
Proceedings Paper:
Stoica, C., Visioli, A., Rossiter, J.A. orcid.org/0000-0002-1336-0633 et al. (9 more authors) (2025) Art and control engineering: developing animated cartoons for Control Education. In: Loiseau, J.J. and Stoican, F., (eds.) IFAC-PapersOnLine. 2nd IFAC Workshop on Control of Complex Systems COSY 2025, 30 Jun - 02 Jul 2025, Gif-sur-Yvette, France. Elsevier, pp. 228-233. ISSN: 2405-8971. EISSN: 2405-8963.

https://doi.org/10.1016/j.ifacol.2025.09.553

Available online at www.sciencedirect.com

ScienceDirect

IFAC PapersOnline CONFERENCE PAPER ARCHIVE

IFAC PapersOnLine 59-11 (2025) 228–233

Art and Control Engineering: developing animated cartoons for Control Education ⋆

C. Stoica *, **A. Visioli** **, **J.A. Rossiter** ***, **J.L. Guzmán** ****, **B. Douglas** †, **A. Venturino** ‡, **A.-C. Braitor** *, **D. Varagnolo** §, **J. McDonald** |, **P. Castillo-Garcia** #, **S. Knorn** ‖, **and M. Ung** ¶,

* *Université Paris-Saclay, CNRS, CentraleSupélec, Laboratoire des signaux et systèmes, 91190, Gif-sur-Yvette, France (e-mail: {andrei.braitor; cristina.stoica}@l2s.centralesupelec.fr)*

** *Dipartimento di Ingegneria Meccanica e Industriale, University of Brescia, Italy (email: antonio.visioli@unibs.it)*

*** *School of Electrical and Electronic Engineering, University of Sheffield, UK (email: j.a.rossiter@sheffield.ac.uk)*

**** *Dep. of Informatics, CIESOL, CeiA3, University of Almería, Spain (e-mail: joseluis.guzman@ual.es)*

† *MathWorks, USA (e-mail: bdouglas@mathworks.com)*

‡ *DIMES, Università della Calabria, Italy (email: antonello.venturino@unical.it)*

§ *Norwegian University of Science and Technology, 7491, Trondheim, Norway (e-mail: damiano.varagnolo@ntnu.no)*

| *Université Paris-Saclay, CentraleSupélec, Centre de Langues, 91190, Gif-sur-Yvette, France (e-mail: julie.mcdonald@centralesupelec.fr)*

‡‡ *Université de technologie de Compiègne, CNRS, Heudiasyc (Heuristics and Diagnosis of Complex Systems), CS 60 319 - 60 203 Compiègne Cedex, France (e-mail: pedro.castillo@hds.utc.fr)*

‖ *Technische Universität Berlin, 10623, Berlin, Germany (e-mail: knorn@tu-berlin.de)*

¶ *2D Animator Freelance, 91400, Orsay, France (e-mail: milena.ung@e-artsup.net)*

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, as well as the potential to reach out to broader audiences. This paper offers some insights from the "∞sCaR – *2D Animated Cart∞ns 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 Cart∞ns for Control Education Rise*" project which consists in

⋆ This work was supported by IFAC Activity Fund via the project "∞sCaR – *2D Animated Cart∞ns for Control Education Rise*".

Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2025.09.553

developing a series of short animated hand-drawn cartoons on Control topics. The main motivation in developing this series of animated Control cartoons 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), open-source toolboxes (e.g., (Varga, 2023)), online resources (Stapleton et al., 2024), comics (Douglas, 2022; Mash, 2010; Sher-DeCusatis, 2023)). However, very few of them combine artistic and scientific aspects.

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 pursue 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 children's interest in Science, Technology, Engineering, and Mathematics (STEM).

2.3 Project implementation

This project aims to create a series of short videos (approx. 2 min 30 sec per video). Each video will illustrate only main concepts on Control, without the technical details (e.g., illustrate the importance of predictive 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 several 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 videos) 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.

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 suitable solution [1]. 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).

Fig. 1. First drawing tests for the characters.

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. 2, with a particular focus on the line types and colors,

[1] Importantly, in order to avoid gender stereotypes or sidetracking the discussion to those, it was decided to avoid human characters.

Fig. 2. Character Design.

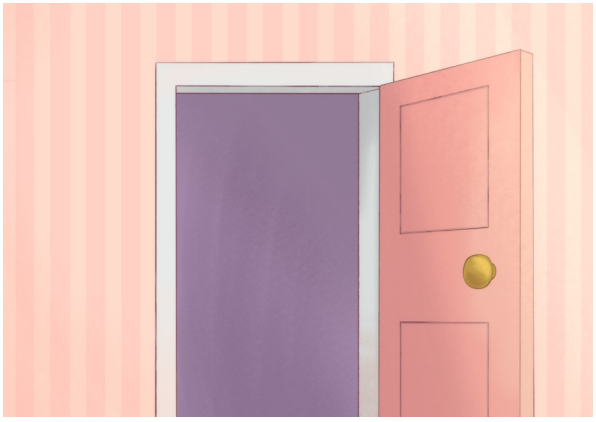

Fig. 3. Example of background.

