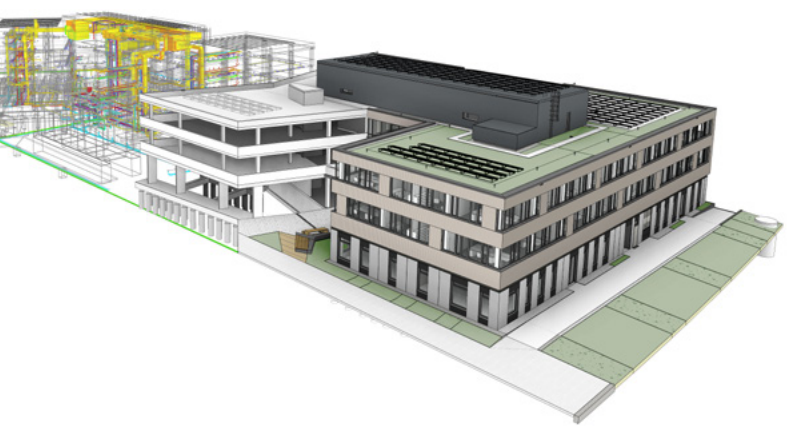

Digital Twins

Technology Report

Vienna,
November 2021

Dear readers,

Vienna is currently home to around 9,000 manufacturing companies employing more than 170,000 people. The product range is very broad and, in addition to goods manufacturing, includes mining and quarrying, energy and water supply, wastewater and waste disposal, environmental pollution remediation, and the construction sector. Overall, the manufacturing companies are responsible for a gross added value of around 29 billion euros annually, which corresponds to just under 33 percent of Vienna's added value.

According to various studies, Vienna scores particularly high on innovative strength, comprehensive support for start-ups, and a strong focus on sustainability. Vienna also ranks as a top "smart city". The city also boasts a research- and technology-friendly climate, geographical and cultural proximity to growth markets in the east, a high-quality infrastructure and education system, and, last but not least, the highest quality of life in the world.

With its "Vienna 2030" strategy, the federal capital is focusing on areas where the city is particularly successful and in order to meet the major challenges of the coming years – from climate change to digitisation. The goal is to be a world leader in six areas within the next ten years and to develop particularly powerful innovations ("Viennese solutions"). One of Vienna's top areas of focus is "smart production in the big city." Due to the integration of high-quality digital solutions and the use of state-of-the-art production technologies, manufacturing companies from Vienna are regarded worldwide as pioneers of modern production technologies. Vienna is also setting new standards on an international level in the greening of production processes and products, thus securing exportable location quality.

New technologies like digital twins create opportunities to implement new business models and optimised processes transparently and securely with Viennese quality. Digital twins have the potential to make a significant contribution to the careful and efficient use of resources.

To make optimal use of the potential at this location, the Vienna Business Agency acts as an information and cooperation platform for Viennese technology developers. It links companies with development partners from business, science, and the city administration and supports Viennese companies with targeted monetary subsidies and a variety of consulting and support services.

This Technology Report provides an overview of a wide range of trends and developments on the topic of "digital twins" in Vienna, taking into account relevant providers of know-how and activities.

We hope you enjoy reading it!
Your Vienna Business Agency team

vienna business agency

REACT-EU ALS TEIL DER REAKTION DER UNION AUF DIE COVID-19-PANDEMIE FINANZIERT.

Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.

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A digital twin is a virtual (digital) model of a system that is often created and operated with the aim of observation, forecasting, planning, or optimisation. The modelled system can be an object and its associated processes, or a "virtual" system such as a service. Therefore, the overall "digital twin" system includes:

- the modelled system or object, usually a physical system
- the model or various models of the object, the actual "twin"
- data and information links, i.e., measurement and mapping relationships between the object and the model.

The digital twin can be used to represent the states of the modelled object, gain insight into system behaviour in the past, and predict system behaviour in the future (often assuming different parameters or control variables). In this context, many digital twins operate in real time and are used for planning and supporting decision-making.

