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Communicating Quantum Computing

A video workflow to reach a broader audience

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Abstract. Communicating complex content to a non-specialist audience is always a challenge. In the realization of a video dedicated to Quantum Computing, VisitLab has adopted a process already tested in previous experiences and which aims to combine aesthetic appeal and scientific soundness of the contents.

Key words. quantum computing; edutainment, computer graphics, interdisciplinarity

1. The second quantum revolution and quantum computing

We are currently in the midst of the second quantum revolution, in which the level of control over the properties of matter is so accurate that it is possible to conceive new and powerful technologies such as quantum computing, which rely on quantum mechanics principles. Quantum mechanics is a branch of physics that deals with the behaviour of atoms and subatomic particles (Hidary (2021)). In the early twentieth century, the first quantum revolution coincided with the discovery and understanding of the laws of quantum mechanics. Thanks to this knowledge, innovative products like cellular phones and lasers were created. However, the products of the first revolution did not directly exploit the quantum properties of matter while the second quantum revolution foresees the ability to tame properties such as entanglement or the superposition of states. The date of birth for quantum computing could be placed in the 80s when the well-known physicist Richard Feynman claimed that, since nature is in essence quantum, it's mandatory to make simulations that follow the principles of quantum mechanics to understand it fully (Feynman et al. (2018)). Facing the problems of high-energy physics, he realised that simulating a quantum system starting from a classical system was not enough. In this frame, quantum computing uses principles of quantum mechanics to store and process data, unfortunately these principles are particularly difficult to understand because they are counterintuitive. There is, on one hand, the need to disseminate to researchers the possibilities offered by this new technology and explain to them how they could exploit and use quantum computing resources but, on the other hand, there is also the need to communicate to a broader audience this new computer science paradigm,

to engage young people toward new possibilities, and inspire a new generation of quantum computing users (Liguori et al. (2019)). Cineca decided, therefore, to create a short video in order to support this endeavour.

2. Production workflow: the importance of cooperation in a multidisciplinary team

Given the complexity of the topic, in order to produce a short video dedicated to quantum computing suitable for the widest possible audience, it was decided to add an introduction about the fundamental concepts of quantum physics, instead of giving just a general overview of the possible fields of application. As a result, it was necessary to adopt a working process different from the usual ones and to rely on a highly multidisciplinary development team, including an electronic engineer and humanist, with basic skills in quantum computing (production and project management); a mathematician (scientific committee); a theoretical physicist (scientific committee); a humanist (director); a humanist (storyboarding, assistant director); a mathematician (junior CG artist); a person with IT economic education (senior CG artist); a Graphic designer (2D artist). The presence of people without scientific training has made a preparatory phase necessary during which to study popularising videos and in-depth articles to reach a minimum common base of understanding. We then moved on to drafting the texts. These were initially elaborated with the project manager, given her basic skills in quantum computing. Only later was the text submitted to the internal scientific committee. Each paragraph was therefore thoroughly debated, taking into account the dual need to maintain scientific accuracy and, at the same time, dissemination ability. Once the final text had been approved, three times longer than the three minutes originally budgeted for the duration of the video and immediately discarded as too stringent for such complex content, the voiceover was recorded. Also in this case, the team faced a choice of whether to make the video in Italian or English, ending up by choosing the more "extended"

