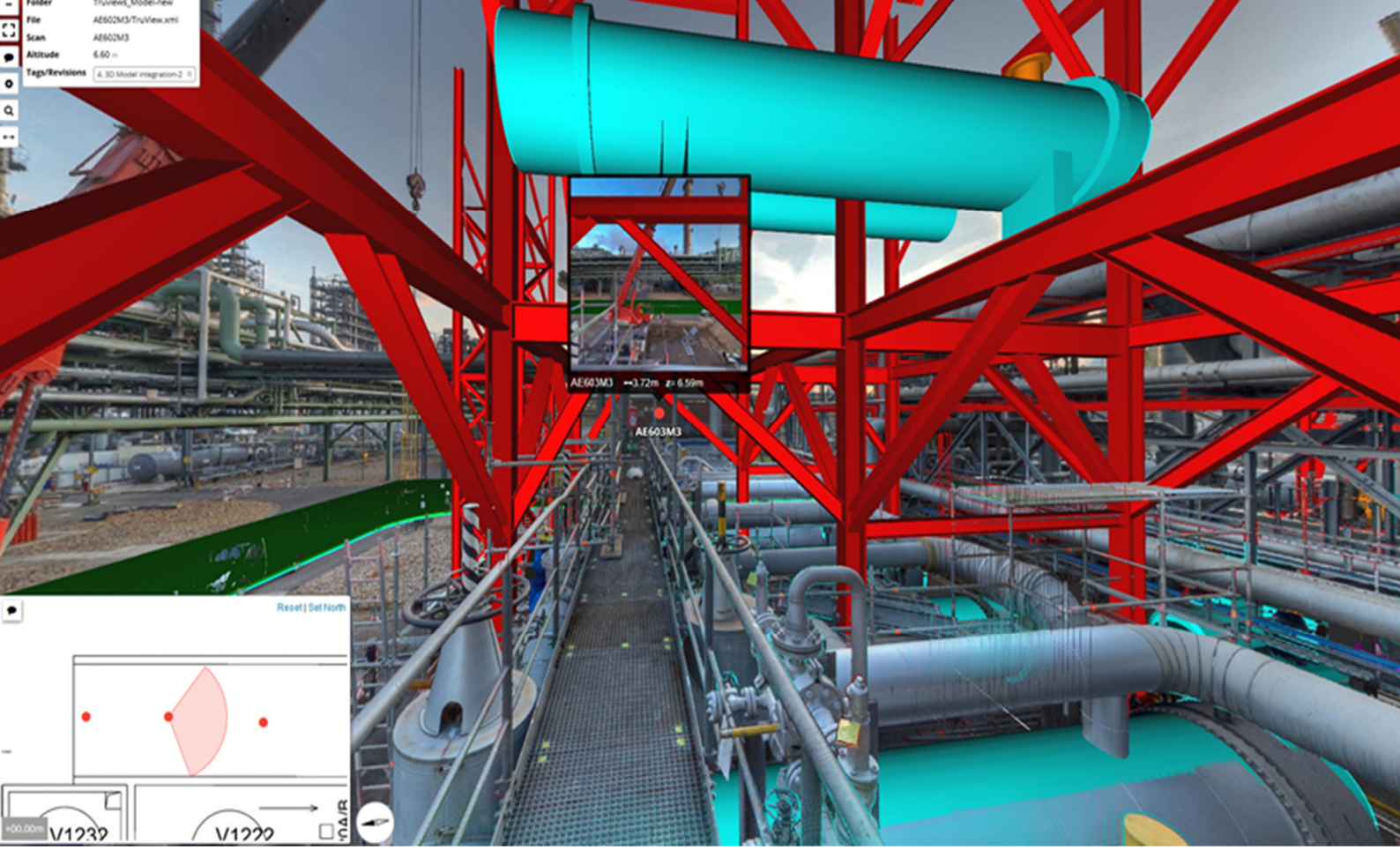


BIM For Management - BIMFM

Building Information Modeling (BIM) to manage complex projects.