Common components of such digital twins are:

1. sensors that provide information about the current state of the modelled system,
2. network connections (connectivity) used to update data,
3. algorithms and data structures for analysing and predicting various system aspects,
4. user interfaces, often with visualisation of the modelled object and its states.

To be a true digital twin, a model must above have all of these components and be able to be used as a unit and not simply different partial models for different parts or aspects of a system. However, there are many possible definitions for digital twins in the literature.[1] Two common definitions should be mentioned here:

- a software representation of a physical object with the goal of understanding the past, viewing the present state, or anticipating future situations (Dan Lohmeyer, GE).
- a virtual representation of a physical asset that, through data and simulators, is enabled to perform real-time prediction, optimisation, control, and improved decision-making (Rasheed et al. 2020).[2]

1.1 Application of Digital Twins

Digital twins represent an approach which is very general and therefore applicable in many different industries. Some examples:

- Energy: power generation, e.g.,solar power plants, wind turbines, etc.
- Health: measurement of vital parameters, e.g., fitness trackers, etc.
- Aviation engines, airports
- Production: production plants, continuous plant processes, model-integrated production controls
- telecommunications: Network monitoring, fault diagnosis, network optimisation

In addition to these possible applications, the construction and real estate industries should also be highlighted. To present all the possible applications of a digital twin in this industry would go far beyond the scope of this Technology Report. Digitisation options, their impact on environmental sustainability (resource efficiency, energy efficiency, and standardisation), and the use of BIM (building information modelling) are presented in detail in the technology report "Digital Design, Construction, and Operation".[3] This report also details many (construction) projects that are currently being implemented.

1
A total of 21 definitions – albeit very similar ones – can be found in Liu M., Fang S., Dong H., Xu C. (2021) Review of digital twin about concepts, technologies, and industrial applications. Journal of Manufacturing Systems, Vol. 58 (B), 346–361, www.sciencedirect.com/science/article/pii/S0278612520301072

2
Rasheed A., San O., Kvamsdal T. (2020) Digital twin: values, challenges, and enablers from a modeling perspective. IEEE Access, Vol. 8, DOI: 0.1109/ACCESS.2020.2970143

3
wirtschaftsagentur.at/fileadmin/user_upload/Technologie/Factsheets_T-Reports/Digitales_Bauen_Technologiereport_DE.pdf

Technologiezentrum Seestadt (tz2); © Vienna Business Agency/Kurt Kuball

○ Example – Technology Centre Seestadt

The second component of the Technology Centre Seestadt (Christine-Touaillon-Strasse 11; Vienna 1220 Austria), which was integrally planned by ATP Wien using BIM, offers ideal conditions for Industry 4.0 companies. The digital model was used directly for decision-making throughout the planning process and contributed to a high-quality, on-time implementation during the construction phase. The second component of the Vienna Business Agency's Technology Centre expands ASCR's state-of-the-art research environment. In Siemens' first BIM project in Austria, Aspern Smart City Research (ASCR) is conducting research in Use Case 15 "Digital Twin" on a complete and uniform building data repository, among other things, which in the future should support not only efficient planning, but also high value creation during the operational phase. 3D laser scans of the building were taken during construction. The shell of the building, the building services, and the final build-out were recorded seamlessly and support complete documentation and quality control of the BIM model. The scans were used to bring the building models into an as-built state and to enrich them with further relevant data for operation. The model was then transferred to operations and integrated into the BIM-enabled building management platform Desigo CC. Subsequently, existing data points were linked to the corresponding objects in the BIM model to ensure optimal operation.[4]

4
www.youtube.com/watch?v=GWWsSyQ4fal (source: Siemens AG Österreich)

1.2 Benefits of a Digital Twin

The first thing a digital twin does is provide current data about the modelled system, for example, the operating status of a system or the traffic flow in a district. The presentation of current measured values through suitable visualisation and user interfaces alone is an important benefit of a digital twin. However, it also enables the targeted simulation of situations, for example, to answer “what if?” questions. Frequently, digital twins serve to anticipate system states with the aim of intervening for control purposes, for example, to determine equipment parameters or to control traffic.

