Case study:

Water wars: managing competing water rights

Topic: Data centres' impact on sustainable water resources.

Engineering disciplines: Civil engineering, Electronic engineering.

Ethical issues: Sustainability, Respect for environment, Future generations, Risk, Societal impact.

Professional situations: Law / Policy, Communication, Integrity.

Educational level: Intermediate.

Educational aim: Practise ethical judgement. Ethical Judgment is the activity of thinking about whether something has a moral attribute. Judgments involve reaching moral decisions and providing the rationale for those decisions.

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Learning and teaching notes:

This case involves a situation where environmental damage may be occurring despite the mechanism causing this damage being permissible by law. The engineer at this centre of the case is to represent the company that is responsible for the potential damage, at a council meeting. It requires the engineer to weigh up various harms and goods, and make a decision that could seriously impact their own job or career. There is also a section at the end of this case study that contains technical information providing further details about the water cooling of ICT equipment.

This case study addresses two of AHEP 4's themes: **The Engineer and Society** (acknowledging that engineering activity can have a significant societal impact) and **Engineering Practice** (the practical application of engineering concepts, tools and professional skills). To map this case study to AHEP outcomes specific to a programme under these themes, access AHEP 4 here and navigate to pages 30–31 and 35–37.

The dilemma in this case is presented in two parts. If desired, a teacher can use **part one** in isolation, but

part two develops and complicates the concepts presented in **part one** to provide for additional learning. The case allows teachers the option to stop at multiple points for questions and/or activities as desired.

Students have the opportunity to:

- apply their ethical judgement to a case study relating to environmental sustainability
- judge the societal impact of a technical solution to a complex problem
- identify and analyse objective and subjective risk
- consider the concept of consensus
- communicate the risks and judgements to technical and non-technical audiences.

Teachers have the opportunity to:

- introduce environmental ethics concepts related to water
- highlight the components and processes of risk analysis
- integrate technical content related to heat transfer and flow

- informally evaluate students' critical thinking and communication skills.

Learning and teaching resources:

- RAEng/Engineering Council Statement of Ethical Principles
- Data centre water consumption
- The secret cost of data centres
- United States data center energy usage report
- Cisco annual internet report White Paper
- The missing piece: A water ethic
- New Zealand river granted same legal rights as human being
- The city where the internet warms people's homes

Summary:

The company Data Storage Solutions (DSS) has built a large data centre on land that was historically used for agriculture and owned by a farming operation. DSS was incorporated as a subsidiary of the farming company so that it could retain the water rights that were attached to the property. This ensured access to the large amount of water needed to cool their servers. This centre manages data from a variety of sources including the local hospital and university.

When the property was used as a farm, the farming operation never used its full allocation of water. Now, the data centre always uses the maximum amount legally allotted to it. For the rainy half of the year, this isn't a problem. However, in more arid months, the nearby river almost runs dry, resulting in large volumes of fish dying. Other farmers in the area have complained that the water level in their wells has dropped, making irrigation much more expensive and challenging.

Dilemma – part one:

You are a civil engineer working for DSS and have been requested by your boss to represent the company at a forthcoming local council meeting where the issue will be discussed. Your employer is sending you to justify the company's actions and defend them against accusations of causing an environmental hazard in the local area which is reducing the water table for farmers and affecting local biodiversity. Your boss has told you that DSS has a right to the water and that it does not intend to change its behaviour. This meeting promises to be a contentious one as the local Green party and farmers' union have indicated that they will be challenging the company's water usage. How will you prepare for the meeting?

Optional STOP for questions and activities:

1. Discussion: **Personal values** – What is your initial position on the issue? Do you see anything wrong with DSS's water use? Why, or why not?

2. Discussion: **Professional responsibilities** – What ethical principles and codes of conduct are relevant to this situation?

3. Activity: Define and identify the relevant data you should compile to take to the meeting. What information do you need in order to be prepared?

4. Activity: **Stakeholder mapping** – Who are all the characters in the scenario? What are their positions and perspectives? How can you use these perspectives to understand the complexities of the situation more fully? Examples include:

   - Data Storage Solutions
   - Farmers' union
   - Local Green party
   - Local council
   - Member of the public
   - Stakeholders who use DSS's data storage services (such as the local hospital and schools)
   - Non-human stakeholders – for example, the fish, birds and insects.

5. Activity: Undertake a technical activity such as civil and/or electronic engineering related to the measurement of stream flow and calculating data centre cooling needs.

