



Information Technologies in Architectural Pedagogy: From “Tool” to a “Comprehensive Educational Strategy”

Tecnologías de la información en pedagogía arquitectónica: de “herramienta” a una “estrategia educativa comprensiva”

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Abstract:

The introduction of Information Technologies (IT) in the field of Architecture has brought about revolutionary developments regarding pedagogical frameworks. This paper examines the influence of IT on educational strategies and presents an innovative educational approach for their use in teaching design. Furthermore, it argues that IT cannot be considered in isolation, as mere tools, but rather as part of a comprehensive educational strategy. Such a strategy should take into account the context, method and the subject of architectural pedagogy while answering questions regarding the time, form and content of design teaching. Firstly, the authors present salient historical points that identify the main circumstances under which IT were inserted in the field of architecture. Secondly, through a critical reflection on the latest research in the field, the authors aim to reveal the impact of introducing IT in architectural education. These observations are then juxtaposed with the challenges of innovative education approaches today. Finally, the authors develop an implementation strategy for renovating the architectural education framework where IT are involved, based on three axes: (a) the cultivation of craftsmanship, (b) the conceptualization of IT as a technique and, (c) the teaching of a computation logic in architecture.

Keywords: IT; architecture; architectural pedagogy; educational strategies.

Resumen:

La inclusión de las Tecnologías de la Información (TIC) en el campo de la arquitectura, ha traído desarrollos revolucionarios en lo concerniente a marcos pedagógicos. El estudio examina la influencia de las TIC en las estrategias educativas y presenta un enfoque educativo innovador para su aplicación en la enseñanza del diseño. Asimismo, sostiene que las TIC no pueden considerarse aisladas, como meras herramientas, sino como parte de una estrategia educativa integral. Ésta debe tomar en cuenta el contexto, el método y el sujeto de la pedagogía arquitectónica, al tiempo que responde a las interrogantes relacionadas con el tiempo, forma y contenido en la enseñanza del diseño. En primer lugar, los autores presentan las principales circunstancias bajo las cuales las TIC fueron incorporadas al campo de la arquitectura. En segundo término, a través de una crítica reflexiva sobre las últimas investigaciones, buscan dar a conocer el impacto que han tenido las TIC en la enseñanza de la arquitectura. Estas observaciones son yuxtapuestas con los desafíos de los enfoques educativos innovadores de hoy día. Finalmente, los autores desarrollan una estrategia de implementación para la renovación del marco educativo arquitectónico en el cual se incorporan las TIC, centrada en tres ejes: a) el fomento del oficio, b) la conceptualización de las TIC como una técnica, y c) la enseñanza de una lógica de cómputo en arquitectura.

Palabras clave: TIC; arquitectura; pedagogía arquitectónica; estrategias educativas.

Recibido: 26/09/2018 | **Aceptado:** 08/11/2018 | **Publicado:** 01/12/2018 | pág. 52 - 71



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1. The use of IT in Architecture: Historical Questions

The combination of the Modernist logic and the technological advances of the 1960s brought about the insertion of IT in the architectural discipline (Koutamanis, 2005). For example, the introduction of high level programming languages in design in 1958 (Clayton, 2005), the first use of algorithms to produce architectural layouts in 1965 (Maver, 2002) or Nicholas Negroponte’s proposal of the machine as a partner in the design process (Tweed & Carabine, 1999), are all cited as origin points for the introduction of IT in architectural design.

However, the democratization and proliferation of the computer (and by extension IT in general) in the 1990s led to a widespread confusion regarding the role of IT in architectural design. Since the 1990s, the rapid evolution of Computer Assisted Architectural Design (CAAD) has influenced all educational

systems, leaving only limited time for the development of a comprehensive and coherent understanding of the actual influence of CAAD, and IT in general, in the design process. Although CAAD’s initial objective was to transfer existing design tools in a digital environment (Asanowicz, 1999) instead of pioneering new ones that take advantage of the new media, in the early 2000s it became clear that CAAD was mainly used as a medium to develop new complex architectural forms (Kolarevic, 2000). In other words, the use of CAAD, not only led to a discussion regarding the necessity of teaching programming to architects (Wurzer et al, 2011) in order to transcend the limitations of graphical-based design software (Fricker et al, 2008) but also brought about a new culture in design thinking. In this way, the new technical skills and new design techniques that CAAD introduced led educational frameworks to go beyond



simply selecting a CAAD software package to teach in the context of an isolated class, something that is still not covered in the present pedagogical strategies.