○ Example – wind turbine

Digital models of wind turbines for power generation enable the optimisation of power production and predictive maintenance, among other things. Digital twins make it possible to run through different scenarios in production and maintenance. For example, the optimisation of the turbine temperature based on the data from the digital twin plays an important role in the operation and maintenance of the system. Another important application for digital twins is training engineers. For example, maintenance work, different settings, and operating states can be tested on the digital twin without risk and at low cost. In this way, engineers gain experience with different situations without the actual risks of use on the real system.

The use cases of a digital twin can be very different in the various phases of a product. In the design phase, digital twins can be used for iterative optimisation of the system, improve data integrity, or support virtual verification of the system. In the manufacturing phase, digital twins are used for monitoring – in real time if necessary, for production planning, control and evaluation, and the management of durable goods. But digital twins have also been used for aspects of human–robot interaction or for predicting the quality of manufactured products.[5] In the operation and maintenance phase, digital twins can be used for predictive maintenance, fault detection and diagnosis, condition monitoring, and performance prediction.

1.3 Digital Twins in Production

In the area of production, digital twins play a special role in that both the manufacturing process and the manufactured product can be the subject of the digital twin. A digital twin can potentially support the entire product lifecycle, from manufacturing to disposal. What is often more important than a graphic simulation is often simulations that allow the influence of manufacturing parameters on the products to be investigated. In this way, not only are production and product parameters monitored, but scenarios can also be run through on the digital twin. These include changes to the production process due to new regulatory requirements, for example.

Digital twins can help to improve information integration in the production process, for example, to dynamically link data from the ERP (enterprise resource planning) system with data from IoT/cloud platforms for predictive analytics, as well as with operational data and maintenance planning and technical documentation. Changes to automation software are usually made infrequently and with great caution because changes always involve some risk and can lead to undesirable downtime. Digital twins help to improve the quality of control software by simulating certain parameter changes on the twin at the very least. However, this requires realistic modelling of the sensors, as well as physical modelling.[6] In the best case, a system is commissioned virtually in the digital twin to detect undesired consequences at an early stage. Even an imperfect twin can help to avoid serious errors before the start of a real test run or to optimise equipment or product parameters.

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For a more detailed description see Liu M., Fang S., Dong H., Xu C. (2021) Review of digital twin about concepts, technologies, and industrial applications. Journal of Manufacturing Systems, Vol. 58 (B), 346–361, www.sciencedirect.com/science/article/pii/S0278612520301072

6
A good overview of digital twins in the system lifecycle is provided by the report of the same name by G. Güntner, S. Hoher (Ed.), Digital Transfer Centre Salzburg. www.salzburgresearch.at/wp-content/uploads/2020/09/Digital_Twin_WP-final-1.pdf

2.1 Technological Development

The historical precursor of today's digital twins were models that were developed for particularly complex situations. The 1-to-1 models of spacecraft developed by NASA as part of its Apollo missions provide one famous example. These models were important development and planning tools to search for solutions that arose with the real space shuttles. While these models, which were not primarily digital, but rather physical and electronic, proved useful, they were not very flexible and were location-bound, complicated, and costly. This suggested the use of digital simulation technologies to model and simulate systems with specific objectives in mind.

The theoretical foundations of digital twins lie in the field of computer science, but also in the natural sciences, mathematics, statistics, and even philosophy, especially epistemology. In particular, systems science and cybernetics of the 1950s and 1960s have provided important theoretical foundations for systems modelling.[7]

An important developmental push in the field of digital twins came from the emergence of digital sensors or the "Internet of Things" (IoT). The availability of up-to-the-minute sensor data and the proliferation and improvement of digital simulation tools (simulation software, modelling tools, protocols, and standard interfaces) reduced the effort required to create digital twins.

Another significant advance was brought about by new prediction methods for systems, for example, through machine learning technologies. Using data-driven methods, it is now often quite easy to draw conclusions about the future states of a modelled system with a high degree of reliability or predictive accuracy.

Overall, from a technical point of view, real-time capable digital twins are becoming increasingly important. Another important technological trend is the automatic or automation-assisted generation of digital twins. Today, for example, models can be generated semi-automatically using machine learning methods, but also using logic-based modelling. However, these models suffer from a certain loss of transparency. Automatically generated digital twins that are also easy to explain, comprehensible, and maintainable are, therefore, also a subject of current research.

