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Art and Control Engineering: developing animated cartoons for Control Education^{*}

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Abstract: Studies have shown the advantages of combining Art and Science allowing a greater range of engagement by students across multiple senses and thus improving their long term retention and understanding of complex scientific notions. This paper offers some insights from the “∞sCaR – 2D Animated Cartoons for Control Education Rise” project. The goal of this project is to develop 2D animated cartoons on Control to both motivate engineering students to pursue further studies in Control and also to help them better appreciate some of the foundational concepts. In consequence, the authors hope this will increase the impact of Control on the younger generation.

Keywords: Control Education, Art and Engineering, Systems and Control for societal impact, Diversity and inclusion in Control Education.

1. INTRODUCTION

The recent technological advances are one major factor of the fruitful symbiosis between numerous artistic and scientific domains, leading to multiple benefits for Art, Science, and society. Cross-disciplinarity between Art and Science have been conducted in several fields: e.g., Medicine and Art (Deshpande, 2025; Crispino, 2025), Art in Material Science (Sun and Zhou, 2024), artistic depictions in Ecology (Davis et al., 2025) and environmental sustainability (Levy, 2024; Ahn, 2024), etc. An example on bridging Art and Science by converting seismic and hydro-acoustic data

into immersive digital artworks is provided in (Ren et al., 2024).

Nowadays, there are more and more outreach activities combining Art and Science, see for instance (Kato and Ito, 2024; Cohen et al., 2024; Li et al., 2023). In addition, students are often involved in creating these activities for children. A workshop combining Architecture and Mathematics notions proposed for secondary-school pupils was reported in Cojan et al. (2024). The same paper also proposed the first hand-drawn 2D short animated Control cartoon, where one teenager explains the notion of feedback and illustrates it on a drone example. This video served as proof of concept for the “∞sCaR – 2D Animated Cartoons for Control Education Rise” project

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which consists in developing a series of short animated hand-drawn cartoons on Control topics. The main motivation in developing this series of animated Control cartoon is to develop new Control resources to engage undergraduate students to continue within a Control Engineer career, and to increase the Control Engineering awareness of the general public. There exist numerous online resources for Control (e.g., videos (Douglas, 2011; Bruton, 2011; Abramovitch et al., 2023), interactive tools (Guzmán et al., 2023; Rossiter, 2024), comics (Douglas, 2022; Mash, 2010; Sher-DeCusatis, 2023)). However, very few of them combine artistic and scientific aspects, which could, for example, engage more girls into taking a deeper interest in the Control field.

This paper presents some insights and current developments of the “ ∞ sCaR” project both from artistic and scientific perspectives. The main contribution of this project consists in developing a series of short 2D hand-drawn animated cartoons on Control. The main target of the proposed videos are undergraduate students who take a first Control course. However, some videos are addressing general notions on Control (e.g., feedback) and its applications, and are, therefore, dedicated for outreach activities. As part of the invited session “*Where Art and Science meet*”, the originality of this paper is to describe some current achievements of the “ ∞ sCaR” project, with a particular focus on the symbiosis between 2D hand-drawn animated cartoons (as Art) and Control (as Science).

The remaining part of this paper is organized as follows. A brief description of the “ ∞ sCaR” project is provided in Section 2. Section 3 details some artistic elements considered during the animated cartoons development, while Section 4 focuses on the scientific concepts to be covered by the videos. Feedback from the project participants is provided in Section 4 before concluding remarks in Section 6.

2. PROJECT OVERVIEW

This section briefly describes the “ ∞ sCaR” project, providing details on the project consortium, goals and implementation.

2.1 Consortium

The project team is composed of several Control Systems researchers/professors/engineers from different countries (France, Germany, Italy, Norway, Spain, United Kingdom, United States), one English professor who was an actress at the early stage of her career (France), and one 2D animator (France). Therefore, both scientific and artistic communities are well represented, within a strong international framework. In addition, the consortium benefits from the vast experience of Brian Douglas on educational videos on Control.