Following this observation, the authors argue that a critical reflection on the methodology of using IT in architectural education can be of use in answering contemporary questions regarding the technological dominance in all disciplines. Specifically, they argue that a pedagogical approach should acknowledge the issues regarding the role of IT in the creative process and the concerns about how to better harness their potential. In our view, these issues remain as pertinent today as they were more than half a century ago. As Walter Gropius stated in the 1964 Boston Architecture Center Conference titled “Architecture and the Computer” (Kotsioris, 2015), the use of IT in architecture can be of value on the level of inventive thought and they should not be relegated solely to mechanical reproduction of pre-conceived designs (Kotsioris, 2015). It is also of interest to highlight Christopher Alexander’s position at the same conference, who noted that

in order to make the most of IT in architecture, one should at first look beyond their apparent utility as tools. Regarding the uncritical utilization of the computer at the time, Alexander further remarked that: “We do not wander about our houses, hammer and saw in hand, wondering where we can apply them” (Kotsioris, 2015).

|2. How do IT Influence Architectural Education?

Turning from the brief identification of certain questions regarding the introduction of IT in architecture, we will now examine two aspects regarding their influence on architectural pedagogy. The first aspect examines the way IT affect the context, methods and subject of architectural teaching. The second one regards the presentation of certain challenges facing contemporary educational strategies. At this point, it is important to note that the present investigation focuses on the influence of IT on architecture as a subject, rather than on educational methods. Thus, topics such as long distance or asynchronous learning will not be examined in the context of this paper.



2.1. Context, Method and Subject of Teaching

For the first aspect of the influence of IT on architectural education we focus on the following discrete levels: a) the context (i.e. the pedagogical goal), b) the methods (i.e. the educational strategy), and c) the tools (i.e. what is actually being taught).

2.1.1.Context

As it has been discussed, the introduction of IT constitutes a paradigm shift in architectural design. This has led to the development of new design methodologies such as algorithmic design (Terzidis, 2006), performative design (Seebom, 2007), and parametric design (Schumacher, 2008). The majority of these approaches utilize tools drawn from the field of natural sciences (such as mathematics, physics or biology) as the basis for the development of an architectural methodology. Although the question of whether these tools are capable of grounding a new architecture in and of themselves remains open (Vesely, 2004), it is important to note that they introduce new concepts to architectural thinking, such as mass customization and emergent form (Oxman, 2008).

Therefore, the organization and dissemination of this new knowledge, as well as its integration into the existing framework of design thinking, emerges as a new pedagogical goal or, in other words, a new context for architectural education.

2.1.2.Method

The second level of influence of IT on architectural education concerns the methods for teaching design. The mainstay of most pedagogical approaches revolves around the design studio, which consists of a simulation of the actual design process (Schon, 1987). Therefore, by changing the design process, IT affect the method by which architecture is taught. In this section we will focus on certain effects IT have on the design process.

First there is a change in the design environment, since the tools used in expressing the design largely determine the result of the design process. In William Mitchell's words: different media consist of different "design worlds" with different primary tokens that the designer manipulates according to different rules (Mitchell, 1990). The introduction



of IT has led to the opening of a whole series of new design worlds, such as three-dimensional modeling and animation. These new design worlds lead to new ways of approaching design.

The second effect is the shift from the production of form to the programming of form. In other words, the use of IT allows the designer to shift from the specification of architectural form to the definition of a system which, when mobilized, produces form or forms in an autonomous fashion (Spuybroek, 2004). Thus, the role of the architect in the design process shifts from the design of a specific form to the setting up of a system that will, in turn, create the desired form. This requires a change of mentality in the way architectural design process is conceived.

The third effect is partly a result of the shift from the production to the programming of the form. The resulting indeterminacy leads to collaboration between the designer and IT, since the architect does not know the form before the system produces it. That is to say that the unexpected results of the system may lead to the evolution of the design in

a direction not originally anticipated by the designer. Therefore, IT have become to a certain extent partners rather than tools in the design process.

