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Simulation in Architectural Research

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Abstract: In the new world of architectural research, technology has a main role to play. It is technology that has made possible the creation of a virtual world that triggers inferences and helps in drawing conclusions from facts and findings. This paper focuses on one of the research processes, i.e., 'Architectural Simulation Research,' which is often more analytical, pragmatic and adaptable in the forthcoming generation of architectural research. Architectural Simulation can be classified into drawings, photographs and different scale-models. This research can be executed in many ways on lines similar to the conventional 'Logical Argumentation,' 'Experimental Research' and, 'Qualitative Research'. The paper also focuses on the tactical part of different categories of simulation research which deal with the characteristics of simulation types.

Keywords: Simulation; Architectural Research; Architectural Photographs; Architectural Models

1. INTRODUCTION

Simulation occurs when a replication of a real world context, or a hypothesised real world context, contains within it dynamic interactions that are a result of various manipulated factors. The interactions are reflective of the interactions occurring in the virtual world, and are useful for application into the real world context (Groat & Wang, 2013). In simple terms, simulation is a process through which one can study and analyse the real world scenario by creating a virtual world. It may be achieved by minimising scale in the real world, or may be digitally created by software. There are factors to be considered during the process of simulation as it proposes a virtual reality. For example, it can predict the possible solutions that are effective in mitigating natural hazards like earthquakes, tsunami, etc. so as to estimate probable threats. It can also provide different types of analytical tools and interpretation interface for accuracy in simulation while dealing with various scales and complexities. Computer technology can also help in material testing by virtual simulation like fire-fighting, wind factor analysis, climatic change and, temperature regulation inside as well as outside the building. (Fraser, 2013).

2. STRATEGY OF SIMULATION RESEARCH

Simulation processes used for architectural research can be sub-divided into categories such as drawing, photography and architectural models. The processes can be equipped with various applications depending on the virtual requirement of the project circumstances.

2.1 Drawing for Simulation

The design process itself can be considered as simulation, as it involves the interpretation of thoughts and feelings of the researcher . An architect designs a building as per the client's requirements, professional ethics and personal innovation. A series of trials can be manipulated by architects, keeping in mind various design determinants such as functionality, structural stability, aesthetics, along with the time and cost needed to complete the project (Groat & Wang, 2013). The architect tries to transform his concepts and his visualisation -- with research implications at different scales and levels -- into a graphical interface that can communicate effectively. This graphical interface, especially when simulating with different line types, line weights, colours, graphics, symbols, conceptual sketches, etc., helps in the process of research for attaining an appropriate, case specific solution that, in turn, is a result of various inferences and implications (Belcher, 2009). The simulations are executed while making Presentation Drawings, Working Drawings as well as Approval Drawings. These 2D representations enable the viewer to easily visualise the proposed form, even without 3D representations. This gives the viewer a chance to simulate with respect to the form extrusion, texture, material applications and aesthetic appeal -- all with different probabilities. Its implication while making Working Drawings enables the construction executive to clearly visualise the end product, thereby minimising the threat of admitting any probable constructional errors (Henmi, 1993).

2.2 Photographs for Simulation

Photographic analysis is another way of representing simulation in architecture. This is the process to understand the photograph, the effort made to relate it to the real world scenario and, to integrate the image into a real world version. A photograph of one place is interrelated to another built space, which may be conceptually and contextually related, such as buildings in relation with water bodies and landscape, etc. (Moore, 1994). Many parameters can be evolved from such photographic analyses.

A sequential process has always been applied for perceiving, observing, correlating, implicating and, visualising a proposal with all its physical attributes. This validates the process of finalisation. Photographic Simulation better helps

the clients, allowing them a virtual look at the application of material, texture, colour, etc. that can be adapted from selected examples to their context. This simulation also helps the observer to understand, analyse and evaluate the appropriateness of the proposal to a specific context, especially with respect to the surroundings and the existing fabric. It also gives the feasibility of cross-checking whether the new proposal would blend with the existing fabric or result into an inappropriate misfit. The process is also applicable to the iconic buildings and landmarks with specific attributes (Walton et al., 2007).

