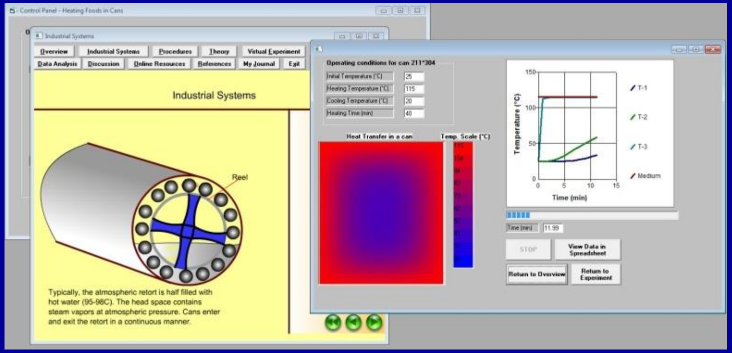
Virtual Experiments in Food Processing for an Enhanced Education

Ferruh Erdoğdu and R. Paul Singh



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Significance

- Hands-on lab experiments are the most effective tools in teaching new concepts and testing novel hypothesis in engineering education.

- Students are typically organized around groups and follow the paradigm of spending a long time clustered around workbenches.

Significance

- **Due to the limited time**
  - **students receive an uneven exposure time,**
  - **it is difficult to design an experiment to examine the effects of various variables on the outcome, and**
  - **this leads to demonstrate only one set of processing condition for the given process.**

Significance

- With this traditional approach, we might not achieve a functional understanding of the effect of various input variables on the process performance.

- Personal observations indicate that only a few active learners actually perform the required tasks in a typical lab exercise.

Significance

- This leaves many of the remaining students to only observe or daydream.
- In addition, many universities cannot afford to maintain up-to-date labs with the latest instrumentation.

Objectives

- to develop virtual labs for various food processing operations,
- to improve understanding of food processing principles, and
- to reduce the cost and time required for lab experiments.

Implementation

- Virtual labs were created using a computer programming language (*Microsoft Visual Basic*) to write the numerical simulation codes.

- The numerical codes were accompanied by
  - Active-X programs for extended graph abilities, visualization and spreadsheet abilities, and
  - Animated picture technologies to give the taste of an actual hands-on lab experiment.

Implementation

- The use of virtual labs involved the users to
  - interact by setting operation parameters,
  - observe changes and
  - record the data for further analysis.

- Use virtual labs in conjunction with lecture and lab experiments.

Comparison

- In a lab exercise, students run an actual process using a limited number of operating conditions and analyze the data

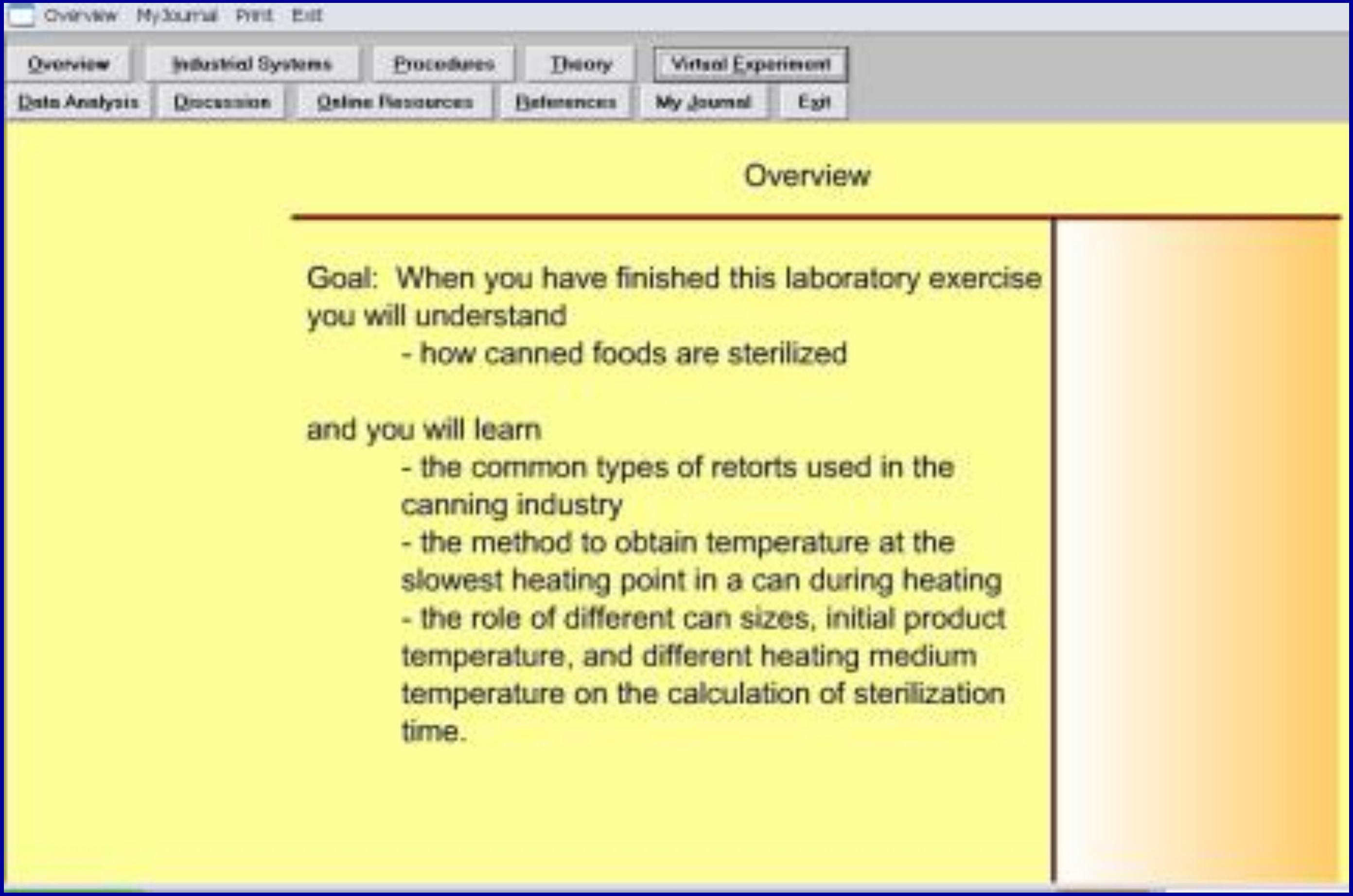
- In a virtual lab (in addition to a traditional lab):
  - Students generate their own set of additional data
  - Understand how industrial systems work
  - The output from the simulations is analyzed as if it were actual data *(like obtained from a hands-on lab experiment)*
  - Students can determine the effects of operating conditions on the results.

