RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year V, v.1 2025. | submission: 07/17/2025 | accepted: 07/19/2025 | publication: 07/21/2025

Analysis of the application of the BIM methodology in the integration of projects and construction management

Analysis of the application of the BIM methodology in the integration of projects and construction management

Felipe José Amancio Holanda

Diego Angeles Carvalho Macedo

SUMMARY

With technological advancements in the construction industry, the search for innovative solutions to address the challenges of project compatibility and project management is becoming increasingly evident. Therefore, this paper aims to address this issue by adopting the BIM methodology as a tool to analyze the most efficient way to implement this technology, promoting greater integration between projects and facilitating project management. Based on a project originally developed in 2D, the 3D remodeling was performed using Autodesk Revit 2018 software, with subsequent analysis using Autodesk Navisworks 2018. This demonstrates the concrete benefits that justify replacing the current project management model adopted by companies.

Keywords: BIM. Project compatibility. 3D modeling.

ABSTRACT

With the modernization on the construction, and searching for new technologies that solve the problems of compatibility of projects and the construction management, to solve this problems we are going to use the BIM to analyze the best way of using this technology to give a synergy between the projects and to facilitate the management, using a project first made on 2d softwares and then redone the 3d modeling using AUTODES REVIT 2018 and analyzing through the AUTODES NAVISWORKS 2018, we can introduce the real benefits so a substitution on the current system of project management on companies.

Keywords: BIM. Compatibility of projects. 3d modeling

1. INTRODUCTION

When observing the development of a construction project, it is clear how much the process becomes fragmented as it progresses, especially when it depends on paper documents as the main means of communication.
Documents generated with errors and omissions in project information often cause additional costs, delays, rework, and possible legal action between various parts of the project team (EASTMAN et al., 2010).

In practically all Engineering, there is a tradition that makes the realization of several services in the same way they have been done for decades. This makes

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

the evolution of the slow process, a work without technological advancement applied in search of improvements and construction agility, the use of the computer, was one of the greatest revolutions in Engineering, both in the design and construction areas, but its use can be improved, this is where we will study the introduction of the concept of Information Modeling and Construction known as Building Information Modeling - BIM (PAPADOPOULOS et
al., 2014).

CAD (Computer-Aided Design) tools were developed to support various engineering disciplines involved in the construction of a project, such as structural, mechanical, and budgetary analyses, among others. With the consolidation of the concept of sustainable construction, the use of software focused on environmental analysis has become increasingly common. These computational tools enable studies focused on the efficient use of natural resources and the optimization of material consumption. Furthermore, advances in telecommunications technologies have boosted remote work, integrating other management systems into CAD platforms that facilitate remote collaboration.

The paradigm shift and advancement of CAD and CAE (Computer-Aided Engineering) technologies culminated in the emergence of Building Information Modeling (BIM) systems. One of the main challenges of the traditional methodology, based on 2D drawings, is the difficulty in quickly accessing specific project information, such as cost estimates, energy performance analyses, structural details, and more, which is time-consuming and reduces process efficiency. The technology of a program that uses the BIM methodology allows the user to combine 3D modeled objects with 2D drawings (EASTMAN et. al., 2018).

al., 2010).

For the BIM methodology to be employed in the workplace, a platform that centralizes design information along with the 3D model is required. This model must also be constructed using objects that have parametric data (in addition to the
geometry parameters, objects have other attributes, obey rules and have relationships with each other) adding all the intelligence necessary for the project. The result is referred to
in this work as a 3D parametric model. Through this type of model, it is possible to perform various types of analyses. All project documentation is generated
automatically from a database formed by the 3D parametric model. This
ensures the consistency of these documents and associated information.

The main purpose of the BIM methodology is to promote integration between the various disciplines and stages of a project, utilizing modern computational tools available on the market. This approach is gradually becoming established as common practice. The development of these tools keeps pace with market demands, which, through their use, reveal new needs. One of the biggest barriers to the full implementation of BIM is the need for greater interoperability—that is, the ability of digital systems to communicate efficiently with each other.

Currently, the BIM methodology has been applied in a timely manner in engineering processes, as its adoption has not yet reached an advanced stage of maturity.