2.3 Model for Simulation

Different kinds of outcomes can be obtained so as to calculate parameters whenever a physical or a virtual model requires evaluation. The influence of orientation of the building, sunlight, wind behaviour, etc. can be calculated through the building modeling process. Physical scale models can be tested in the laboratory by Wind Tunnel Test for testing wind pattern, BESTEST (Building Energy Simulation Test) for calculating the building energy intake for a particular time period and giving results to optimize it effectively (Walton et al., 2007). Various softwares, like 'Design Builders' and the 'Ecotect Analysis Software,' simplify the task of identifying variables like DBT (Dry Bulb Temperature), WBT (Wet Bulb Temperature), humidity levels inside the rooms, and so on. One can change the parameters during the research process, check the calculations for different probabilities and, thus, infer the best option for implementation into the respective site specific building design.

3. TYPES OF SIMULATION RESEARCH

3.1 Iconic

In this kind of research, testing of material or products is executed with the help of simulation-oriented interventions. The simulation mainly involves the process of changing variables limit, rather than a change in materials for the simulation. 'Iconic Simulation' helps in assessing the behavioural aspects of any material or any design solution for a specific task. The influence and impact of variable parameters on the physical attributes of any particular materials help in deriving the behavioural aspect in a given context. It thus, indirectly helps in the appropriate application of a customised context for a given content, both for interiors and exteriors of buildings. One can understand, as well as assess, the physical consequence virtually by applying the variables on the material, thus influencing the feasibility of applicable parameters on specific content (Cullen, 1996).

3.2 Analogous

This kind of simulation occurs when an actual or proposed physical system is carried by adopting a comparative analysis matrix. It includes 'Model Simulation' by considering all the parameters and comparing the attributes and impacts simultaneously (Hirschel, 2012), so as to get an appropriate case-specific inference. This type of simulation helps in postulating the most appropriate set of variable parameters on which one can determine the withstanding capacity and the longevity of the entity.

3.3 Operational

'Operation Simulation' deals with people's interaction with the physical context, but emphasis is laid upon data generated by role play. This kind of simulation incorporates advantages of skit plays, or some kind of act, for generating awareness among people. Audience, who change their views according to emotional attachment of the story in the virtual world and the ways in which they relate to real world scenario, are the variable parameters here (Sharma, 2006). A motion picture strikes a psychological impact on the perceiver as it presents a complete visual in the form of a play, advertisement, or, through a walk-through that is enacted or animated. The sequential simulation experienced by the perceiver, or the spectator, while watching the visuals makes him involved, thus giving a feasibility of experiencing an intangible realistic feel in a virtual world. The total process triggers the stakeholder's inclination towards discussion-making and finalisation of the project.

3.4 Mathematical

Systems of number coding capture real-world relationships in quantifiable abstract values that are related to the virtual world scenario. 'Mathematical Simulation' mainly deals with estimation and costing of a building. While making the preliminary budget many permutations and combinations occur between choice of materials, labour and, in fragmenting project milestones. All these can be done with either physical or virtual models. The concepts for all types are the same, but the analysis or outcome may vary as each involves different parameters and situations (Groat & Wang, 2013). Simulations that occur at a larger scale are generally acquainted with planning aspects, from the smaller community to the larger city level. These deal with formulating empirical solutions, projections that help in experimenting with permutations and combinations. Various mathematical models, equations, etc. help in simulating the physical attributes of the vicinity with respective densities, mass-space ratio, post-construction consequences, and other attributes.