The three effects briefly outlined above highlight the impact that the introduction of IT has on the design process. Since the simulation of the design process has a central position in design pedagogy, it follows that IT affect the methods by which we teach architecture.

2.1.3. Subject

Beyond the influence of IT on the context and the method of architectural education, the most self-evident area of effect is the educational subject. In other words, the introduction of IT implies the introduction of new design media in the context of architectural education. We will briefly examine the following aspects of this matter.

The first aspect regarding the new design media is the representational possibilities that they provide. As it has been already described in relation with the available “design worlds”, IT allow multiple new ways of representing the architectural form. Beyond the introduction of new forms



this brings about the need of teaching new modes of representation, such as rendering or Computer Assisted Manufacturing (CAM).

The second aspect is connected to the relation between designer and design. It has been argued that in sketching there is a link between the movement of the hand and the mind (Graves, 1977). In the case of IT, a new relation replaces this link. Although interesting research has been conducted regarding the replication of sketching in the computer (Cheng, 2007) for the purposes of the present argument, suffices to say that designing utilizing IT constitutes a very different proposition than sketching with pen and paper. This is not only due to the new representational possibilities mentioned previously but also because of the different kinesthetic dynamics that come into play.

The third aspect of this brief presentation of IT as new design media focuses on the freedom they afford. It has been noted that due to limitations inherent in their design, most CAAD software requires a precise definition of the forms (Abdelhameed, 2004). Although this issue has been at least

partially addressed in recent years, the precision required by IT can prove detrimental, especially in the early stages of the design.

The aspects presented above highlight the effects of IT on the act of designing and by extension the design process. Therefore, the authors argue here that the mere introduction of IT as educational subjects brings a change that affects the pedagogical framework even if we disregard the influences on the context and method of architectural education.

2.2. Challenges facing contemporary educational strategies

The issues examined before present certain challenges to architectural pedagogical frameworks, which constitute the second aspect of the influence of IT on architectural education. Namely, the need has emerged to rethink and adapt educational strategies in order to incorporate the changes brought about by the introduction of IT (Oxman, 2006). Although the full extent of the issues raised cannot be covered in the present paper, certain pertinent questions will be examined, concerning the time, form



and content of architectural education in relation to IT.

2.2.1. Time - When to teach

Given the influence exerted by IT on the design process, the precise time of their introduction in architectural education remains a matter of debate.

On the one hand, many scholars argue that an early introduction enables students to attain mastery of the new media as soon as possible (Angulo & Vermillion, 2012). On the other hand, advocates of a delayed introduction contend that the complexity of issues raised by the introduction of IT related to design processes require a level of maturity on the part of the students and; therefore, it should come at a later stage of architectural education (Maldonado, 2014).

In relation to this debate, it is of value to note that the introduction of IT should not overshadow the use of other media in architectural education (Ham & Schnabel, 2014). In this context, certain studies indicate that in cases of early introduction of IT in the curriculum, students displayed a poorer grasp of spatial reasoning when compared to students that were introduced to IT at later stages of their education (Kara, 2015).

It can be argued that what is crucial is not the timing of the introduction per se, but rather the role of IT in an educational approach. Such a strategy should incorporate the undeniable influence of IT in a broader context, combining them with other media as well as providing the necessary contextual and methodological framework for their use in design.

2.2.2. Form - How to teach

The way in which IT are introduced in design education is an equally important question for pedagogical strategies (Senske, 2011). Admittedly, the manner of introduction is to a certain extent defined by the selected time as well as the content. We highlight two issues related to this question.

The first one is the debate regarding the extent to which the architectural curriculum should be modified in order to incorporate the introduction of IT (Mark et al, 2001). One view calls for a radical redesign of the entire pedagogical strategy around the new media, while the other advocates the addition of specific classes and courses within existing frameworks.

The second subject concerns the



question of whether IT should be taught as separate subjects or integrated into the design studio, which is the central element of architectural education. Both approaches have their merits. On the one hand, the integration into the design studio allows for an implementation of IT in the design process, allowing for a better understanding of their use in an architectural context (Asanowicz, 2007). On the other hand, the nature of the new media necessitates some form of abstract approach that cannot be achieved in the context of a design problem (Globa et al, 2014).

Although the discussion regarding the method of integrating IT in the architectural education frameworks remains open, it is apparent that any such decision cannot be made in isolation but rather in the context of a broader educational strategy.

