator to have a good understanding of the OCES toolkit. Also, OntoCommons will explain and suggest some tools suitable for non-expert users.

Are our data OK?

Semantics requires proper data and for AI, e.g., this necessitates high (human) effort to produce and curate which is expensive. So, the Translator will have to be driven by the quality of the existing data and start with an appropriate semantic solution. Also, the Translator team needs experts in the domain, to understand thoroughly what data are needed. If cross-domain knowledge is needed ontologies as well as data documentation need to be cross-domain, too.

How shall we finance this big team you need and why?

The Translator may start with a small pilot project, such as bringing ontology in as part of some more generic data science/ machine learning effort.

How will we train our team?

OntoCommons is aiming to provide Training Materials/resources/for a community of practice and will provide a training portfolio of existing CPD.

5. Conclusions

In this White Paper, we have developed the "ideal" KM Translator role, well aware that they largely do not yet exist. However, there are similar Translator roles in materials modelling as well as data science and also there are already knowledge engineers and consultants effectively working as KM Translators.

We call on interested parties to join a KM Translator community to further develop the role, and to educate both the clients as well as the providers of such services. We also would like to manage their expectations – it is ok to start with small semantic changes such as a better way of storing data or fixing an existing vocabulary. One does not have to move straight to ontologies or Triple Stores to make an impact.

We are looking for clients and providers who are interested in such a venture and are interested in using emerging digital marketplaces in Industry Commons to match them. The latter can also be used as learning environments and match the learners with courses or materials to self-train. Furthermore, we will need to establish a community of practise where experts can share their knowledge and co-create new methods.

This work should also give some ideas to educators at colleges or universities or similar institutions to teach knowledge management and knowledge engineering skills to a wider range of professions.

6. Acknowledgements

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7. Disclaimer

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8. Acronyms, Abbreviations and Elucidations

AI - Artificial Intelligence

ASTM - American Society for Testing and Materials: International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services, see https://www.astm.org/

B2B – Business to Business

CARE - Collective Benefit, Authority to Control, Responsibility, Ethics

CPD - Continuous Professional Development

Domain Ontology - A domain-level ontology is one that identifies types that further specialise the basic types from one or more mid-level ontologies. Domain ontologies describe objects, events, and relationships that are of interest to a more limited number of knowledge domains (e.g., Intelligent Analyst Role, Portion of Ammonium Nitrate, or Act of Watercraft Registration). https://www.nist.gov/system/files/documents/2021/10/14/nist-ai-rfi-cubrc_inc_004.pdf

EMMC - European Materials Modelling Council: https://www.emmc.eu

GDPR - General Data Protection Regulation

H2M - human-to-machine

IA - Information Architecture: is the structural design of shared information environments; the art and science of organizing and labelling websites, intranets, online communities and software to support usability and findability; and an emerging community of practice focused on bringing principles of design, architecture and information science to the digital landscape https://en.wikipedia.org/wiki/Information_architecture

ICT - Information and communications technology

JIT - Just-In-Time

JUST - Judicious, Unbiased, Safe and Transparent

KE - Knowledge Engineering: refers to all technical, scientific and social aspects involved in building, maintaining and using knowledge-based systems. https://en.wikipedia.org/wiki/Knowledge_engineering

KG - Knowledge Graphs

KM – Knowledge Management: the collection of methods relating to creating, sharing, using and managing the knowledge and information of an organization. It refers to a multidisciplinary approach to achieve organisational objectives by making the best use of knowledge. https://en.wikipedia.org/wiki/Knowledge_management#:~:text=Knowledge%20management%20(KM)%20is%20the,the%20best%20use%20of%20knowledge .