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.

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.

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

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

- 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.

The first video is available on the IFAC YouTube channel `https://youtu.be/BiQjCmzFsrU`.

4. SCIENTIFIC PERSPECTIVE

4.1 Background and motivation of the 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 and beyond). They have been involved in a number of initiatives in recent years to increase interest among both school leavers and undergraduates in the general area, e.g., outreach workshops / summer school *Girls in Control* (Jackson et al., 2021; Knorn et al., 2021) during IFAC World Congress 2020, 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), and gamified approaches (Axelson-Fisk et al., 2022; Gil et al., 2024), etc. Indeed in general terms, one could add that there are

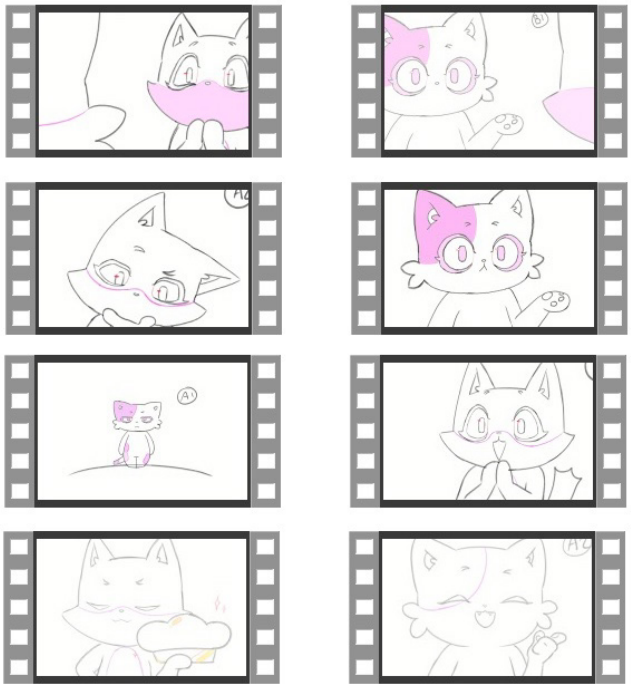

Fig. 5. Some animation cuts of the first video.

Fig. 6. Example of one frame colored picture.

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) as a career; nevertheless the particular scientific focus of this paper is Control and feedback due to its obvious importance (Annaswamy et al., 2024; Rossiter 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, constructive 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 a balance between the visual and audio representations on the 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.*

S. Knorn: *Combining control and art is an unusual but very enjoyable experience. Apart from looking forward to use the videos in my teaching, I also appreciate the new perspectives on how control can be explained and taught.*

A. Venturino: *As a researcher in control theory, I have always believed that teaching fundamental concepts should not be limited to equations and formal proofs. This project is a fascinating experiment in making control concepts more intuitive and engaging. If a short animation can make a student think, "Ah, so that's what feedback really means!", then we have already achieved something valuable.*

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 Cart∞ns 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, disseminate the videos online, and reporting students' feedback.

REFERENCES

Abramovitch, D., Jackson, R., Knorn, S., Bauer, M., Leang, K., Steinbuch, M., and Cho, D. (2023). What is Automatic Control? https://a2c2.org/presentation/online/what-automatic-control.

Ahn, C. (2024). Introduction to the special issue, sculpting solutions: Art Science collaborations for environmental sustainability. *Nature-Based Solutions*, 5, 100133.

Annaswamy, A.M., Johansson, K.H., and Pappas, G. (2024). Control for societal-scale challenges: Road map 2030. *IEEE Control Systems Magazine*, 44(3), 30–32.

Axelson-Fisk, M., Gentsch, M., Jackson, R.R., Knorn, S., Paasche, L., Topalovic, D., and Voit, S. (2022). Ctrl+esc: An escape/exit room to teach control and its relevance to an audience outside engineering. *IFAC-PapersOnLine*, 55(17), 255–260.

Bruton, S. (2011). Youtube channel. https://www.youtube.com/@Eigensteve.

CentraleSupélec (2022). Summer camp. https://summercamp.centralesupelec.fr/.

Cohen, E., Novis-Deutsch, N., Kashi, S., and Alexander, H. (2024). Interdisciplinary teaching and learning at the K-12 level in the humanities, arts, and social sciences: A scoping review. *Educational Research Review*, 44, 100617.

Cojan, M., Colas, F., Fritz, P., Renout, A., Stoica, C., and Ung, M. (2024). Control engineering and mathematics: a new hands-on pedagogical approach through the perspective of art. *IFAC-PapersOnLine*, 58(3), 88–93. 22nd IFAC Conference on Technology, Culture and International Stability.