2.2 Project goals

The main goal of the project is to create a series of 2D hand-drawn animated cartoons on Control to

- Motivate engineering students who are taken a first Control class to pursuit in the “Control Engineering”

specialization, and later on with a Control engineer career;

- Disseminate basic Control notions (e.g., feedback, stability) to the general public, combining elements from Art and Engineering in order to arouse girls’ interest¹ in Science, Technology, Engineering, and Mathematics (STEM).

2.3 Project implementation

This project aims to create a series of short videos (approx. 2min30 per video). Each video will illustrate only main concepts on Control, without the technical details (e.g., illustrate the importance of robust control without presenting equations). All the videos will have the same two main characters who will introduce to each other different Control concepts.

The consortium decided to create one topic-based standalone videos, which should allow a broader audience. Indeed, this concept targets persons who want to quickly understand the principles of important topics in Control, without having to watch a long series of videos to get the necessary information. This should allow for a broader audience. However, for the interested persons, some pathways (a sort of navigation routes between the series of video) will be suggested to facilitate their progression.

In the following, the main steps for the video development are provided:

- *Before starting a script.* The videos developed during this project have a pedagogical goal. Therefore, before starting to write the script, it is important to define the message of the video (e.g., the main points for the students to see, the main source to motivate them watching this video such as points to hit and take-aways).
- *Writing the script.* During the script writing phase, the author of the script considers several aspects: as the scientific content (both in terms of theoretical concept and examples of practical applications), the scenario (i.e., the context of the discussion between the two characters), etc. In addition, the script author provides detailed indications for the voice recording (e.g., words to be emphasized) and the storyboard (e.g., graphics to be added on background to better illustrate the considered scientific concept.).
- *Creating the storyboard.* Several ideas are indicated for the storyboard, however this step involves a lot of creativity from the 2D animator and therefore is one major part of the artistic development of this project.
- *Voice recording.* The two project members involved in this step have a tremendous experience in video recording or theater performance, and they offer a new artistic perspective by adding their voice signature.
- *Creating the animation.* This part mostly benefits from the creativity of the 2D animator, leading to the cumulus of artistic and scientific developments.

¹ This is a key factor for diversity and inclusion in future engineering students’ recruitment.

In addition, at each step there are iterations with other members of the project resulting in an improved final version of the animated videos.

3. ARTISTIC PERSPECTIVE

This section presents the artistic developments, with details on the considered characters, backgrounds, scenes, storyboards, animated cuts, etc..

In the early stage of the project, one of the key questions was related to the characters of the animation. There were several constraints in choosing the characters. The project members wanted to keep neutral, inclusive, common, well-known, somehow funny, easy to draw characters. In order to facilitate the animation, only two main characters were considered within the perspective of conversation-based scenarii. With all these constraints, the project members decided that proposing two cats could be a nice solution. Each video is constructed on a learner-teacher scenario, with the possibility to switch roles between cats from one video to another (e.g., the two characters could be seen as teammates).

The 2D animator proposed several types of cats (see Fig. 1) with different simplified shapes for the body, head, paws, and different colors. All these elements define somehow the artist's signature. Once the global shape of the cats was selected by the project members, the cats were fine-tuned by the 2D animator. Therefore, a similar shape is used for the bodies of the cats, but with different fur color, eyes shape and color, nose and mouth shape, etc. The selected version of the *Character Design* is illustrated in



Fig. 1. First drawing tests for the characters.

Fig. 2, with a particular focus on the line types and colors, together with an example of animation. The reader will notice that one cat has some blue-ink spots, expressing its affinity for science. The eyes expression of the orange cat illustrates its passion for learning and the star-shape of its tail tip open the perspective of a bright future in science for this young cat.



Fig. 2. Character Design.

Several backgrounds are used during the videos, some indoor, other outdoor, during different day moments. One example of background is presented in Fig. 3: the open door invites one character to join the other one into the considered scenario.



Fig. 3. Example of background.

The first video explain the concept of the PID controller based on a baking example. An example of the storyboard of the first video is presented in Fig. 4, showing the oven with a fine PID controller, a happy cat who learned how a PID controller can help to keep a constant temperature in an oven and another happy cat who explained the PID functioning principles. The attentive reader will notice some of the drawing elements (e.g., stars, diagonal lines) that will be used to emphasize the actions during the animation phase. The characters attitude is also well highlighted on the storyboard extract.