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

In countries like the United States and the United Kingdom, BIM is already widely used by companies in the AEC (Architecture, Engineering, and Construction) sector. In Brazil, however, there are still few examples of its use and little documentation on its application.

Previous studies indicate that the incorporation of BIM technology into the AEC industry has occurred at a slower pace compared to the initial introduction of 2D CAD tools. The success of BIM tools depends on collaboration between teams involved in the same project, which must develop interoperable practices. It is important to note that these teams often belong to different companies and frequently use different working methods and software, which hinders integration between organizations. Therefore, the need for interoperability and the adoption of new working practices is evident for new technologies to be effective.

This explains the difficulties in adopting BIM tools when compared to the times the adoption of 2D CAD (TAYLOR AND BERNSTEIN, 2009).

BIM has the potential to change the way construction is carried out and documented and may eventually become the main source of information for the management and planning of an enterprise.

Future research will be needed to develop methods of measuring the value of BIM in construction (GOEDERT AND MEADATI, 2008).

As research into BIM methodology advances, scientific foundations will be established that will contribute to the improvement of specifications and standards, encouraging software developers to enhance their tools and adapt them to market demands. Furthermore, legislation will also need to adapt to recognize the 3D parametric model as a valid form of official documentation in the future.

As this research progresses, companies will increasingly understand the benefits of BIM, recognizing it as an inevitable path to meeting the demands of a constantly evolving market, where constructions become progressively more complex. With the ability to interoperate and integrate multiple analysis tools that the BIM methodology offers, this new working model will be essential for the future development of architecture and civil engineering.

2. The project phase

When developing a building project, several stages are evaluated, all dependent on the work of professionals working together toward a common goal. However, the project development process remains undervalued, which often results in projects being delivered while construction is underway. This practice generates additional costs due to the limited time available for professionals to perform all necessary checks, often resulting in projects that are incomplete or inconsistent with existing documentation.

As a result, deadlines are extended and costs increase. Unlike Brazil, many countries place great importance on the project phase, achieving precise goals and

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

reducing problems throughout execution. This approach represents an evolution from outdated technologies, applying the principle that a project must be rigorously followed, with the ultimate goal of achieving the planned product.

For this reason, projects must be recognized as essential elements for the viability of a project. According to Melhado (1994), the function of the project is to develop, organize, record, and communicate the technical and volumetric characteristics of the product for use during its execution. It is a representation of the characteristics of the building and its construction processes that will be interpreted in the construction phase (GOES, 2011).

However, what occurs is a frequent dissociation between the design activity and adaptation. construction, with the project generally being understood as an instrument, compressing its deadline and cost, with minimal depth and almost merely legal content, to the point of making it simply indicative and postponing a large part decisions for the construction stage (MELHADO; VIOLANI, 1992).

According to Melhado (2005), the project in the initial phase of an enterprise must be prioritized, even if it requires a greater initial investment and a longer time for its completion. elaboration, as it is with a well-designed project that higher monthly costs can be avoided in the project.

Figure 1 – Ability to influence project costs throughout the phases.

Source: CII, 1987.

2.1. Project compatibility

With the growth of the real estate sector, project specialists began expanding their expertise into areas beyond their existing expertise, allowing them to understand all the factors necessary for the comprehensive development of a building. Initially, this approach worked well, as with comprehensive knowledge, professionals were able to coordinate all complementary projects.

However, as time went by, this generalist knowledge was lost, and the

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Professionals increasingly specialized in specific areas, moving away from the systems for which they designed. As a result, incompatibilities arose in the projects, which only became evident during construction.

This problem was only identified in the 1980s, when companies dedicated to project compatibility began to emerge, creating an additional step in the process. The information contained in the basic designs was not sufficient to execute the work, making an integrated review between all parties involved necessary to enable the construction of the model.

For Mikaldo Jr. (2006), one of the main reasons that gave rise to the need to coordinate and make projects compatible was the conceptual separation between design and execution activities over the last few decades.

Melhado (2005) concludes that the traditional design method fragments the various disciplines responsible for creating the final product, so that the agents involved act only within their specific specialties, without considering an overview of product development and its impacts on different areas. This results in a final product of inferior quality.