2.2 Market Development

The global digital twins market was estimated at $3.1 billion[8] and $5.04 billion[9] in 2020, respectively. These forecasts assume global growth of 58 percent (CAGR) by 2026 and 42.7 percent by 2028. The global market will thus reach approximately $48 billion by 2026 and $86 billion by 2028. Despite a minor dip in 2020, this strong growth is at least partly due to the pandemic. An important part of the demand arises from healthcare, the pharmaceutical industry, and other industries in response to manufacturing challenges. Key industrial players like ABB, Dassault, General Electric, SAP, and Hexagon AB strongly influence the global market. Along with household and retail, the manufacturing sector is one of the most important markets for digital twins. Agriculture, energy, utilities, and healthcare are also important sectors.

Key global factors driving the demand for digital twins include advancing industrialisation, increasing digitisation (IoT), and disposable income and urbanisation. As mentioned, the increasing popularity of machine learning and artificial intelligence also represents a positive driver of the rising interest in digital twins.

In 2020, Europe accounted for about 30 percent of the global market, roughly equivalent to that of North America. Fundamentally, Europe provides a favourable environment due to a high level of industrialisation, automation, and digitisation or IoT. In addition, important strengths of European industry lie in areas that offer favourable conditions for digital twins. These include the automotive industry and mechanical engineering, but also the energy sector. Likewise, an innovative healthcare sector represents an important driver for digital twins.

7
A well-founded and mathematically oriented look at the basic issues of mathematical modelling of dynamical systems is provided, for example, by Casti J.L. (1992) Reality Rules, Vol. 1 and 2, Wiley-Interscience.

8
www.marketsandmarkets.com/Market-Reports/digital-twin-market-225269522.html

9
www.grandviewresearch.com/industry-analysis/digital-twin-market

In general, the commercial focus of the use of digital twins is currently on complex systems and high-value goods. These include, aircraft turbines and wind turbines, for example. However, digital twins are also increasingly being used in the public and semi-public sectors, such as for modelling parts of transportation systems.

2.3 Challenges

Despite great progress in standardisation and interfaces, there is still a lack today of standardised procedures and widely applicable standard solutions. Many digital twins emerge from practical experience and are also often expanded incrementally. This can lead to complicated and difficult-to-maintain conglomerations of parts of a digital twin. In the area of industrially oriented digital twins, organisations like the Industrial Digital Twin Organisation[10] are trying to establish standardised procedures and harmonising partial models.

An important practical limitation is the fact that digital modelling is usually already done with certain (explicit or implicit) assumptions about how the model will be used. This means that, while digital twins represent virtual models of their respective systems, they cannot be used in just any way with no restrictions. That means that situations may arise for which a different modelling approach than the one chosen would have been more appropriate. Therefore, when using digital twins for purposes other than those originally intended, caution should be exercised in interpreting the model data (e.g., forecasting).

As with any model, there is also the issue of the accuracy or limitations of the simulation. Typically, all models function reliably only within certain parameter limits and cease to provide meaningful forecasts outside certain limits, for example. These limits mainly arise where the relationships between different quantities are no longer linear, because in these cases, small deviations of the model from the object to be modelled can lead to large deviations in the result. In any case, the validity of the data of a digital twin should always be verified through systematic comparison with the modelled object as well. As with the creation of artificial intelligence models, it can also be difficult to precisely explain the behaviour of a model. This is especially true when models are created at least semi-automatically.

While digital twins can often provide extremely good simulations of a physical model, in practice it is not easy to derive the correct interactions, control actions, or recommendations for system interventions from the system behaviour. It is true that digital twins can help determine good decisions through "what-if" simulations. However, automatically generating such recommendations is often beyond the scope of a digital twin.

It is important for companies that want to address the issue to have both domain experts and modelling experts. While domain experts typically have many years of experience in the field of their physical systems, modelling experts are more likely to be experienced in systems science, statistics, sensor technology, or interfaces.