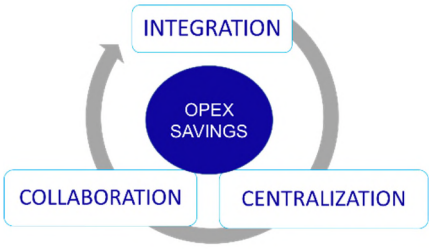
The digitization of the industrial sector is an essential component to optimize processes and increase its productivity. Building Information Modeling (BIM) allows us to understand the design in a simpler way, streamline communication flows, and reduces errors by centralizing the integrated information in a single environment that in turn facilitates the engagement of all those involved.

Author: Andoni Borjabaz Modrego
IDOM METALS & MINERALS
October 2020
Ed #00

IDOM

BIM methodology

BIM was conceived as a methodology to revolutionize management and construction in all its aspects. With BIM, **3D** design modeling is envisaged as a simple graphic environment evolving to the next level; BIM is not just for design, it is also a powerful Project Management tool that interfaces construction, schedules (**4D**), costs (**5D**), sustainability (**6D**), operation and maintenance (**7D**), thereby managing information through the entire life cycle of a build asset.



From the outset, **centralization, integration and collaboration** are the pillars of the methodology of the project, which as it is developed will provide a **truly global vision of progress**. It allows for design improvements, accelerates the understanding and production process, provides great agility in the study of alternatives and the realization of modifications, all of which are the ingredients of success to ensure a satisfactory result in a changing environment.

Using digital workflows on **a single information support platform**, all the actors can be included during the design process, thereby guaranteeing the design at cost and minimizing work times (*Integrated Project Delivery*).

At the same time, the incorporation of the opinions of the project leaders avoids changes, unforeseen needs or the introduction of late requirements. Supply can be accelerated, stock management improved, which benefits the use of the resources, equipment and materials necessary to obtain an optimized product upon delivery to the plant.

Investments in resources made during CAPEX maximize returns and reduce OPEX costs, eradicating equipment with proven low performance or excessive life cycle costs.

Several countries have already begun to integrate BIM in the **public sector**. The proven efficiency of the methodology has resulted in many authorities making **its use mandatory**. Meanwhile, the **private sector** is increasingly aware that to increase profitability, they must get on the **Industry 4.0** bandwagon, as it is increasingly required to deliver services such as design, engineering and project management.

The three Pillars of Project Management

The success of any project, complex or not, critically depends on the correct control of the multiple variables that affect the pillars of its management, Design Quality (3D), Schedule (4D) and Price (5D), all of which are present in one of the dimensions and uses of BIM.

3D	4D	5D
Design	Planning the work	Cost Control

Integration of new technologies

The objective is to provide a more accessible and visual exchange of information between platforms, documents and products.

- **KPI**. Key indicators to measure the overall performance of a particular attribute.
- **Link** gateways between computer software.
- **IoT**. Connection of on-site sensor monitoring data with a centralized database model for updating and consultation in real time.
- Based on **Big Data** for the consultation and control of information during the execution of the project: reports on budgets and work progress.
- **Business Intelligence** (BI). Data processing for analysis and presentation of information tables.
- Structured reports using standard forms.

Project sequence as a productive process

The communication capacity, data analysis and behaviors that the virtual model offers, allow us to experiment and predict the results of different improvements to the construction process; from forecasting the consumptions of different design alternatives to validating construction flows or anticipating finance requirements.

Documentation management

The requirement of the model as an unequivocal source of information, means that the functional and relevant information is embedded in various ways in the 3D objects that compose it. These cross references generate a synergy that allows access to all the information in its entirety, as well as any aspect that affects it: drawings or plans, its category, location, characteristics, etc. This interrelation turns asset management into a powerful and intuitive tool for analyzing performance, costs, deadlines, preventive and corrective maintenance, etc.