4. RELATION OF SIMULATION WITH OTHER RESEARCH TYPES

4.1 Relation of Simulation Research and Logical Argumentation Research.

'Logical Argumentation' prompts involvement of the participant so as to assimilate the facts and findings derived out of Tangible Experimentation Processes and inferences of Physical Consequences. The variables are likely emerge during Logical Argumentation Research as a result of conditional requirement, extending the feasibility of executing a comprehensive activity influencing both context and content. On the other hand, many of the parameters in 'Simulation Research' are predetermined as the content is unaltered during the process. The researcher logically analyses various aspects with respect to recorded facts and findings regarding the subject so as to propose a more appropriate solution, whereas simulation is carried out on the basis of the knowledge quotient, relying upon various artificial parameters. The facts and findings can be postulated in both the cases, but one can effectively interpret a theoretical note in Logical Argumentation Research, evolved out of observations and inferences, while being a part of the research process. The Logical Argumentation Research explains the dynamic interactions and relationships but cannot actually demonstrate them. But Simulation Research is designed to enact a particular case or, at the most, a limited number of case specimens of the general theory (Groat & Wang, 2013).

4.2 Relationship between Simulation Research and Experimental Research

Experimentations concerned with the testing of a particular content with known characteristics are done by recording observations when subjected to various alterations in one or more variables. This process helps in projecting probable improvisations in the properties of the content so as to make it more sensitive to various contexts. Experimental Research is carried out on the basis of available variables occurring naturally in the atmosphere so as to propose better living conditions. It proposes various case-specific design solutions applicable for respective target groups (i.e., socio-economic, socio-cultural, and vernacular groups), as it works out different permutations and combinations regarding content and context. On the other hand, Simulation Research can be executed on a holistic model that can be applied to a larger context.

Experimental Research isolates a context and identifies a particular variable that can be manipulated to see how it affects the other variables. It is more related to Iconic Simulation Research. But Simulation Research recognises that cause-effect relationships are usually not clear in real world context, which always involves probabilistic factor (Groat & Wang, 2013). Experimental Research involves the realistic approach of finding the factor

associated with the concerned project, whereas the Simulation Research only gives us a virtual recognition of diagnosing the project aspects.

4.3 Relationship between Simulation Research and Qualitative Research

Qualitative Research is more oriented towards public interaction and relies upon analysing the opinions, suggestions and objections expressed in the public domain during surveys undertaken as a part of research. It concentrates more on postulating various design solutions, satisfying various inferences derived out of such surveys. It also contributes towards framing design criteria for a new or a redevelopment proposal, on the basis of information assimilated before proposing solutions. Concepts such as gated communities, vertical neighborhoods, etc. procure their design strategies out of such reports. On the other hand, the workability, adaptability and suitability of various innovative concepts and proposals are generally tested and validated (for determining their sustainability concerns) by subjecting them to simulations, which are executed virtually by projecting variables.

Simulation Research involves conducting online interviews and checking records accurately in a shorter span of time. It also includes checking documents, or other kind of field-work, which are mainly supposed to be oriented towards Qualitative Research (Groat & Wang, 2013). A comparative analysis between these methods is given in Table 1. It has been found that Simulation Research is somehow related to all the above-said architectural research in some of the cases and contradicts with the other cases.

5. TACTICAL CONCERN

Replicating the real world scenario through Simulation Research has some limitations in terms of errors. Data error is a liability that is sometimes found in such processes. Errors may occur during entering the data, recording the data, interpreting data at various stages of simulation (Inmon & Krishnan, 2011). Optimizing and mitigating such probable errors results in accurate simulation. Errors generally occur due to various agents such as:

a. **Respondent:** Possibility of misinterpretation of data while communicating;
b. **Situation:** Possibility of occurrence of unfavourable conditions during recording and/or entering data;
c. **Measurer:** Possibility of inaccurate recording/measuring of data;
d. **Instrument:** Error in the instrument either due to a manufacturing defect or property of material, resulting in misinterpretation of data.

Table 1: Comparative Analysis of Simulation Research and Other Kinds of Research.