Additionally, it can be important and difficult to clarify the legalities of designing and deploying digital twins. Questions arise about data use, maintenance and customisation, intellectual property, confidentiality, and even liability. This is especially true where the design and, where relevant, maintenance of a digital twin are offered as a service. The use of data generated by humans that can be interpreted as personal data can also become particularly challenging, as special data protection obligations apply in this case.

Finally, it is worth mentioning that digital twins can also strongly interfere with familiar ways of working and workflows. Their use can change familiar ways of working if, for example, employees' experience with the behaviour of physical systems is replaced by simulations. Depending on the situation, such use of a digital twin can lead to greater employee competence, or to a reduction in the scope of their tasks and thus to a loss of competence. Another critical point may be reached when employees are remotely monitored at the workplace directly or indirectly via the digital twin. Things can become particularly complicated if the use of the digital twin also involves algorithmic decisions that directly affect people. Such issues are among the fundamental strategic considerations that should be carefully examined before using digital twins and are just as important as the question of the exact business model or value creation to be achieved with the digital twin.

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idtwin.org

3.1 Activities of the City of Vienna

Since about 2019, the city of Vienna has been working on a digital twin of the city. This is based on numerous data points that are linked to realise a virtual representation of the city, its processes, objects, and people. This twin will be used to track procedures, processes, and the use of resources and to optimise them through data-based decisions. The digital twin “geoZwilling” represents an important component of this process. It extends the semantic vector-based model to bridges, vegetation, terrain objects, tunnels, street furniture, etc.[11] Apart from the 3D modelling, this provides important semantic information to serve as a basis for a dynamic digital simulation. In addition to the physical objects of the city, other types of data, like microcensus data on population, socio-economic data, and energy consumption information, will also be incorporated.

○ Example – Thermal Twin 4.0

In a cooperative project with Cloudflight, ENRAG, Wien Energie, and the Vienna University of Technology, funded by the Vienna Business Agency, an overall model of the combustion processes of a thermal waste treatment plant is being created. In addition to control engineering methods, machine learning approaches are used to mitigate the incomplete data situation. Together, they help create a digital twin of the incineration plant to optimise both energy efficiency and CO_2 emissions. Key challenges in creating the twin included modelling the likelihood of certain fuel classes being in the combustion process and developing an optimisation procedure that minimises the error between the modelled and actual sensor values.

3.2 European Project Change2Twin

The Austrian high-tech company TTTech is a partner in the EU project Change2Twin[12], which aims to support digitisation in manufacturing companies by creating digital twins. TTTech Industrial provides the project with its open edge computing platform Nerve Blue. This is used to collect real-time data from the machine or production line and is being implemented in several pilot projects. This is meant demonstrate the use of edge computing to implement a digital twin. The project also provides interesting resources on its website for getting started with digital twins. They range from introductory videos to a marketplace for digital twin technology.

11
Details about the Digital geoTwin Vienna can be found in: Lehner H., Dorffner L., Digital geoTwin Vienna: towards a digital twin city as geodata hub. PFG – Journal of Photogrammetry, Remote Sensing and Geoinformation Science, 88, pp. 63–75, 2020. doi.org./10.1007/s41064-020-00101-4

12
www.change2twin.eu

4. Services of the Vienna Business Agency

The objective of the Vienna Business Agency is the continuous development of international competitiveness by supporting both Vienna-based companies and their innovative strengths, and the sustainable modernization of the city as a business location. To achieve this, the Agency provides free consultations to all entrepreneurs in Vienna on the topics of business creation, business location or expansion, business support and financing. Furthermore, networking contacts in the Viennese economy are also made available.

The Vienna Business Agency supports and helps businesses complete their research and development projects with both individual consulting and monetary funding. Depending on requirements, they will receive information about sponsorships, financing opportunities, possible development partners, research service providers, or research infrastructure, according to their needs.

The Vienna Business Agency sees itself as a network of the Viennese Green Tech & Social Tech industry and supports businesses with consultations, as well with distribution and networking among themselves. Events and workshops on topics from the sustainability sector are held regularly.