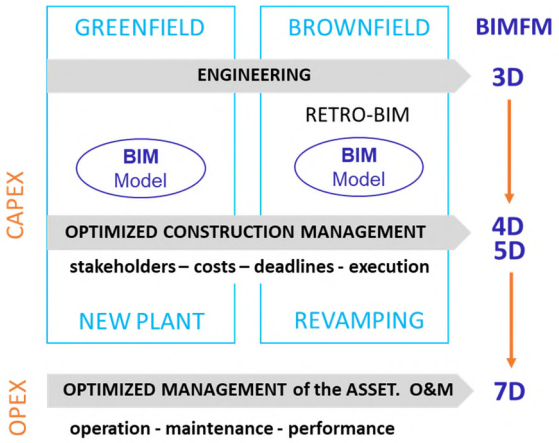
Virtual model for asset management. O&M - 7D

If the management relies on Computerized Maintenance Management Systems (CMMS) enabled to manage the project documentation, the information upload time is drastically reduced. The data is structured and indexed, making the search for information easier and faster, as the plant can literally be navigated visually. This allows the study and optimization of elements by locating assets in their real environment.

BIM Application for a Complex Project

Potential of BIM

Greenfield. Using the tool from the outset of the project uncovers its full potential. The pillars of the methodology can be established in a solid way and the best performance of all its aspects can be achieved.



Brownfield. The advantages of its use in complex projects, such as Brownfield and Revampings, are multiplied compared to a traditional methodology. The overlapping of the new infrastructure with the existing facilities critically conditions the design and subsequent construction, a problem that is commonly aggravated by insufficient As Built information for older facilities.

The complexity of a Brownfield project can reside in many factors such as innovation, complex geometries, dimensions, density of facilities and systems, risk management, accessibility, work and operation logistics, number of participants, information management, commissioning, etc.

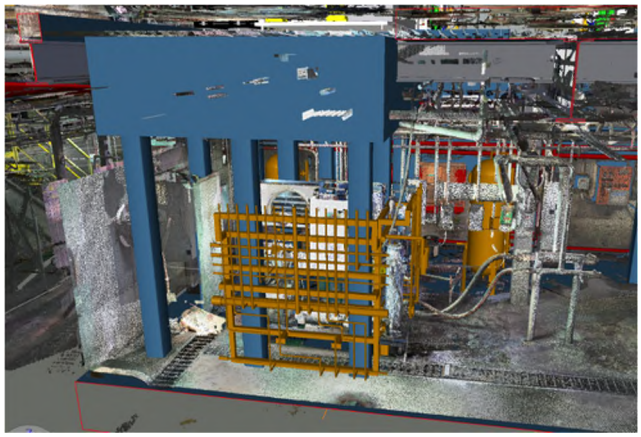
Each and every one of these is simplified by introducing the methodology. The investment in **Retro-BIM** is justifiable, and will greatly facilitate future actions, as it already has models of the installation therefore eliminating the need to carry out data collection with the plant active or in operation.

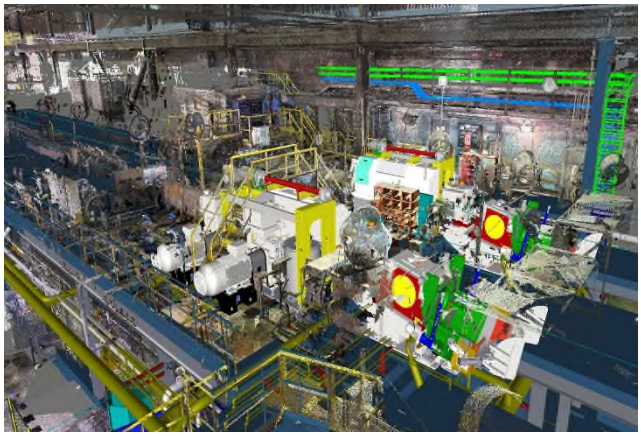
Retro-BIM. Complex Brownfield projects

This involves retroactively converting a conventionally developed project, with 2D documentation, into 3D As-Built models that are used as a basis for applying the methodology.