According to Sousa (2010), project compatibility has been identified as the most effective approach to overcoming the challenges of fragmentation in the construction sector, reducing one of the main problems: physical interference, loss of functionality, and waste caused by project incompatibilities. This approach focuses on the use of tools to manage and manipulate information, both geometric and non-geometric, promoting a more integrated and efficient construction process.

Thus, the concept of compatibility began to be worked on as an activity of managing and integrating related projects, seeking to improve the fit between them. same and achieving total quality control standards for a given work (SINDUSCON-PR, 1995 apud MIKALDO JR., 2006).

Thus, project compatibility is the activity that integrates all of a building's designs, seeking a perfect fit between them to ensure a final quality standard for the project. This process is accomplished by superimposing different designs, checking for possible interference and problems, and should be performed after completion. of each project stage (MELHADO, 2005).

According to Lockhart and Johnson (2000), the process of compatibility involves a continuous sequence of refinement and analysis. It is a dynamic and cyclical process, repeating itself from the initial to the final stages, making compatibility an essential part of project development. Novaes (1998) also emphasizes that compatibility must occur throughout all phases of the project, being a crucial factor in improving constructability and promoting rationalization through the integration of the various professionals and disciplines involved.

2.2. BIM Technology

According to Kowaltowski (2006), global advances and transformations in social relations have significantly impacted the development of architectural design worldwide. New tools emerging in this globalized context have increased the complexity of projects, bringing to light new demands, such as the need for greater environmental quality in large-scale construction.

Technology, applied to this segment, has always favored competitiveness, migrating drawings made on drawing boards with a "T" ruler to the computer, reducing the time spent on the project. Some time later this became insufficient and then technology once again showed itself in frequent evolution presenting a system of modeling that allowed 3D visualizations (NUNES, 2013).

Volumetric studies, at the design stage, serve as a formal evaluation of the project, verifying technical interferences, such as roof surfaces, for example. Thus, the development of electronic models has become an important tool to improve understanding of the system created and any interference that may arise (KOWALTOWSKI, 2006).

The first software programs to incorporate BIM technology emerged with the aim of improving the presentation dynamics of architectural projects, which evolved into a new way of representing buildings under construction. This approach, which combines new technologies and management techniques, marked the spread of concurrent engineering.

One of the main challenges in implementing this technology is integrating the various stakeholders. While several programs offer the flexibility and features characteristic of BIM, the combined use of different software—which are designers' standard tools—still poses a challenge.

On the other hand, firms that already master this methodology are converting this knowledge into a competitive advantage. BIM has also transformed the way projects are conceived and planned, as the phases of the process have changed. The initial stages require more time due to the need for detailed input of information, while later phases are completed more quickly.

BIM adoption varies depending on the type of project and the desired results at each stage. At certain stages, using other software may be more efficient and agile. However, when considering project continuity, preference generally falls on BIM technology.

3. Case study

For the case study presented in this work, the software available were analyzed for the development of the study. Since the BIM methodology advocates for the speed and agility of the development process, bringing benefits to the project, the remodeling of the disciplines in BIM does not match what the platform offers, that is,

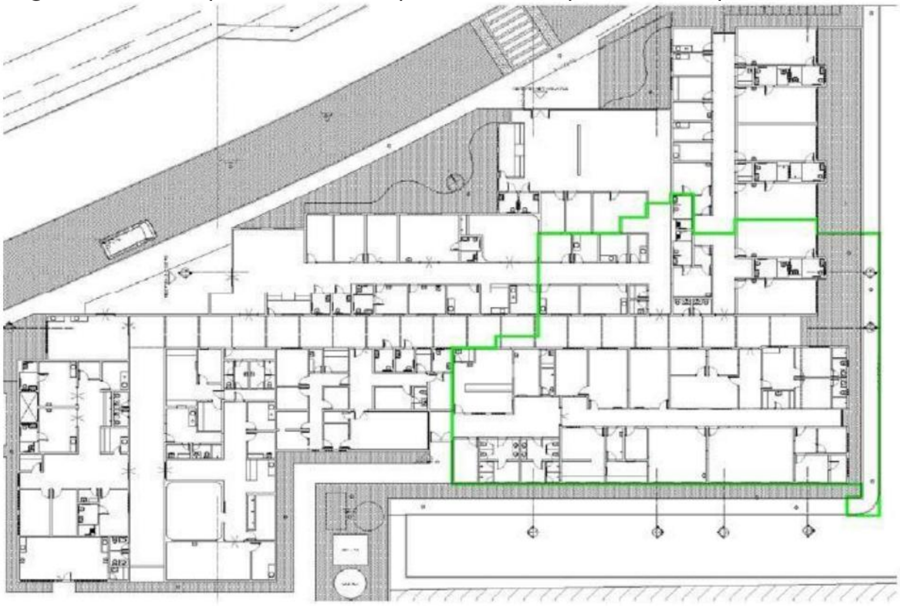
RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