Additionally, the Vienna Business Agency helps with company relocations or internationalization services. Assistance is provided to business founders and young entrepreneurs in the start-up area. Free workshops and training sessions on topics of everyday business are offered as well as small, affordable office spaces.

Founders Labs[13] support aspiring entrepreneurs and founders with a two-month, part-time program to help them get started.

In the Co-Creation Lab[14], the Vienna Business Agency offers a service to define innovation products more precisely and enhance their market potential. Established companies and organisations bring their challenge to the Co-Creation Lab where, in confidential workshop settings, they work together with experts to develop and find solutions. Subsequent public calls for tenders offer an opportunity to extend the challenge to 1,800 companies, start-ups and research institution in the Vienna Business Agency's network – to learn about innovative solution approaches and find the right partners.

All funding programs of the Vienna Business Agency can be found here: viennabusinessagency.at/funding/programs

13 viennabusinessagency.at/startup-and-grow/lets-talk-founding-1/founders-labs

14 viennabusinessagency.at/technology/co-creation-lab-vienna/co-creation-lab

5. Companies in Vienna

In the alphabetical listing[15] on the following pages, we offer you an overview of selected companies from Vienna that offer services in the field of Digital Twins.

Companies in the field of Digital Twins

COMPANIES	DESCRIPTION	CONTACT/WEBSITE
RESEARCH AND TRAINING INSTITUTIONS		
ACDP – AUSTRIAN CENTER FOR DIGITAL PRODUCTION	Founded in August 2017, the COMET CDP Center for Digital Production is one of the leading research and development platforms in the field of flexible manufacturing automation, machine-to-machine communication, and production networks. In addition to the relevant institutes of Vienna University of Technology, its scientific partners include international institutions like ETH Zurich and the Karlsruhe Institute for Technology. Its corporate partners include more than 40 well-known users and technology providers in the centre's research areas. The Industry 4.0 Pilot Factory of the Vienna University of Technology is available as a test and development environment in the Aspern Seestadt district.	Seestadtstrasse 27/19 1220 Vienna info@acdp.at www.acdp.at
AIT – AUSTRIAN INSTITUTE OF TECHNOLOGY	At the Austrian Institute of Technology, digital twins are constantly emerging from close collaborations between industrial companies in various fields of application. One particularly active area is digital twins for industrial plants and production. The spectrum of activities at AIT ranges from the analysis of individual system components to the creation of digital twins for entire production plants. One current important objective is their use for decarbonisation and resource efficiency. www.ait.ac.at/en/solutions/decarbonisation-and-digitalisation-in-industry/digital-twin-for-industrial-plants	Giefinggasse 4 1210 Vienna office@ait.ac.at www.ait.ac.at
FRAUNHOFER AUSTRIA RESEARCH GMBH	Digital twins are developed and researched at Fraunhofer Austria Research with a focus primarily on the Internet of Things (IoT) and virtual reality (VR). VR can be useful to intuitively display a large number of measured values or to make the interaction with the digital twin as realistic as possible.	Theresianumgasse 7 1040 Vienna office@fraunhofer.at www.fraunhofer.at

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This list is not intended to be exhaustive.