A digital twin is generated that represents the installation in its current state with a high level of detail and reliability; a **solid starting point**. The new designs are already developed in a three-dimensional environment, considering the logical units for project management: not just engineering, but also the procurement units and construction units for planning and control.

This offers great precision in the design, by simultaneously visualizing the design of the new parts on the existing plant. In turn, the 360º images generated reduce the need for visits to the site during the construction stage.





Digital scanning

Geometry. Point cloud. By means of a digital scan, the point cloud is generated, composed of millions of points positioned three-dimensionally, forming a physical entity with millimeter accuracy and representing its surface. After the point cloud processing, geometries are defined, objects are modeled, and construction elements are created.

Attributes as metadata. Once the geometry is defined, each element is given an entity by incorporating attributes in the form of metadata. Characteristics, categories, specifications, parametric data, engineering data, coding information and standards, etc. are defined and linked.

BIM Methodology for Blast Furnace Revamping

The Revamping of a blast furnace is the paradigm of a complex project and it is also a critical period in the life of a steel manufacturing plant. It involves the entire closure of the facilities with its consequent loss of production and therefore income. It is a time-critical operation that must be planned down to the last detail to properly manage risks.

Main challenges

Unique project. A blast furnace is a complex and multidisciplinary system, with a large number of systems coexisting in a small space. It is a unique and specific product, for which its revamping requires an Ad Hoc design.

Critical planning and coordination. The reduced time available to carry out the work, and the need to minimize it even further, require that all work, equipment and resources are prepared and highly coordinated.

Uncommon and lack of experience. The number of duly qualified companies and contractors in the market, with the necessary high capacity and experience is very limited, and even non-existent in many geographical areas.

High number of participants. The need to combine international companies specialized in blast furnaces with other national companies with different degrees of experience, as well as other local companies without specific knowledge, requires a great effort in terms of coordination, integration and collaboration.

Complex procurement management. The different procurement strategies for core equipment, conventional equipment and a myriad of "bulk material" purchases, involve a very high number of purchasing units that require an important effort for their activation and monitoring throughout the entire supply chain.

Keys to the success of a Revamping Project

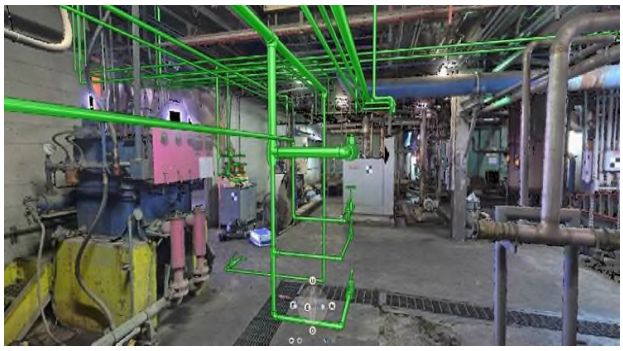
Success critically depends on:

- The quality of the engineering.
- Procurement management.
- Comprehensive planning control.
- Reliability of the designs and their correct integration.
- Minimization of interference, design and assembly.
- Induction of non-specialized assembly companies.
- Reliability of pre-construction works.