Virtual experiments in food processing – 27 experiments

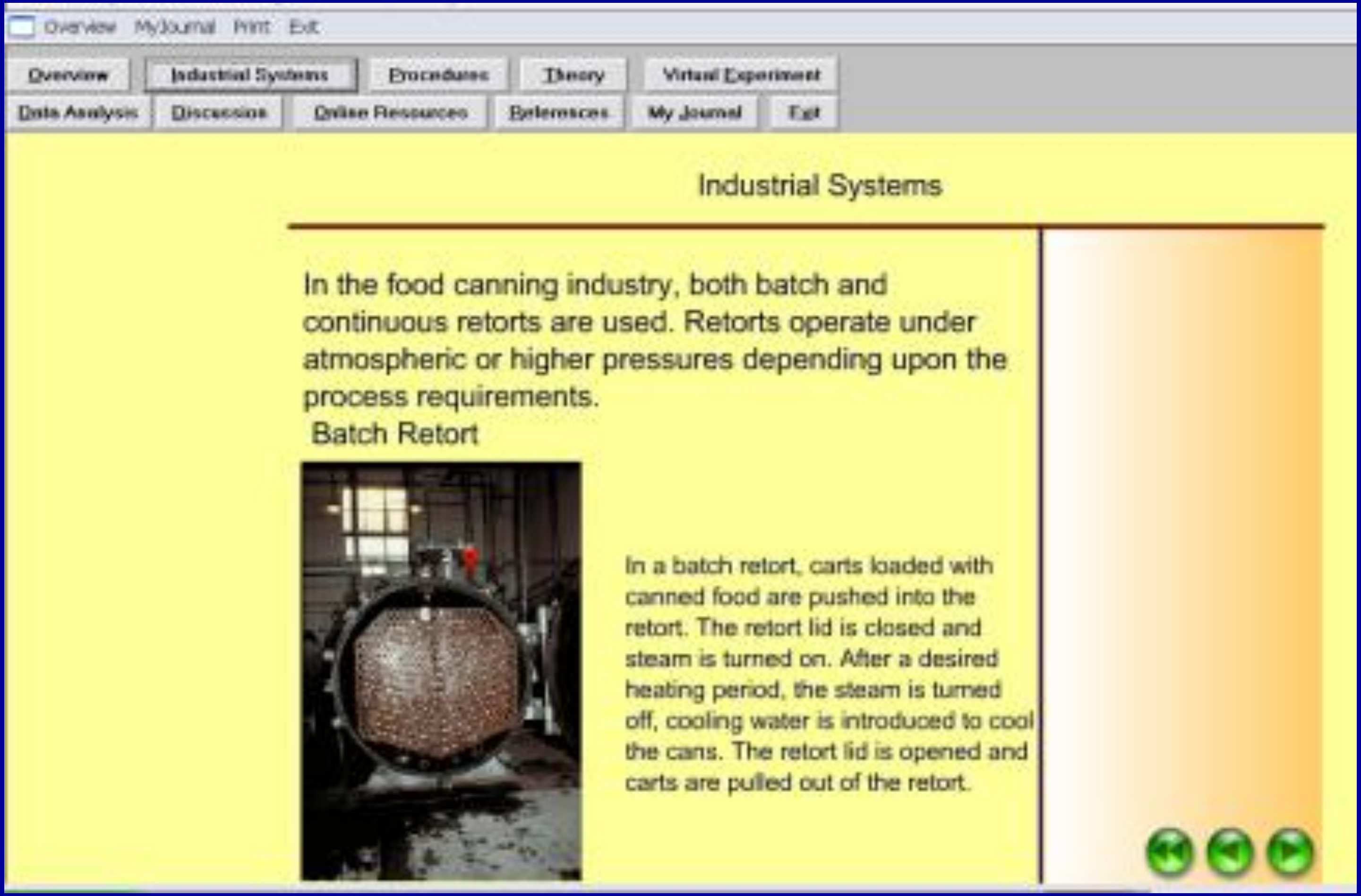
- Fluid flow
- Heat transfer fundamentals
- Mass transfer operations
- Food processing operations
- Food storage and transport