A sequence of animation cuts is represented in Fig. 5, illustrating part of the dialog between the two characters.



Fig. 4. Extract from the storyboard of the first video.

It is interesting to notice the mindset of the two cats (from left to right, and top to bottom):

- The astonishment attitude of the *learner cat*;
- The persuasiveness of the *teacher cat*;
- The incredible joy of understanding the presented scientific concept;
- The satisfaction of correctly using a PID-based oven for a perfect baked cake (also see the colored image in Fig. 6);
- The achievement of the *teacher cat* to convince a new disciple about the advantages of the PID controller.

A video frame is available on [toadd](#).

4. SCIENTIFIC PERSPECTIVE

4.1 Background and motivation of authors

Most of the authors work and carry out research within the global Control community (as part of the IFAC Technical Committee on Control Education). They have been involved in a number of initiatives in recent years to increase interest amongst both school leavers and undergraduates in the general area (e.g., Summer school *Girls in Control* (Knorn et al., 2021) during IFAC World Congress 2020,

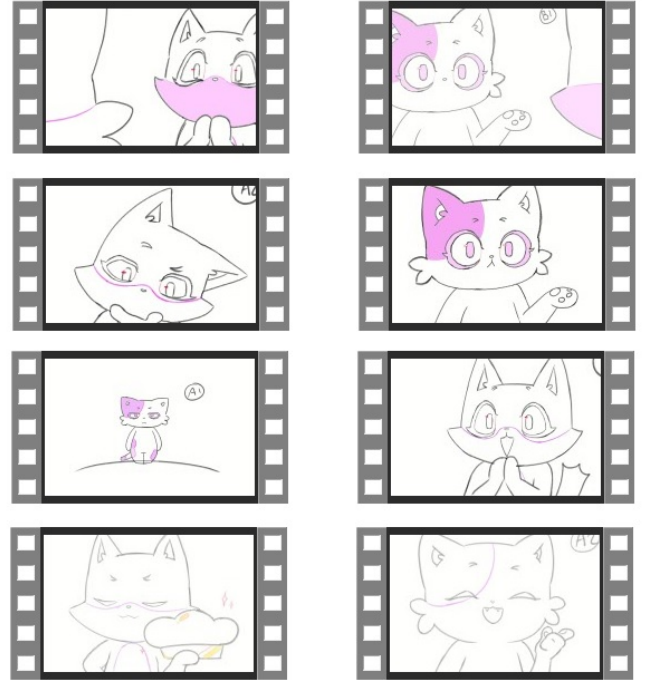


Fig. 5. Some animation cuts of the first video.



Fig. 6. Example of one frame colored picture.

the regular outreach activities at IEEE American Control Conference and IEEE Control and Decision Conference originally coordinated by B. Pasik-Duncan, the Advent Control Calendar Knorn et al. (2024), etc.). Indeed in general terms, one could add that there are initiatives across the entire globe in trying to encourage school leavers, especially underrepresented groups such as females, into considering engineering (EngineeringUK, 2025; IEEE, 2025; CentraleSupélec, 2022; Ministère de l'Education Nationale et de la Jeunesse, 2022; OSER, 2016) **others to add** as a career; nevertheless the particular scientific focus of this paper is Control and feedback due to its obvious importance (Cassandras and et.al., 2023; Rossiter and et al, 2023).

The authors have all been involved in recent IFAC projects considering the place of Control within the curriculum and indeed, a sensible curriculum (Rossiter et al., 2020) to engage and enthuse students as well as the choice of resources (Rossiter et al., 2022) to support this. However,

these projects did not consider the prior step, that is, how to engage and enthuse students to either:

- (1) Select a control course where this is an elective;
- (2) Become more motivated to engage and learn where the course is compulsory.