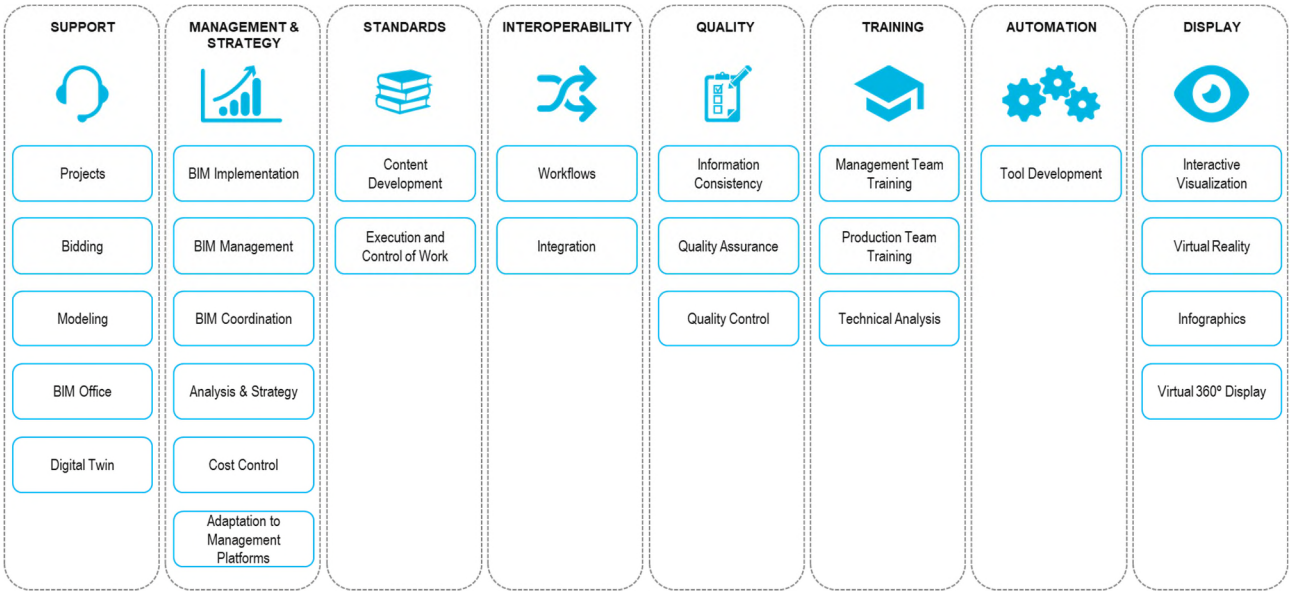
BIM methodology is a powerful tool that provides a **common and collaborative workspace**, unifying criteria and access to **unique and unambiguous information**. It greatly facilitates the development of certain functions **remotely**, dissipating the dependency on the scarcity of local knowledge and experience in some geographical areas.

It integrates the supply chain of the project as a whole, in which each element is identified, including all its information: design (identification on a plan), procurement, activation, monitoring, assembly and operation.

The ability and flexibility to test **alternatives** and generate comparisons, obtaining a virtual simulation instantly, allows its impact on the construction sequence to be evaluated, reinforcing the decision-making process and providing **precision in planning control**, reducing the risk of subsequent modifications and expensive reworks.



Implementation of BIM and IDOM Services



While the word BIM has been used on occasion by almost everyone, and even more and more frequently in the industrial sector, it is a common conception that "BIM is software or a work platform" or "BIM is a graphical environment, a 3D-render to display," leading to the underuse of its power and capacity.

It is a work methodology in a context which is collaborative and integrated. Its application entails a profound transformation that affects all levels, from the design and construction processes, to asset management.

The need to **implement the tool** is unquestionable, both due to the obligation imposed in many countries and due to the demands of a sector fully evolving into **Industry 4.0**. Its adoption must be from top to bottom, from the General Management, since it affects the conventional workflows of the client's PMO, maintenance and operation departments, but also internally, between different departments that traditionally work as impermeable information units.

The key to the **success of its implementation** requires a strong managerial commitment, knowing how to properly manage the resistance to change at the personal, departmental level and organization level that will surely arise.

Plantview is a digital navigation tool that intuitively and efficiently integrates documentary information and the physical reality of any industrial facility. It's the first step to a digital twin.

It is a visual Database Manager linked to installation documentation that can be easily updated with other sources of information, including documentation, plant personnel notes, and operation databases.

The 360º navigation environment integrates panoramic images, 3D point clouds, documents, 360º videos and connections with other databases, which are organized in a very intuitive way. PlantView runs on a scalable software platform that can be fully customized.

- Manages the physical reality of the plant by including 360º panoramic images and point cloud laser scanning.
- Index the plant documentation for quick access linked to physical reality.
- Allows quick and easy access to both physical reality and documentation in a bidirectional way.
- The information is publicly accessible to all users.