instead of gaining time in preparation and analysis, the client, when hiring this type service pays for rework, demanding more time.

The main objective is to describe the management of an enterprise using the BIM methodology. The development of three-dimensional files followed the steps using the 2D files and the construction process to generate the parameterized file, using the Autodesk Revit 2018 tool.

The project used in this study is the first stage of the Campos Municipal Hospital Sales – CE, which covers part of the complex as shown in figure 2.

Figure 2 – Floor plan of the Campos Sales hospital with emphasis on the first stage.



Source: Adapted from Quopa assessoria, 2017.

The office responsible for developing the project did not perform the compatibility process. Therefore, unlike the study by Góes (2011), there is no compatibility file available for comparison purposes. The objective of this study is to highlight how the BIM methodology can positively contribute to the compatibility and project management phases, offering support to the project coordinator—when present—or to other professionals involved in the project development, management, and documentation stages.

The project analyzed was kindly provided by Quopa Assessoria, a company based in Fortaleza, Ceará, which authorized its use for the purposes of this study. The case study was divided into two phases, each aimed at demonstrating the characteristics of BIM and its practical applications.

In the first phase, three-dimensional models of the selected disciplines were developed for compatibility, enabling conflict analysis between them. In the second phase, the model was examined in conjunction with the construction schedule, enabling simulation and monitoring of construction progress.

3.1. Detected interference

The projects were matched based on the guidelines established by the verification matrix. After selecting and interpolating the disciplines and their respective elements, the software

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

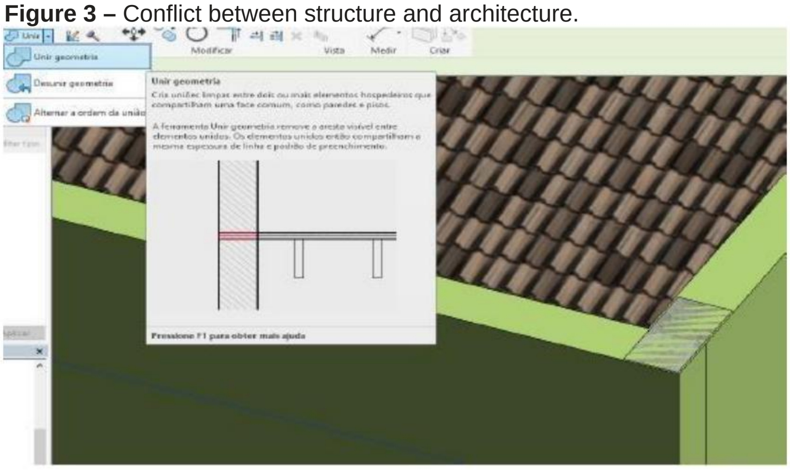
generated a report of inconsistencies, which were analyzed individually. Although the program offers automatic conflict detection functionality, many of these issues can already be identified during the modeling process or when importing links from other disciplines.

This is because three-dimensional modeling allows the project to be viewed from different angles and perspectives, making it easier to identify flaws. At all stages of the compatibility process, it was observed that most of the errors automatically identified by the software were related to flaws that occurred during modeling—whether due to lack of experience, carelessness, or connection issues between elements.

Modeling, therefore, requires extra care, as much relevant information is not present in the original design and needs to be gathered manually.
Starting from a previously developed 2D project makes this task even more complex. Migrating to developing projects directly in the BIM platform tends to streamline this process, as it allows for greater information accuracy from the outset.