COMPANIES	DESCRIPTION	CONTACT/WEBSITE
UNIVERSITY OF APPLIED SCIENCES TECHNIKUM WIEN	A digital factory is available at the University of Applied Sciences Technikum Wien for teaching and research on typical Industry 4.0 scenarios. Students of the university have developed many digital twins, for example, in the field of robotics.	Höchstädtplatz 6 1200 Vienna info@technikum-wien.at www.technikum-wien.at/digitale-fabrik
VIENNA UNIVERSITY OF TECHNOLOGY	The variety of different institutions at the Vienna University of Technology working in the field of digital twins reflects the breadth of the topic.	Karlsplatz 13 1040 Vienna www.tuwien.ac.at
VIENNA UNIVERSITY OF TECHNOLOGY – INSTITUTE FOR ENERGY SYSTEMS AND THERMODYNAMICS	Research activities focus on the simulation of industrial systems over their entire lifecycle, as well as applications in the field of ENERGY 4.0.	Getreidemarkt 9/BA 1060 Vienna sekretariat+e302@tuwien.ac.at www.iet.tuwien.ac.at
VIENNA UNIVERSITY OF TECHNOLOGY – PILOT FACTORY OF THE VIENNA UNIVERSITY OF TECHNOLOGY	The Vienna University of Technology Pilot Factory is a learning, innovation, and demonstration factory for smart manufacturing and cyber-physical production systems. New concepts and solutions for multi-variant series production in the discrete manufacturing industry are developed and researched here.	Seestadtstrasse 27 1220 Vienna www.pilotfabrik.at
VIENNA UNIVERSITY OF TECHNOLOGY – INSTITUTE OF MANAGEMENT SCIENCE	Activities in the area of digital twins are carried out primarily in the research area of advanced industrial engineering.	Theresianumgasse 27 1040 Vienna sekretariat+E330@tuwien.ac.at www.imw.tuwien.ac.at
VRVIS ZENTRUM FÜR VIRTUAL REALITY UND VISUALISIERUNG FORSCHUNGS-GMBH	For more than 20 years, the application-oriented research centre VRVis has been working with digital models and thus with digital twins. Simulation and visualisation are their focus, whether the digital twin of an Austrian municipality for flood protection, models of the brain for neuroscience, or geographic models for planning infrastructure buildings.	Donau-City-Strasse 11 1220 Vienna office@vrvis.at www.vrvis.at/forschung/digitaler-zwilling

COMPANIES	DESCRIPTION	CONTACT/WEBSITE
INTERMEDIARIES		
ASSOCIATION INDUSTRY 4.0 AUSTRIA – THE PLATFORM FOR INTELLIGENT PRODUCTION	The Industry 4.0 platform supports the networking of organisations from business, politics, science, and the media with the aim of promoting digital technologies in the industrial sector. In this context, the topic of digital twins, which the platform addresses periodically in events, for example, also plays an important role. plattformindustrie40.at/forschung-entwicklung-innovation/simulation-digital-twin	Mariahilfer Strasse 37–39 1060 Vienna office@plattformindustrie40.at www.pattformindustrie40.at
COMPANIES		
ATOS IT SOLUTIONS AND SERVICES GMBH	Atos is a global leader in the digital transformation with 110,000 employees in 73 countries. As the European market leader for cloud services, cybersecurity, and high-performance computing, the Atos Group offers integrated solutions for the orchestrated hybrid cloud, big data, business applications, and the digital workplace.	Siemensstrasse 92 1210 Vienna kontakt.at@siemens.com www.atos.net
CLOUDFLIGHT	Cloudflight is a provider of customised software solutions with a focus on scalable platforms in digital business models. For digital twins, Cloudflight develops data-based (statistical and AI) approaches for characterisation based on historical data and process models.	Walcherstrasse 1A, stairwell 3 3rd floor 1020 Vienna info@cloudflight.io www.cloudflight.io
CRAFTWORKS GMBH	craftworks develops AI and software solutions to improve industrial processes using AI. The development of a digital twin – that is, the virtual mapping of processes by transferring real-time data to machine learning models – makes it possible to solve problems in the areas of predictive quality, predictive maintenance, and quality assurance. The design, set-up, and maintenance of the necessary big data infrastructure is also part of craftworks' core business.	Schottenfeldgasse 20/6A 1070 Vienna office@craftworks.at www.craftworks.at
DELOITTE	In its study "Limitlessly Networked", management consultant Deloitte presents the possibilities that arise from use of digital twins.	Renngasse 1 1010 Vienna www.deloitte.com/at
DWH GMBH	This company analyses, calculates, models, and simulates data and processes of its customers and supports decision-makers in meeting complex challenges and optimal decision-making.	Neustiftgasse 57–59 1070 Vienna office@dwh.at www.dwh.at