Item Particulars	Simulation Research	Logical Argumentation Research	Experimental Research	Qualitative Research
Concept	Develop a model to streamline reality	Totally logic and interpretation based	Evaluate the validity and reliability of any object	People descriptive oriented
Objectives	To create a virtual world to know about the real world scenario.	To know the facts by developing alternative interpretation of reality	To know the facts by developing and testing theories for specific item	To know the facts by socially constructed reality
Research Goal	Development of objects about the behaviour of complex system	Develop interpretative and theoretical understanding	Identify the formal links between the objects and test theory	Describe situation holistically, including public participation
Variables	Pre-determined and also emerge during research	Emerge during research	Pre-determined	Emerge during research
Data analysis	Descriptive, quantitative and qualitative	Descriptive	Parametric	Descriptive
Participant's Role	Both artificial and real	Directly involved	None	As informant
Researcher's Role	External audience during the process of research	Theoretical interpreter	External audience	Interactive participant and observer
Relationship with Environment	Mix of positive and negative	None	Socially & economically friendly but non-sensitive towards environment	None
Target Discipline	Artificial Science	History based	Natural Science	Social and Cultural
Architectural Example	Building simulation, cost benefit analysis, object based parameter analysis	Analysis of Architectural history and previous theory (Rao, 1988)	Material testing upon fixed parameters	Different planning theory based on public participation

Duplication of data, or wrongly placed data, or wrong input of data is sometimes caused by manual errors, which is conventionally a drawback of simulation processes. Accuracy in replication is also a matter of concern in this procedure (Hughes & Tanna, 2013). Co-ordination problems may also arise if there is improper balance in execution. Output printing/ modeling errors are also possible in such a scenario (Lin, 2011). Ways of overcoming such errors becomes an integral part of tactics.

6. CHARACTERISTICS OF SIMULATION RESEARCH

6.1 Strength of Simulation Research

Simulation Research is capturing the complexity of real world behaviours, both natural and social. It provides a variety of ways of understanding future behaviours of a context, i.e., pattern and projection of behaviours. It provides harmony between Logical Argumentation Research, Qualitative Research and Experimental Research and, keeps a constant relationship between them (Marans, 2013).

6.2 Weakness of Simulation Research

Simulation Research replicates a real world scenario but there is no assurance of completeness of the research in a projected schedule. This approach may not fulfill the essential requirement of an appeal. There might be many possible computing errors during this process (Sharma, 2006). The lack of accuracy might result in certain technical liabilities in the scenario. The expense undertaken in this phenomenal process is relatively high (Shrimali, 2012) and the installation expenses are also considerably costly. The time taken by such a process is also very long. It consumes more time to take care of every amenity of this process, which would extend the total agenda to a longer period of time.

CONCLUSION

Architectural Simulation Research can be an effective instrumental tool in appropriate and case-specific design processes, as it infers potential parameters derived out of various research modules. Architectural Simulation Research helps in streamlining end-user preferences and impacts by influencing proper design applications. Analysis of air pollutant dispersion is identified using atmospheric dispersion modeling in building industry. Design of noise barriers to effect roadway noise mitigation is also one of these approaches, mitigating the backdrops of acoustical errors in a design Weather forecasting is also a contribution of simulation in today's practical world. The information and near-accurate predictions of weather and climate are made with the help of executing

simulation identifying techniques in certain instruments to retain the value of climate characteristic of a place. Behaviour of structures under stress (such as buildings and industrial parts) and other conditions are also estimated via simulations. This phenomenon is useful in undertaking the stability assurance of a structure. Strategic Management and Organizational Studies, as well as Urban Simulation Models that simulate dynamic patterns of urban development and responses to urban land use and transportation policies, are managed properly by these processes. Traffic engineering utilizes it to plan or redesign parts of the street network from single junctions over cities to a national highway network, for transportation system planning, design and operations. Modeling building crashes to test safety mechanisms in new building models is an exotic output of the simulation oriented technological advancement.

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