Experience and Project References

IDOM has experience both in the development of projects using BIM methodology, and implementing the tool itself at corporate level. We accompany our client from the initial stages in which the most appropriate execution plan is defined after a functional analysis of the organization, in the definition of software and processes as needed, as well as the correct training for the application of the tool and monitoring.

IDOM has been recognized as the Leading Company in BIM according to the National BIM Survey developed in 2019 by the Faculty of Architecture and Urbanism of the University of Chile

CODELCO. BIM Methodology Implementation

Codelco, the world's leading producer of mined copper, as of 2020, has made a commitment to develop all its projects using BIM. In this context, it requested IDOM, as an engineering and specialist consultant, to provide assistance for the implementation of the methodology, definition of procedures and workflows required for the construction and commissioning stages of various projects. This work will also serve as a pilot test of BIM implementation in future projects that may be carried out at corporate level.

ACEROS AREQUIPA. EPCM for Various Projects

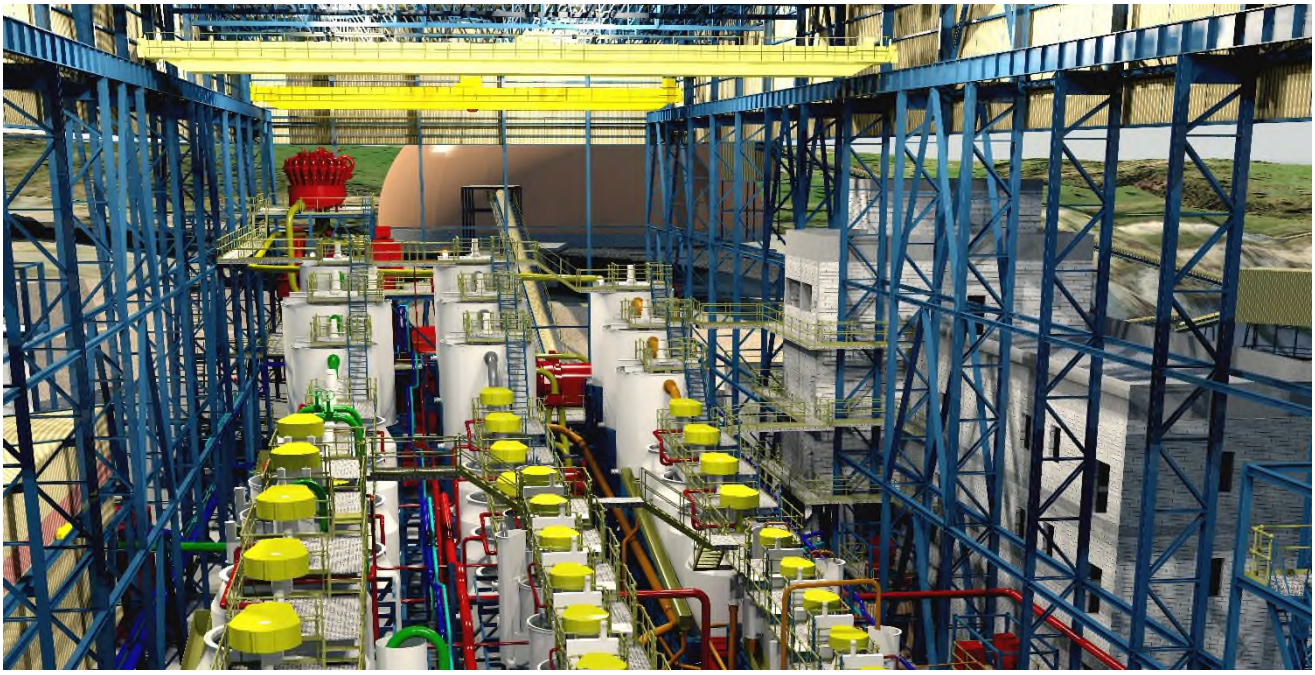
Construction of a new Steel Complex. Modernization of the Rolling Mill and Water Plant. The greatest complexity of these projects is that the revamping is being built while the plant is still in operation. After the 3D survey of the existing facilities and the design of the new actions, the application of the BIM methodology has allowed the construction to be undertaken with an exhaustive control and management of overlaps.