2.2.3. Content - What to teach

The final question regarding the challenges facing architectural education and IT concerns its content, in other words, what it aims to teach.

Although a detailed description of the various models of the design process escapes the scope of this paper, for the

present argument we can envision it as a puzzle. In this context, the architect defines both the parts of the puzzle as well as the rules by which they are assembled, modifying both aspects as the design process progresses (Seebohm, 2007).

Thus, the content of the educational process consists – among other things – in teaching students to recognize and define the rules and pieces that are particular to a given design problem. It can be argued that this process remains the same regardless of the introduction of IT. Therefore, the educational content should remain focused on the design process. In other words, the introduction of IT in architectural education should not be at the detriment of the design aspect but rather at its service.

|3. Introducing IT Theory in Architectural Pedagogy

Based on the previous discussion regarding the effects of IT on design education as well as the challenges facing architectural pedagogy, it can be argued that their introduction cannot be considered in isolation but rather as part of a comprehensive educational strategy. Such a strategy



should consider the context, method and the subject of architectural pedagogy, while answering questions regarding the time, form and content of design education.

This pedagogical approach can be articulated on three axes: the cultivation of craftsmanship, the conceptualization of IT as techniques and, the teaching of a computation logic in architecture.

3.1. Design Craftsmanship and IT

One of the main obstacles regarding the integration of IT in design is the lack of sufficient understanding of their workings by the designers. In other words, architects find it difficult to judge a design method based on IT in the same way that they would evaluate one based on traditional media (Senske, 2014).

The reason for this is the absence of the ability to critically evaluate the task at hand in order to select the optimal method of approach. A craftsman, as opposed to a regular user, is able to utilize the available tools and media in ways that a regular user cannot. This is not exclusively due to the fact that he is more proficient in the use of said tools, but also because of his

understanding of the task as well as the capabilities of the individual tool that allows him to proceed in the most efficient way.

Therefore, what is necessary for the context of a pedagogical strategy regarding the introduction of IT in architectural education is the development of design craftsmanship vis a vis the new media.

It is important to note that such proficiency is not achieved solely through time but requires a deeper understanding of how IT work, as well as their role in the design process. It is not sufficient to achieve proficiency in the use of IT in design if that proficiency is not paired with the development of the critical ability to determine when and where to utilize them in the architectural process.

Such ability is largely linked with the development of individual judgment. This presupposes the understanding of both the tools and the task at hand in order to be able to decide on the optimal approach in each case. Through the development of judgment, the designer is able to lay out a strategy regarding the use of IT in the design process, instead of haphazardly implementing



individual tools. To paraphrase Christopher Alexander's remark cited previously, the development of craftsmanship is necessary in order to avoid wandering aimlessly around the design, wondering where to utilize the new media.

3.2. IT as a Design Technique

The introduction of computational concepts as design techniques is the second axis on which a pedagogical approach regarding IT in architectural education can be based.

The main element would be the integration of IT in the design process through the utilization of computational concepts, such as generative algorithms, parametric modeling, and performative design. The goal is to gain hands-on experience regarding the utilization of the new media in the architectural process. In contrast to the first axis concerning design craftsmanship, such an approach does not explicitly address the cultivation of a different logic but rather focuses on the intuitive integration of IT into existing architectural approaches.

What is of interest, in this case, is the conceptualization of the design

process in order to determine the role of IT within it. In other words, the need to structure a design approach around a computational concept leads to the need to describe the stages or structure of the architectural process. Although there is no one model to describe the process of design, the mere act of attempting to outline one has an educational value, in the sense that it leads to the mapping out of a strategy, bringing to fore the individual conceptions regarding the architectural process and; thus, enabling the students to critically reflect upon them and re-evaluate them.

Furthermore, the case-based introduction of IT in design education allows for the development of individual skills and competence, not in an abstract manner but rather based on concrete architectural paradigms. Of course, this requires a parallel teaching process that, on the one hand, promotes individual experimentation and, on the other hand, provides a broader context in order to avoid limiting the students to a specific tool or method. Rather, the chosen computational model and design example is utilized as a springboard to introduce students



to the broader field related to the introduction of IT in architecture.

In other words, such an approach consists of a bottom-up approach to cultivating craftsmanship that can work in parallel to the top-down approach described previously.