Dilemma – part two:

As you prepare for the meeting, you reflect on several competing issues. For instance, you are an employee of DSS and have a responsibility to represent its interests, but can see that the company's actions are environmentally harmful. You appreciate that the data centre is vital for the local community, including the safe running of schools and hospitals, and that its operation requires sufficient water for cooling. Your boss has told you that you must not admit responsibility for any environmental damage or biodiversity loss. You also happen to know that a new green battery plant is planning to open nearby that will create more data demand and has the potential to further increase DSS's water use. You know that obtaining water from other sources will be costly to DSS and may not be practically possible, let alone commercially viable. What course of action will you pursue?

Optional STOP for questions and activities:

1. Activity: Debate what course of action you should take. Should you take the company line despite knowing about the environmental impacts? Should you risk your reputation or career? What responsibilities do you have to fellow employees, the community, and the environment?

2. Activity: ***Risk analysis*** – What are the short- and long- term burdens and benefits of each course of action? Should environmental concerns outweigh others? Is there a difference between the environment locally and globally?

3. Activity and discussion: Read Sandra Postel's case for a Water Ethic, and consider New Zealand's recent legislation that gives a rainforest the same rights as a human. With this in mind, does the stream have a right to thrive? Do the fish have a right to a sustainable environment? Are humans ultimately at risk here, or just the environment? Does that answer change your decision? Why?

4. Activity: Prepare a statement for the council meeting. What will you argue?

   ■ You could take the company line and refuse to consider any compromise. After all, you have the legal right to the water.

   ■ You could take the environmentalists' side and go against your boss, admitting that the company is aware of the environmental damage, but that they refuse to do anything about it.

   ■ You could work up a proposal for obtaining the water from a different source, or alternative technical solutions, despite not having the backing of your boss.

   ■ Are there other alternatives available to you?

5. Activity: The students should interrogate the pros and cons of each possible course of action including the ethical, the practical, the cost, the local relationship and the reputational damage implications. They should decide on their own preferred course of action and explain why the balance of pros and cons is preferable to other options.

   The students may wish to consider this from other perspectives, such as:

   ■ What actions are available to individuals at each level of hierarchy in DSS – for example, a junior engineer compared to a senior manager?

   ■ What would the best outcome be if the business or cost considerations were of no consequence?

   ■ What course of action would be taken if different perspectives were taken as the priority – for example, if the environmental perspective were the main priority what action would be taken, compared with action taken if the cost to the local economy were the main priority?

   ■ What are the wider implications of data storage on the environment and how can these be mitigated?

   ■ What could be other direct and indirect benefits of data centres, other than being a place to house data – for example, is there an opportunity for the waste heat from DSS to become a benefit? [use the The city where the internet warms people's homes article].

   ■ What are the possible solutions open to you?

   ■ Are there any short-term solutions versus longer-term solutions?

6. Activity: Role-play the council meeting, with students playing different characters representing different perspectives.

7. Activity: Allow students to reflect on how this case study has enabled them to see the situation from different angles, and whether this has helped them to understand the ethical concerns and come to an acceptable conclusion.

Annex: Accompanying technical information

ICT equipment generates heat and so most devices must have a mechanism to manage their temperature. Drawing cool air over hot metal transfers heat energy to that air, which is then pushed out into the environment. This works because the computer temperature is usually higher than the surrounding air. There are several different mechanisms for data centre cooling, but the general approach involves chillers reducing air temperature by cooling water – typically to 7–10°C, which is then used as a heat transfer mechanism. Some data centres use cooling towers where external air travels across a wet media so that the water evaporates. Fans expel the hot, wet air and the cooled water is recirculated. Other data centres use adiabatic economisers – where water is sprayed directly into the air flow, or onto a heat exchange surface, thereby cooling the air entering the data centre. With both techniques the evaporation results in water loss. A small 1 MW data centre using one of these types of traditional cooling can use around 25.5 million

litres of water per year. Data centre water efficiency deserves greater attention. Annual reports show water consumption for cooling directly paid for by the operator, so there is an economic incentive to increase efficiency. As the total energy share of cooling has fallen with improving PUEs (Power Usage Effectiveness metric), the focus has been on electricity consumption, and so water has been a low priority for the industry. However, the largest contributor to the water footprint of a data centre is electricity generation. Where data centres own and operate the entire facility, there is more flexibility for exploring alternative sources of water, and different techniques for keeping ICT equipment cool.

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