KPI - Key Performance Indicators

M2H - Machine-to-Human

ML - Machine Learning

MLO – Mid-Level Ontology: Middle-level (or mid-level) ontologies are primarily intended to extend TLO concepts towards a specific discipline (e.g., manufacturing, materials science, chemistry) with the aim to provide a core shared vocabulary for lower-level modules. An MLO will provide a higher level of detail than a TLO, extending the taxonomical structure of the ontology more along on the horizontal dimension (i.e., sibling classes under the same superclass). (Slaughter & Otten, 2022)

OCES - OntoCommons Eco System (d'Aquin, 2021)

R&D – Research and Development

ROI - Return-On-Investment

SME – Small and Medium Enterprises

TDA - Trusted Data Access

TDS - Trusted Data Sharing

TLO – Top-Level Ontology: top-level ontology (or foundation ontology) is an ontology (in the sense used in information science) that consists of very general terms (such as "object", "property", "relation") that are common across all domains. (Slaughter & Otten, 2022)

9. Picture Credits

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Figure 1 depicts "Wall Mounted Ladder to Access Rooftop" by Sami Aksu, adapted by Alexandra Simperler.

Figure 2 was created by Michael Noeske and adapted by Alexandra Simperler using free icons from MS Powerpoint and https://www.iconfinder.com/, respectively, adapting Figure1.

Figure 3 was created by Alexandra Simperler following Klein et al. (Klein, et al., 2021)

Figures 4-6 and 8-11 depict free icons from MS Powerpoint and https://www.iconfinder.com/, respectively.

Figure 7 was provided by Dimitrios Kiritsis.

Figure 12 depicts "Anonymous man standing on roof" by Özgür Ünal, adapted by Alexandra Simperler.

Figure 13 depicts "Photo of people holding each other's hands" by fauxels, adapted by Alexandra Simperler.

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11. APPENDIX

Job Title: *Knowledge Management (KM)Translator*
Job Purpose • Support building KM solutions to business problems ensuring that technical and business objectives are met. • Ensure that the right KM approach is applied to the right business problem • Support building a KM culture in the organisation • Has and builds awareness of Internal technology biases ○ Semantic trade-offs for all stacks ○ Mitigation strategies for all trade-offs and their cost ○ Bridges between Knowledge Engineering (KE) stacks ○ The landscape of tools, incl. maturity levels, costs, etc ○ FAIR semantics, re-use and collaborative workflows
Role in the organisation The KM Translator works across departments and interacts with multiple roles inside and outside of the organisation. It involves working with science and engineering teams, internal and external data scientists/ontologists as well as business managers. In particular: • Working closely with the business team to map out innovation cases. • Working with ontology curators, ontology engineers, devops experts and data engineers to coordinate solutions. • Coordinating with domain experts for terminological curation • Coordinating with engineers for the logical modelling
Main Duties • Interfacing between engineering (data, ontology engineering) and the business team. • Perform readiness assessment with respect to human resource, tools, ontologies, and data maturity • Identify innovation case and elaborate on the benefits of adopting semantic technologies • Conceptualise the Innovation or Data-to-Knowledge Governance Case • Determining relevant existing vocabularies, taxonomies, ontologies, and standards as well as required data and sources • Propose potential knowledge engineering solutions. • Delegate work to experts

- Deliver internal adoption of solution including training

Qualifications

PhD in a Knowledge Engineering discipline or a PhD in Physical Sciences and relevant post-doctoral or industry experience or MSc with several years of industry experience in Knowledge Management.

PhD in the field of interest (other than Knowledge Management, e.g., materials science, metallurgy, biochemistry, etc) with 5+ years of industry experience in multidisciplinary R&D projects with an adequate second master or similar degree in knowledge management

Relevant experience

- Several years of experience in KM solutions
- Good knowledge of the Business Sector
- Experience of working with the OCES tools is desirable

Aptitude, skills, and abilities

Must be an excellent communicator

Should be familiar with, but not necessarily an expert in:

- Knowledge representation formalisms and their semantics
- Various reasoning approaches, implementations, and algorithm
- The ideas behind Neurosymbolic AI and how it relates to KM

Personal attributes

- Team player
- Solution-oriented