3.3. Architectural Logic and IT

The main element of this characteristic is that IT are not treated as tools in the design process but rather as a medium, that enlarges the scope of architectural education. In other words, what is important is not the teaching of a specific tool but rather the development of a theoretical framework that governs their implementation in design.

The basis of this argument is that, although IT allow for considerable freedom in the design process, their abilities cannot be fully exploited within existing frameworks. In other words, IT cannot be utilized to their full extent without a theory of design that incorporates the multiple aspects of the new media. Therefore, the introduction of IT should lead to a re-examination of the design discipline, in order to escape the confines of

an ephemeral trend and aid in the expansion and improvement of the field.

At the educational level, this means that IT cannot be integrated in a disjointed and isolated manner but, on the contrary, as part of a comprehensive pedagogical approach that addresses the full scope of issues and questions mentioned above. Such an approach requires a balance between theory and praxis in order to allow students to understand the multiple aspects of the influence of IT in architecture.

The rapid evolution of IT is one of the main factors that render problematic a purely practical approach, i.e. the teaching of specific CAAD software, given the fact that specific tools become obsolete in a matter of years. This demands the existence of a theoretical framework, which will allow the development of a more spherical approach to IT in architecture on the part of the students. The goal is not to teach a specific tool or method but rather to cultivate a critical view through the presentation of multiple aspects of IT in design, through a variety of lectures, workshops and assignments.



Therefore, IT would be treated as the starting point for a critical examination of the field of design. Thus, the objective is not the transfer of a definitive viewpoint but rather the development of a personal position regarding IT in design. In other words, the objective is to aid the student to develop an understanding of IT not as design tools but rather as lenses that allow a different view of the broader architectural context.

This means the replacement of a narrow teaching model with a broader pedagogical approach, as well as the identification and reconsideration of preconceptions both on the part of the students and of the teachers.

|4. Practical Considerations

Beyond the outline of the axes for a pedagogical strategy regarding the introduction of IT in architectural education, it is valuable to briefly consider some of the practical considerations of such an undertaking. In this paper, we will highlight three such considerations, namely the difference between architectural and computational thinking, certain characteristics

of courses that implement such a pedagogical approach, as well as potential challenges and pitfalls.

4.1. The Difference between Architectural and Computational Thinking

In considering the introduction of IT in the design process, it is important to consider the difference between the architectural and the computational aspect of design thinking (De Boissieu et al, 2013).

In this sense, one can make a distinction between those actions of the design process that refer to the architectural object in question, such as the dimensions of a room or the form of a building, and those that are primarily concerned with the computational aspect, for example the definition of an algorithm or the setting of certain parameters. Although there exists a clear link between these two sets of actions, that is to say, the architectural choices govern the computational actions and vice versa, what is of interest is which actions take precedence during the design process. In other words, it is important to specify if it is architectural or computational



considerations that will guide the design process.

The main value of such a specification is not to establish a correct or proper method to approach the introduction of IT in design but rather to allow feedback. In other words, an architectural decision that is translated into a computational action should be open to re-evaluation depending on the results of that action. Similarly, the choice of a computational system should be informed by architectural considerations that result from its implementation. Put simply, the definition of architectural and computational aspects of design thinking opens them up to critical evaluation and modification. Therefore, students should be made aware of them in order to be able to engage in a reciprocal dialogue with them rather than being limited to a serial implementation of enclosed, self-sufficient systems.

4.2. Course Characteristics

We have already briefly touched upon the issue of the position of courses revolving around the introduction of IT in the broader framework of the architectural education curriculum,

as well as the questions and challenges facing them. Here we will attempt to highlight certain characteristics that, in our view, such a course should have.

The first characteristic is the structuring of the teaching around a design project. As it has already been mentioned, this allows for hands-on experience that aids in the better understanding both of the uses of IT in design as well as the theoretical aspects that the introduction of the new media entails. Care should be taken to avoid limiting the educational approach to a simple training in specific software, rather than using the implementation of IT as a linchpin around which the aspects already presented are structured.

Secondly, the course should be articulated into smaller units or phases – e.g. research, creative development, implementation, and presentation –, which aid in providing structure, as well as a roadmap for the educational process. Nevertheless, it should also be stressed that a single project is preferable to multiple smaller ones (although this does not limit various discrete phases of the same project) in order to afford students the necessary



time to explore and evolve their ideas in depth rather than being forced to produce multiple projects in the same course that will invariably lead to a superficial approach.