Crispino, J.D. (2025). The developmental clock: where art and science meet. *Experimental Hematology*, 142, 104695.

Davis, C.C., Kehoe, J., Knaap, A.C., and Atkins, C.D. (2025). Science × art: spotlighting unconventional collaborations. *Trends in Ecology & Evolution*.

Deshpande, S.H. (2025). Interconnecting surgical science, art, philosophy and technology for holistic health. *Journal of Ayurveda and Integrative Medicine*, 16(1), 101010.

Douglas, B. (2022). IFAC bimonthly Newsletter - Cartoon. https://www.ifac-control.org/publications/cartoons.

Douglas, B. (2011). Youtube channel. https://www.youtube.com/@BrianBDouglas.

EngineeringUK (2025). School outreach. https://www.engineeringuk.com/school-outreach/.

Gil, J.D., González-Hernández, J., Cañadas-Aránega, F., Pataro, I.M., Ángeles Hoyo, Otálora, P., Rodríguez, F., Guzmán, J., and Berenguel, M. (2024). Gamification in control engineering: An ongoing initiative at the university of Almería. *IFAC-PapersOnLine*, 58.

Guzmán, J.L., Costa-Castelló, R., Berenguel, M., and Dormido, S. (2023). *Automatic Control with Interactive Tools*. Springer.

IEEE (2025). Women in Control. https://www.ieeecss.org/doda-activities/women-control, https://dabramovitch.com/pubs/.

Jackson, R.R., Knorn, S., and Varagnolo, D. (2021). An outline of the story of girls in control and its success in motivating girls internationally. *IFAC-PapersOnLine*.

Kato, T. and Ito, T. (2024). Exploring play experience with Japanese science, technology, engineering, and mathematics undergraduates in interactive art making: A qualitative study. *The Arts in Psychotherapy*, 90, 102199.

Knorn, S., Visioli, A., Stoica, C., Lichtenberg, G., Varagnolo, D., Sánchez, H., Rotondo, D., and Guzmán, J. (2024). Santa has everything under control: A control themed advent calendar. *IFAC-PapersOnLine*.

Knorn, S., Jackson, R., and Varagnolo, D. (2021). Girls in control: Reaching out with control. *IEEE Control Systems Magazine*, 41(4), 16–18.

Levy, S. (2024). Showing and doing: Art & Science collaborations for environmental sustainability. *Nature-Based Solutions*, 6, 100135.

Li, L., Shi, J., and Zhong, B. (2023). Good in arts, good at computer? Rural students' computer skills are bolstered by arts and science literacies. *Computers in Human Behavior*, 140, 107573.

Mash, S. (2010). [random inputs]. *IEEE Control Systems Magazine*, 30(4), 120–120.

Ministère de l'Education Nationale et de la Jeunesse (2022). Fête de la Science. In French. https://www.education.gouv.fr/la-fete-de-la-science-12287.

OSER (2016). Ouverture sociale pour l'egalité et la réussite. https://www.oser-cs.fr/.

Ren, Y., Wu, T., Li, C., Yao, P., and Ding, W. (2024). Bridging science and art: Auralization and visualization of the ocean soundscape. *iScience*, 27(9), 110696.

Rossiter, J. (2024). A novel MATLAB toolbox for Control101 courses. *European Journal of Control*, 80. 2024 European Control Conference Special Issue.

Rossiter, J., Visioli, A., Serbezov, A., Douglas, B., Hedengren, J., and Zakova, K. (2022). Open access resources to support learning of control engineering. *European Control Conference*.

Rossiter, J., Zakova, K., Huba, M., Serbezov, A., and Visioli, A. (2020). A survey of international views on a first course in systems and control for engineering undergraduates. *IFAC Journal of Systems and Control*.

Rossiter, J.A., Cassandras, C.G., Hespanha, J., Dormido, S., de la Torre, L., Ranade, G., Visioli, A., Hedengren, J., Murray, R.M., Antsaklis, P., Lamnabhi-Lagarrigue, F., and Parisini, T. (2023). Control education for societal-scale challenges: A community roadmap. *Annual Reviews in Control*, 55, 1–17.

Sher-DeCusatis, C. (2023). Riko-chan – cybersecurity engineer. https://tinyurl.com/IEEE-WIE-Manga.

Stapleton, L., Wang, F., Netto, M., Jia, Q., Visioli, A., and Kopacek, P. (2024). Shaping the future of advanced automation and control systems for society strategic directions and multidisciplinary collaborations of IFAC's social systems coordinating committee. *Annual Reviews in Control*, 58.

Sun, J. and Zhou, J. (2024). Metamaterials: The Art in Materials Science. *Engineering*.

Varga, A. (2023). *Solving Fault Diagnosis problems. Linear synthesis techniques with Julia code examples*. Springer, 2nd edition. https://sites.google.com/view/andreasvarga/home/book2ed/julia-files.