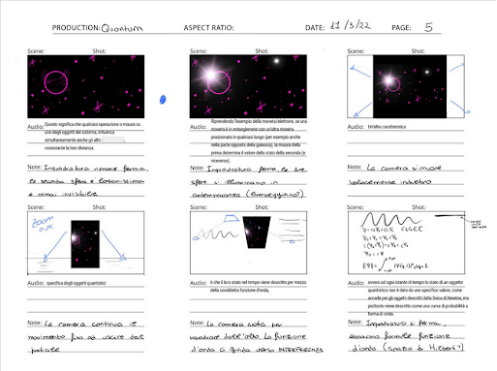

Fig. 1. A page from the storyboard for the short video on quantum computing

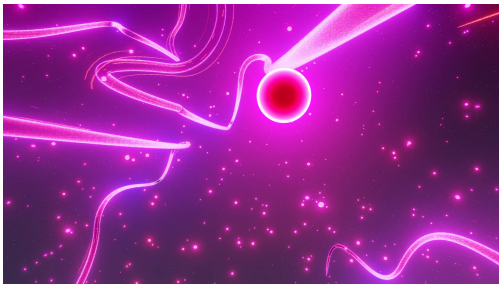

Fig. 2. A frame from the 3D animatic

option, and the voiceover was recorded in both languages. We then moved on to storyboarding, which defines what is displayed scene by scene, including the movements of the assets in the scene and the camera movements. In this phase the assistant director, the senior CG artist, and the 2D artist worked on their own, independently from the other team members, thanks to a well-defined script, and presented the storyboard for validation only once completed See Fig. 1. After some minor corrections, the team moved on to the creation of the 3D animatic See Fig. 2, which received nothing more than formal approval from the scientific committee and, therefore, to the creation of the actual video.

The interesting aspect of this workflow was, therefore and first of all, the initial concentration on the definition of the text in very close collaboration between the scientific committee and the development team, which made

it possible not to overburden the two parties thanks to step-by-step processing which safeguarded the communication aim of the development team and the aim of the scientific accuracy of the committee.

3. Production workflow: scientific accuracy and dissemination purposes

Once the first preparatory phase was completed, we moved on to the production of the shots starting with the modelling and shading of the objects in the scenes, as defined by the storyboard. Given the desire to reach as wide an audience as possible, the dual necessity in writing the text to maintain scientific correctness and disseminative capabilities was equally taken into account and declined in the actual production, guiding the choice of elements to be represented as well as their graphic rendering. Taking as an example the initial shots about Physics in the early 1900', on the one hand, the text tells how Newton's laws of mechanics and Maxwell's laws were not sufficient to describe the subatomic world and a "new physics" was needed, on the other hand, the video shows the formulas involved. The text remains scientifically accurate and accessible to a non-expert audience, the formulas shown fulfil the first requirement, giving scientifically correct support to the narrative voice, but not the second one, at least in the first instance. The formulas turn out to be known and understandable to a viewer skilled in the subject but are more difficult to comprehend, if not incomprehensible, to the inexperienced viewer, who has generally led away from the narration. Our disseminative necessity, however, requires that we engage both types of viewers. So, the graphic rendering of the features of the formulas was chosen in such a way as to be intriguing, detailed, and appealing and thus aesthetically pleasing to a general viewer. This was achieved by using a stroke characterised by cross-hatching, as seen in Fig. 3, a technique generally used in black-and-white drawings to add shading and texture to objects.

In this way, the requirement of disseminative intent is also fulfilled since the less

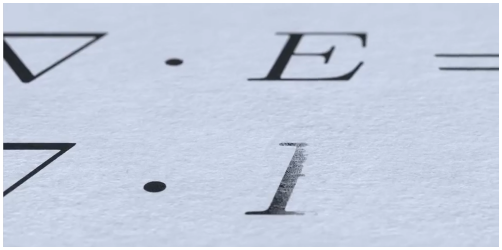

Fig. 3. Detail of the cross-hatching strokes of the formulas within the first shots.

experienced viewer, although unable to fully grasp the meaning of the formulas, continue to follow along attentively because he or she is intrigued and attracted by the details of the graphic rendering, while the experienced viewer also appreciates what is shown. The same paradigm was used in the object and camera animation stage as well. Considering again the example of the formulas, we see how, although these are presented on a "sheet of paper" or a blackboard, they are not framed statically from above, as if being analysed by a student but are progressively revealed, with irregular and jagged edges, suggesting the viewer about their connection to what is being told by the narrator.

4. Conclusions

The final version of the video will be presented in as many events as possible, such as the Night of the Researchers (EU project, Marie Sklodowska-Curie actions, G.A. n. 101061722) and the school tours held at Cineca headquarters. In these events, feedback will be gathered about the effectiveness and overall appreciation, as done on other occasions with encouraging results.

References

Hidary, J.D., 2021, Switzerland: Springer International Publishing, 2021, Quantum Computing: An Applied Approach.

Feynman, R.P., et al. 2018, United States: CRC Press, 2018, Feynman Lectures On Computation (Originally published: 1996).

Liguori, M. C., et al. 2019, Storia e Futuro, Rivista di storia e storiografia on line, n. 51, 2019/12, Evaluating an immersive interactive VR experience: MUVI-Virtual Museum of Daily Life VR case study