Thirdly, any such educational approach should encourage exploration and experimentation, something that can be achieved through the choice of unusual subjects that force students out of their comfort zone and deter them from falling back into preconceived ideas and methods. It is important to impart to the students that the course is an open-ended process of exploration that does not necessarily aim solely at the elaboration of a final product. Such a process should necessarily implement multiple aspects and approaches in order to avoid being limited to a dry training seminar in architectural theory or computer practice. On the contrary, the students should be made aware of the multifaceted and complex nature of architectural design rather than being limited to the completion of a single project.

Finally, it is of paramount importance to be able to evaluate these courses both in regards to the results

obtained, as well as in relation to their success in the context of a broader pedagogical strategy. It is our view that the most important assessment is whether a course succeeded in transcending the simple transfer of specific knowledge and provided meaningful input in their broader pedagogical development or not. Such an evaluation requires a long-term examination of the development of students, as well as the tutors and the course itself.

4.3. Challenges and Issues

One problem regarding the introduction of IT in the context of architectural education is their utilization without understanding the underlying logic that governs them. This leads to instances where the utilization of the new media is treated as an end in and of itself. Furthermore, without comprehension of the underlying concepts, the use of IT in architectural design is limited to a small pool of software that leads to uniformity in the produced results, despite the apparent freedom offered.

A second issue faced by attempts to articulate a comprehensive pedagogy concerning the use of IT in design



is the focus on the memorization of specific commands without the necessary context. We have already mentioned this aspect in relation with the necessity of a practical design aspect in relevant educational strategies. Nevertheless, all too often we witness the introduction of IT in architectural design as abstract systems without specific use, in whose frameworks we then attempt to fit the individual design project, regardless of its specific characteristics.

Finally, one of the main issues that confront architectural education in matters related to the role of IT in design is the lack of a concise strategy on the part of the Educational Institutions themselves. For various reasons, the integration of IT in the architectural curriculum is more often than not based on individual efforts and initiatives rather than on a collective approach. As a result, a comprehensive pedagogical strategy as has been outlined in the present paper is hampered by lack of continuity in teaching and the fragmentation of the educational programs.

|5.Conclusion

The introduction of IT in the field of architecture has led to a series of profound changes in design theory and praxis. The new media, far from being merely glorified pencils have altered the how and what we design. This is an issue that cannot be ignored by architectural pedagogical frameworks.

The influence of IT in regards to design education can be traced on multiple levels. By changing the tools of design, they affect the teaching subjects, while their effects on the methods of design, in turn, have repercussions on the way by which we teach design. Finally, IT's role as centerpieces of a new architectural style also modifies the broader context of architectural education.

Therefore, contemporary educational frameworks are faced with a series of challenges, ranging from questions about the optimal time and method to introduce IT in the architectural curriculum to issues surrounding the content of relevant teaching.

The influence of IT and the resulting challenges presented to architectural



pedagogy cannot be faced in an isolated manner and require the articulation of a comprehensive pedagogical strategy regarding the introduction of IT in design education.

Suggested axes along which such a strategy can be articulated include the development of craftsmanship regarding IT in architecture, the introduction of computational principles as a design technique and the development of a broader architectural logic regarding the introduction of IT.

Beyond the broad theoretical outlines of these directions, it is of value to consider the practical parameters of such courses that include issues of difference between computational and architectural thinking in design, as well as desired characteristics of relevant courses and possible challenge that their implementation may face.

Admittedly, the cutting edge developments regarding the

introduction of IT in Architecture are taking place in universities and institutions with more financial resources and greater tradition in the field. Nevertheless, given the proliferation of IT, the issues outlined in the present paper will surely affect the whole Architectural Education community, regardless of geographical location. Furthermore, the democratization and increasing accessibility to these new technologies present new opportunities to a wider array of users, whereas until recently the necessary means were limited to 'elite' academic institutions.

In conclusion, the ongoing technological evolution makes the introduction of IT in architectural practice and education inevitable. What is important is not whether pedagogical strategies acknowledge this fact but rather how they will assert themselves in the face of the new age.



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