CONTROL ENGINEERING

WITH THE TOTAL CHANNEL CONTROL™ TEAM

Talking *points*

KNOWLEDGE

1. What feedback loops exist in the Total Channel Control™ (TCC) system?
2. What role do sensors and actuators play in feedback control systems?

COMPREHENSION

3. Why is the global demand for fresh water increasing?
4. What role does feedback play in the TCC system?

APPLICATION

5. What examples of feedback loops can you think of, in both natural and artificial systems?
6. If a farmer extracts water for less time than usual, how will the TCC irrigation system automatically compensate for this?
7. How might a control engineer contribute to the building and operation of a chemical manufacturing plant?
8. Other than water, what resources are subject to variable supply and demand? How could control engineering help to match supply to demand?

ANALYSIS

9. Why is it important to use models when automating the decision-making process in dynamic systems?
10. How have the experiences and backgrounds of each team member inspired them to become engineers?

EVALUATION

11. Aside from improving the efficiency of irrigation systems, how else could control engineers make our industrial society more sustainable?
12. How would you assess the suitability of automatic control systems for use in irrigation systems in lower income countries?

Activities

AN EVERYDAY FEEDBACK CONTROL SYSTEM

A simple feedback control system can be found in every school and home – in the toilet!

"Think of the way a toilet cistern automatically fills after flushing," says Michael. "There is a float that 'senses' the water level in the cistern. The lever attached to the float 'acts' on a valve to set the flow into the tank." Flushing the toilet is an unpredictable outflow disturbance – the toilet cannot predict when you will flush it or what volume of water will be used in an individual flush (half or full). "The float-lever-valve-tank feedback loop results in adjustment of the inlet flow, which may also be uncertain because of fluctuations in supply pressure," explains Michael. "Once the float rises to the desired cistern water level, the inlet valve closes as the tank has been restored to its original full state."

1. If you have access to a toilet cistern with a removable lid, take the lid off and flush the toilet. Watch what happens as the flush mechanism opens the outlet valve to empty the cistern, then the float mechanism opens the inlet valve to refill it to the original water level.

2. Draw a labelled diagram of a toilet cistern, showing the components it contains and how they are connected.

3. Draw an information flow chart to represent the feedback control system found in a toilet cistern. Your flow chart should highlight the role of the measured variable, the disturbance to the measured variable, the sensor and the actuator in maintaining the setpoint

Feedback control causes a toilet cistern to refill to the correct water level after each flush © retbool/stock.adobe.com

in the system, and label how these are each represented by the components and functions of the cistern.

4. What other feedback control systems can you find in your school or home? For each one, draw a labelled flow chart to show the components of the system and how the measured variable, the disturbance to the measured variable, the sensor and the actuator maintain the setpoint in the system.

THE IMPORTANCE OF WATER FOR SUSTAINABLE DEVELOPMENT

In 2015, the United Nations (UN) agreed upon a set of Sustainable Development Goals (SDGs) that are to be achieved by 2030. However, in 2020, the UN Water group identified inadequate water distribution as a threat to reaching several of these goals (www.unwater.org/publications/un-water-2030-strategy).

Visit www.sdgs.un.org to learn about the UN's 17 SDGs. Individually or in a group, choose one of these goals and prepare a presentation about it. Your presentation should include why the goal is important for society and the planet, how inadequate water distribution impacts our ability to reach this goal, and what steps governments and individuals should take to manage water distribution and availability to ensure the goal can be achieved by 2030.

More *resources*

- Learn more about Rubicon Water (www.rubiconwater.com) and the partnership with the University of Melbourne that led to the development of the Total Channel Control™ system (www.research.unimelb.edu.au/research-at-melbourne/impact/irrigation-conservation)
- Rubicon Water has a YouTube channel (www.youtube.com/c/RubiconWater) which contains videos and animations about irrigation system technologies and case studies where these have been implemented.
- The Institute of Electrical and Electronics Engineers (www.ieee.org) has a Control Systems Society (www.ieeecss.org).
- The World Bank has produced a report (www.2030wrg.org wp-content/uploads/2021/12/WRG-Annual-Report_2021_Final-VDec.pdf) about the economic shortage of water.
- Visit Yale Environment 360 for informative articles about industrial agriculture (www.e360.yale.edu/topics/food-agriculture/industrial-agriculture) and water use (www.e360.yale.edu/topics/cities/water).
- Visit the UN-Water website (www.unwater.org) to find out more about the UN's strategy for water security.