It is worth noting that the analysis performed in this study considered only solid three-dimensional elements, disregarding incompatibilities related to 2D drawings, standardized graphic symbols, and other aspects typical of the traditional compatibility process. Although these factors are relevant—as they can lead to errors in interpretation and execution—they were not evaluated in this study.

Figure 3 – Conflict between structure and architecture.



Source: Author's own, 2017.

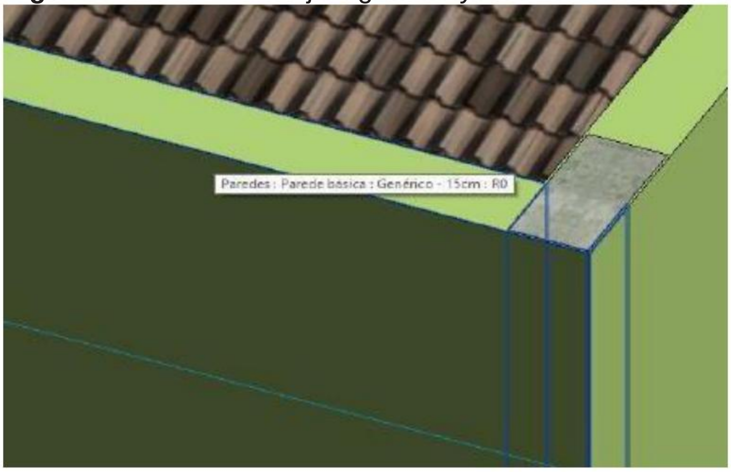
As illustrated in Figure 3, it is possible to identify the most common type of incompatibility found during the analysis. Since the analysis was performed only on the architectural, structural, and cold water installation models, the conflicts detected are common at this intersection. However, it is important to highlight that the hospital complex analyzed encompasses several other disciplines, which can generate even more interference between the systems.

To correct the identified overlapping errors, you can use the "Merge" tool.

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Geometry", first selecting the element to be cut, followed by the one that will perform the cutting. This procedure adjusts the wall volume, which then contours the pillar correctly, resulting in more accurate values for areas and linear footage of the services, ensuring greater fidelity to the project's quantitative data.

Figure 4 – Result of the join geometry tool.



Source: Author's own, 2017.

4. Conclusion

The initial study focused on assessing the design compatibility process, demonstrating that traditional methods, based on simply overlaying 2D drawings, are ineffective and time-consuming to analyze. This preliminary stage identified advantages and disadvantages of using BIM as a design tool—aspects that were later confirmed through the case study.

One of the main challenges identified concerns the high processing and storage capacity requirements of BIM software, which requires more powerful and, therefore, expensive equipment. This requirement hinders access to the technology for students and professionals with limited resources. Another critical point is related to the cost and complexity of the platforms that support the BIM methodology.
Most of these programs are expensive and present usability barriers, especially for beginners. Autodesk Revit, for example, offers incomplete and difficult-to-understand tutorials, leading many interested parties to turn to paid courses offered by the developer itself.

During this project, it became necessary to learn how to operate a tool compatible with the BIM methodology. The software chosen was Autodesk's Revit. Learning took place through technical books and participation in online communities. From this interaction, it was observed that most users in these groups still do not fully understand the concept of BIM, using the program only in its most superficial function, focused on creating electronic models. When the project advanced to modeling for structural and electrical disciplines, the difficulty in finding people with technical expertise in these areas was even greater, given the focus

The predominant part of the discussions revolves around the architectural use of the software.

Therefore, it can be concluded that, currently, BIM technology has been used mainly as a design tool in architectural offices, without effective integration with the other disciplines involved in the design and execution of a building.

This scenario also highlights the urgent need to update Architecture and Civil Engineering course curricula, including specific content focused on BIM training. The lack of compatibility of certain software with Brazilian technical standards is another limiting factor that may explain the difficulty in adopting the methodology by engineering companies.

The main objective of this study was to evaluate the potential of BIM as a tool for project compatibility. To this end, the development process within a BIM environment was presented, analyzing the incompatibilities encountered and investigating the main obstacles that hinder the adoption of this technology by professionals and companies.

The modeling stage was executed quickly, primarily due to the designer's experience and the excellent performance of the equipment used. Thus, the proposed objective was fully achieved through the case study, in which, despite a small number of incompatibilities, the results demonstrated the value of the integration provided by the BIM methodology. Practical experience also demonstrated the platform's efficiency in detecting interference between disciplines, as well as its usefulness as a tool to support project management and monitoring.