OPTIMUS STEEL. Modernization of the Steel Mill and Rolling Mill Beaumont (Texas)

Detailed engineering and integration of the new equipment. For this, various 3D scans were carried out and integration engineering was developed using the E3D software, in which the cloud points were inserted. This allowed the new designs to be modeled while simultaneously viewing the existing elements, greatly facilitating their routing and connection.

PAUL WURTH. Engineering and Supply of Coke Gas Treatment Plant Equipment

The detailed engineering development is for the Arcelor Mittal South Africa plant in Vanderbijlpark. It is a Brownfield with no initial documentation. For this reason, by means of a 3D scan and subsequent inclusion of cloud points, the existing facilities were modeled, on which the new designs were later integrated, working in an environment in which the overlaps and available spaces can be visualized.



CONSORCIO VINCI - ASTALDI. MEP Arturo Merino Benítez Airport Expansion, Santiago

IDOM has worked on the design of the installations for all the buildings, as well as outdoor networks, modification of services, roads, landscaping and architecture. We have worked collaboratively with the client and contractor companies using BIM models to generate design requirements for each specialty, coordination of overlaps between all the disciplines involved, complementing and following the workflows defined in the BIM Execution Plan of the project.

MOP. Referential Preliminary Project Expansion and Improvement of La Florida Aerodrome, Chile.

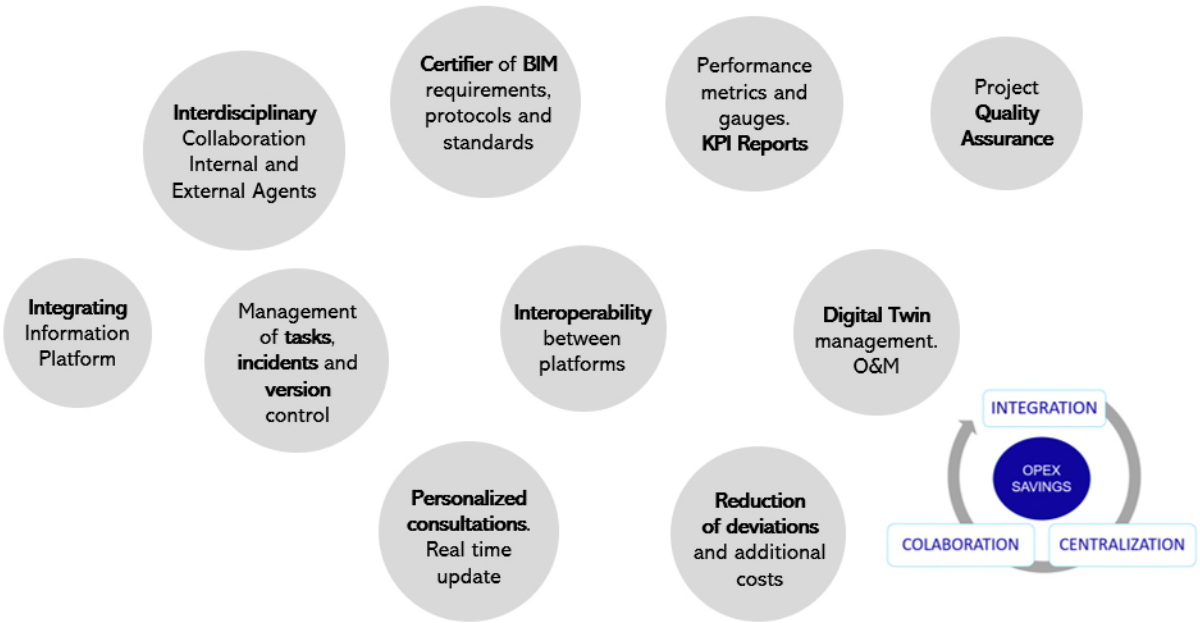
IDOM has been collaborating in the development of the passenger terminal, auxiliary buildings, exterior works and roads, landscaping, among others. BIM models are used to obtain measurements / quantities of each item that are linked to the project scheduling, which subsequently have allowed the generation of work progress simulations showing the feasibility, cost and constructability of the project over time, in addition to the review of compliance with current regulations of the reference preliminary design. Collaborative work methodologies were established in the different stages, adapting the models to the new National BIM Standard and respecting the designs of sustainability, quality and universal accessibility.