COMPANIES	DESCRIPTION	CONTACT/WEBSITE
ENRAG AG	This company offers customised software development and digital engineering in the fields of thermodynamics and process engineering, as well as simulation services (CFD simulations, process simulations, and cycle calculations, self-designed models for special processes, as well as strength analyses and multiphysics).	Industriestrasse 18, 4800 Attnang-Puchheim Mayerhofgasse 1/11 1040 Vienna office@enrag.at www.enrag.at
EY	As a management consultancy firm, EY focuses on auditing, tax consulting, and strategy development. EY has also been active in numerous digital twin projects, especially on an international level, for example, in supply chain solutions: www.ey.com/en_gl/advanced-manufacturing/can-a-supply-chain-digital-twin-make-you-twice-as-agile	Wagramer Strasse 19, IZD Tower 1220 Vienna www.ey.com/de_at
FPRIMEZERO	With its SUPPLYBRAIN software, FPrimeZero offers tools for the supply chain. Their focus is on topics such as digital twins, as well as real-time optimisation and artificial intelligence.	Anton Krieger-Gasse 108 1230 Vienna office@fprimezero.com fprimezero.com
GNISTA.IO	The gnista.io team develops software that helps industrial companies improve their energy efficiency. Thanks to explainable AI, gnista.io makes organising and working with IoT sensor data intuitive and efficient. This allows engineers at gnista.io to independently create digital twins of customer systems and feed them with their own data. This then forms the basis for optimisation measures.	Taubstummengasse 11 1040 Vienna www.gnista.io
SIDE STUDIO FOR INFORMATION DESIGN	SIDE sees itself as a technology partner for companies in the construction and real estate industries that want to successfully implement digitisation. The focus of their work is the digital building information model (BIM), the digital twin. This building data model is the basis for a lifecycle-oriented approach during planning, construction, and operation. It forms the basis for integral planning, analyses, simulations, visualisations, evaluations, and even predictive maintenance.	Mariahilfer Strasse 101 1060 Vienna studio@side.gmbh www.side.gmbh
SIEMENS ÖSTERREICH AG	Siemens AG is a globally active conglomerate focusing on automation and digitisation in industry, infrastructure for buildings, decentralised energy systems, mobility solutions, and medical technology. A total of around 8,800 people work for Siemens in Austria, with sales of around 2.6 billion euros in fiscal year 2020. Siemens has developed numerous digital twins and uses them worldwide, including in the pharmaceutical industry, for example. An overview of activities with digital twins can be found here new.siemens.com/digital/enterprise	Siemensstrasse 90 1210 Vienna kontakt.at@siemens.com www.siemens.at

COMPANIES	DESCRIPTION	CONTACT/WEBSITE
SYNGROUP MANAGEMENT CONSULTING GMBH	As Austria's largest industrial consultant, Syngroup supports companies worldwide in with their business transformation and digital transformation along the entire value chain. Adaptations of strategic business areas and consistent implementation at the operational level result in more efficient and effective work and thus in a sustainable competitive advantage.	Kärntner Ring 17/17 1010 Vienna office@syn-group.com www.syn-group.com
TTTECH INDUSTRIAL AUTOMATION AG	The TTTech Group consists of globally active high-tech companies with headquarters in Vienna, where it was founded. With its real-time network platforms and safety controllers, TTTech Group's solutions improve the safety and reliability of electronic systems in the industrial and transportation sectors and contribute to making the Internet of Things and automated driving a reality. TTTech Group brings proven networking technology from aerospace and aviation to mass markets like automotive and manufacturing. TTTech is a pioneer in the development of deterministic Ethernet and a driving force behind the IEEE TSN and SAE Time-Triggered Ethernet standards.	Schönbrunner Strasse 7 1040 Vienna office@tttech.com www.tttech-industrial.com
VISPLORE GMBH	Visplore GmbH offers a very dynamic graphical solution for the analysis of large amounts of data from machines, sensors, and simulations. For the creation and use of digital twins, it is essential to quickly prepare the complex data basis and to understand it in depth. Visplore software makes this possible in a very short time through preconfigured analysis tools and helps people without data science experience to better validate models for digital twins. Its particular strengths include interactive cleaning, selection and labelling of data, analysis of correlations and parameter studies, and seamless integration with platforms like Python, R, and Matlab.	Mariahilfer Strasse 136, Top 2.10 1150 Vienna office@visplore.com www.visplore.com

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