Overall, the BIM methodology has proven highly promising for the construction industry, pointing to a future in which all professionals are equipped to operate in an integrated manner. It is expected that, as the use of this technology becomes more widespread, licensing and training costs will gradually decrease, making access more democratic.

In addition to compatibility, BIM also stands out for its ability to reduce project development and rework time, as conflicts are identified early on, facilitating corrections and adjustments to drawings. The methodology contributes significantly to all phases of a building's lifecycle—from initial design, through the generation of quantities and budgets, to execution planning, construction site management, and other technical aspects—adding value to the final quality of the project.

5. References

ANDRADE, M., RUSCHEL, R. **INTEROPERABILITY OF BIM APPLICATIONS USED IN ARCHITECTURE THROUGH THE IFC FORMAT. Management & Technology**

of Projects, Vol. 4 No. 2, p. 76-111, São Carlos, 2010.

AUTODESK. **Building Information Modeling.** Autodesk Building Industry Solutions, 2002.

AUTODESK. **Revit structure 2015.** User's Guide. Autodesk, 2014.

AUTODESK. **User's Guide.** Autodesk Navisworks manage 2017. Autodesk, 2016.

EASTMAN, C.; TEICHOLZ, P.; SACKS, R.; LISTON, K. **Bim Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors.** 2nd Ed. Hoboken: John Wiley & Sons, 2010.

GOEDERT, JD; MEADATI, P. **Integrating Construction ProcessDocumentation into Building Information Modeling.** Journal of Construction Engineering and management, Vol. 134 No. 7, 2008.

TAYLOR, J.E.; BERNSTEIN, PG **Paradigm Trajectories of building information modeling practices in Project networks.** Journal of Management in Engineering, Vol. 25, No. 2, 2009.

COSTA, EN **Evaluation of the BIM Methodology for Project Compatibility.** Master's Dissertation. Federal University of Ouro Preto: Ouro Preto, 2013.

GOES, RH; SANTOS, ET **Project compatibility: comparison between BIM and 2D CAD.** In: TIC 2011: 5th Meeting on Information and Communication Technology in Civil Construction. Salvador, 2011.

MIKALDO JR., J. **Comparative study of the project compatibility process in 2D and 3D using IT** Master's Dissertation. Curitiba: Federal University of Paraná: Curitiba, 2006.

SOUSA, FJ **Project compatibility in multi-story buildings - case study.** Master's Dissertation. Catholic University of Pernambuco: Recife, 2010.

MALHEIROS, PVL **Use of 4D Modeling in Planning and Construction Monitoring.** Monograph. Federal University of Bahia: Salvador, 2014.

Papadopoulos, K., Paralikas, T., Barouti, M., & Chronopoulou, E. (2014). Self-esteem, Locus of Control and Various Aspects of Psychopathology of Adults with Visual Impairments. International Journal of Disability, Development and Education, 61(4), 403-415.

MELHADO, SB Design quality in building construction: application to the case of development and construction companies. São Paulo: 1994. 294p. Thesis (Doctorate) – Polytechnic School, University of São Paulo.

GÓES, Adriana Ramos Silva. Demystifying the Role of the LIBRAS Interpreter in Inclusion, Edition 09 – 2.- Arara Azul Publisher Magazine 2011 Available at: http://editoraarara-azul.com.br/site/edicao/46 Accessed December 15, 2020.

MELHADO, SB, VIOLANI, MAF Quality in civil construction and building design. São Paulo. Technical Text. TT/PCC/02 EPUSP, 1992

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

LOCKHART, SD; JOHNSON, CM Engineering design communication: conveying design through graphics. USA: Prentice-Hall, 2000. 719p.

NOVAES, R. Brief history of the emergence of Physiotherapy in Brazil. Text used in the undergraduate course in Physiotherapy, at UNISANTA, for the subject History of Physiotherapy and Ethics, in 1998.

KOWALTOWSKI, DCCK et al.Reflection on design methodologies architectural. Built Environment, Porto Alegre, v. 6, n. 2, p. 7-19, Apr./Jun. 2006.