This is where the “ ∞ sCaR” project fits in. There is a need for illustrations and resources (in this case animated cartoons) which are easy to access for persons across a reasonable range of ages (e.g., 16-25 years), draw people in so once they have started they are inclined to view until the end and, of course, subliminally or more explicitly, communicate the core concepts and importance of feedback systems.

4.2 Core concepts

The proposed resources are not intended to replace detailed lectures and materials on Control and feedback but rather are intended to capture the viewers interest and communicate some inkling of the core concepts that are required. For example, a critical factor is to pitch the cartoons within an everyday scenario that most people can relate to easily and then encourage the viewer to consider how they act within that scenario and what drives their actions. Often a reflection on our own activity is precisely what underpins an effective feedback loop and thus the link to feedback, and the benefits of Automatic Control is natural.

It is unsurprising therefore that the first video focuses on what is feedback and why is this needed? The intention is to use a scenario where open-loop control fails due to the uncertainty within the environment, and thus continuous corrective action is required to ensure we deliver good performance. The readers hope to draw viewers into thinking about corrective action: what is this and how is it determined? Of course, one is also interested in how this could be automated.

The videos that follow give a concise insight into special cases of Control approaches and indeed include many approaches that would only appear in detail in advanced Control courses at university level. Nevertheless, the motivation and underpinning ideas for many of these are still relatively simple and can be communicated to young people in a short animated cartoon video, for instance on:

- PID (Proportional, Integral and Derivative) – The mainstay of industrial control and linked to basic human behaviours;
- State estimation – What is this and how/why do we use this?
- Predictive control – Again something that is innate to humans and thus the core concepts are simple.

5. SOME FEEDBACK FROM THE PROJECT PARTICIPANTS

It is well known that teamwork will nearly always outperform an individual. Apart from the obvious, that more skills are brought into the project, it is also clear that as individuals we do not see our own failings, weaknesses or mistakes as clearly as others. Frank and open conversations in a team expose weaknesses and opportunities for

improvement which, in general, will lead to a far better outcome. The regular online meetings have been very fruitful in focusing the project and delivering useful products. None of the authors are entertainment specialists, and nor do we have access to expensive software and support, but within that limitation, we believe the output is highly functional and will be effective for the global community.

The complementarity between Art and Control is essential in this project. The 2D animator and the English professors had the opportunity to discover a new scientific field, while the Control team discovered the beautiful world of hand-drawn animated cartoons with cute characters with lovely voice and attitude. Finding an equilibrium between the visual and audio representations on one hand, and the scientific level on the other hand, while respecting time-constraints, is a challenge in this multidisciplinary project.

5.1 Quotes

J.A. Rossiter: *I am quite excited about this project and was delighted when Cristina asked me to be involved. It is clear that the young of today learn and are motivated in a different way to my generation and therefore it is critical that we find new and effective ways of reaching out to them. I believe this type of project will be an important and useful tool we can use.*

J.L. Guzmán: *I am very happy and grateful to be part of this project and to be able to collaborate with a fantastic group of colleagues and friends with great enthusiasm for teaching innovation. I firmly believe that visual abstraction of concepts is one of the best ways to convey and teach complex concepts. When such visual abstraction is brought to life in the form of engaging videos, it is a fantastic tool for conveying key ideas, capturing the attention of users/students, and transmitting the important concepts. For me, this project is a real learning experience and I am convinced that the results derived from it will have a great teaching/learning impact for the Control Education community.*

C. Stoica: *I would like to thank all the participants to this project for their enthusiasm and passion to develop new pedagogical resources combining Art and Science for an innovative Control Education, supported by the IFAC Activity Fund via the “ ∞ sCaR” project.*

6. CONCLUSION

This paper proposed some insights from the “ ∞ sCaR – 2D Animated Cartoons for Control Education Rise” project, both from an artistic and scientific perspectives. This project focuses on creating new valuable video resources for Control Education. Indeed, a particular form of short 2D hand-drawn animated cartoons are developed during this project. As part of the invited session “*Where Art and Science meet*”, this paper shares the enthusiasm of the authors on creating a series of animated Control cartoons.

Current work focuses on finalizing the videos, proposing additional quizzes for each video, and disseminate the videos online.

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