METRO S.A. Extension of Line 2 of the Santiago Metro

The project acquired the commitment to expand the scope and uses of the BIM methodology according to the new National BIM standard, in order to include the work phase (As-Built project and Operation and Maintenance), with a view to reducing costs, errors, development times. IDOM participates as a specialist consultant in BIM for the technical inspection of works, providing our experience in the development of a new bidding process for the project construction phase. IDOM is also undertaking the Technical Inspection of Works and monitoring these new works, assisting in the correct execution of said methodology and the development of procedures and workflows during the construction stage.

JUDICIAL SYSTEM IN CHILE. Design of the Copiapó & Vallenar Judicial Center

IDOM developed the design and BIM Coordination, according to the building requirements defined in the new law of the criminal procedure system in Chile. The BIM models were used as the design scheme for the updated and parameterized extraction included in the bidding documents. Area programs were generated, preliminary design, basic and detailed design were carried out, using BIM coordination to predict and anticipate overlaps during the construction phase. With this project, IDOM took the first steps towards the implementation of the new National BIM standard, mandatory for all public projects in 2020.



IDOM

IDOM is an association of independent professionals, working in the fields of Engineering, Consulting and Architecture, united in a common way of doing things and objectives, at the service of our clients.

IDOM has more than 3,800 people around the world. The firm is fully owned by its employees with 100% of its capital belonging to the personnel currently working in the company.

Since its inception in 1957, the firm has served Clients on five continents, striving to provide excellent service, of the highest technical level, while offering efficient and innovative solutions to solve their problems.

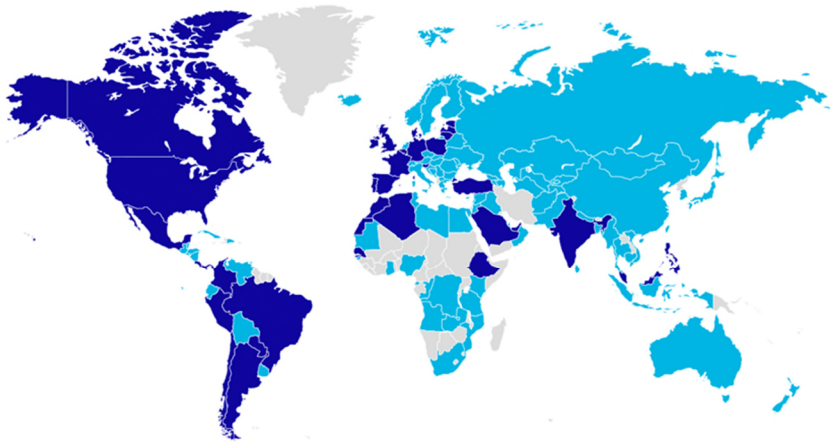
IDOM understands by innovation not just to be the proactive search for new products and services, but also the introduction of new work methods and tools, new technologies to optimize management processes. Therefore, innovation forms an integral part of the business model of the firm.

IDOM's approach to innovation has been a strategy of continuous development, allowing us to position ourselves at the technological leader in industrial digitization and all its advances.

Our commitment, your success

Andoni Borjabaz
Metals & Minerals Director
+ 34 609 007 962
abm@idom.com

Javier Bailly-Bailliere
Head of Mining
+ 34 650 385 039
jbb@idom.com



The internationalization process is an important part of our strategy, bringing the company closer to the client to guarantee the best service. This map shows all the countries in which IDOM works and where its 45 offices are located.

Countries with IDOM offices in which it has developed projects

Countries in which IDOM has developed projects