Navigation bar used in each experiment

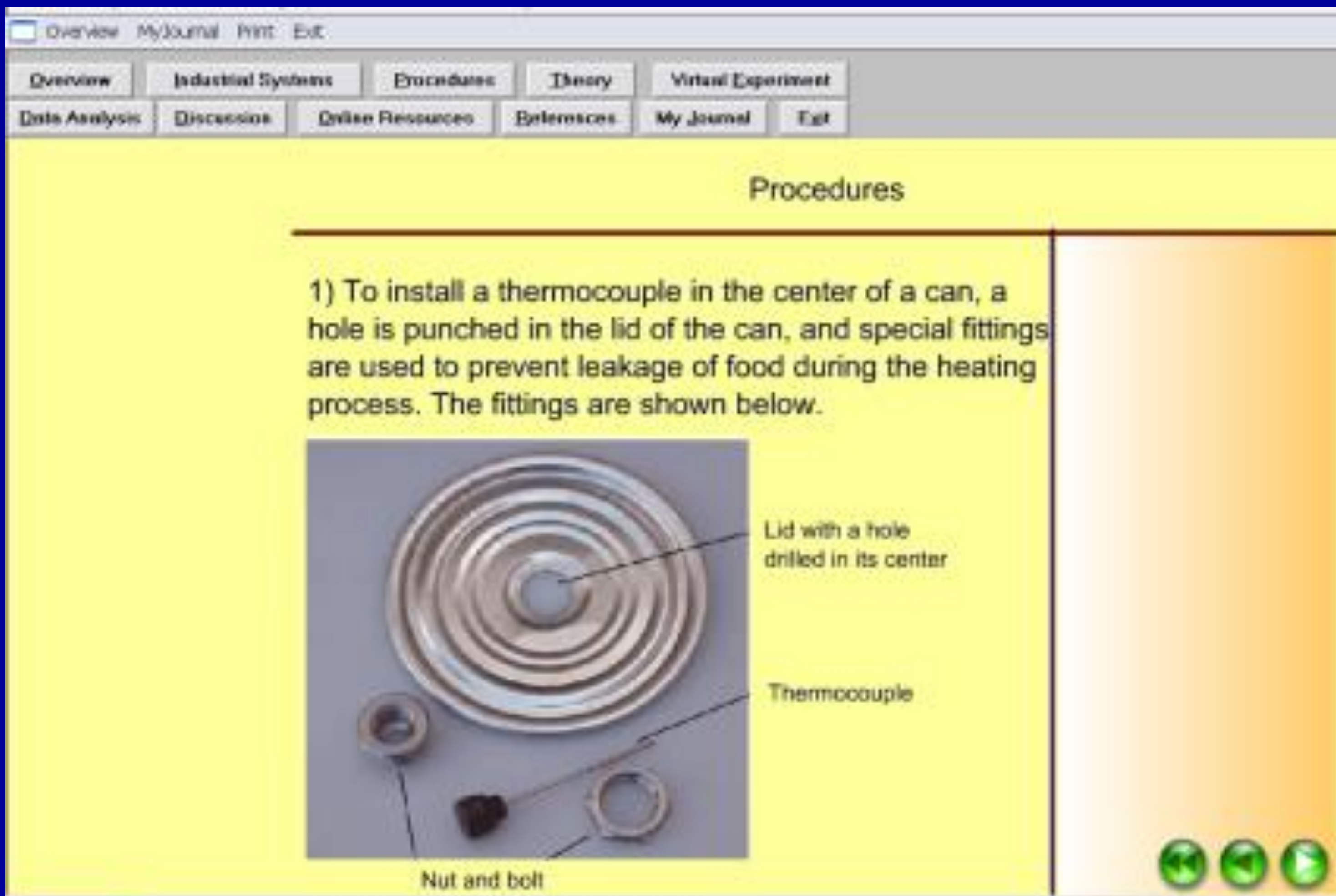
Overview of a virtual lab exercise



Industrial applications relevant to each exercise



Photographs and diagrams how an exercise is conducted in a lab



Theoretical considerations

Overview MyJournal Print Exit

Overview | Industrial Systems | Procedures | Theory | Virtual Experiment

Data Analysis | Discussion | Online Resources | References | My Journal | Exit

Theory

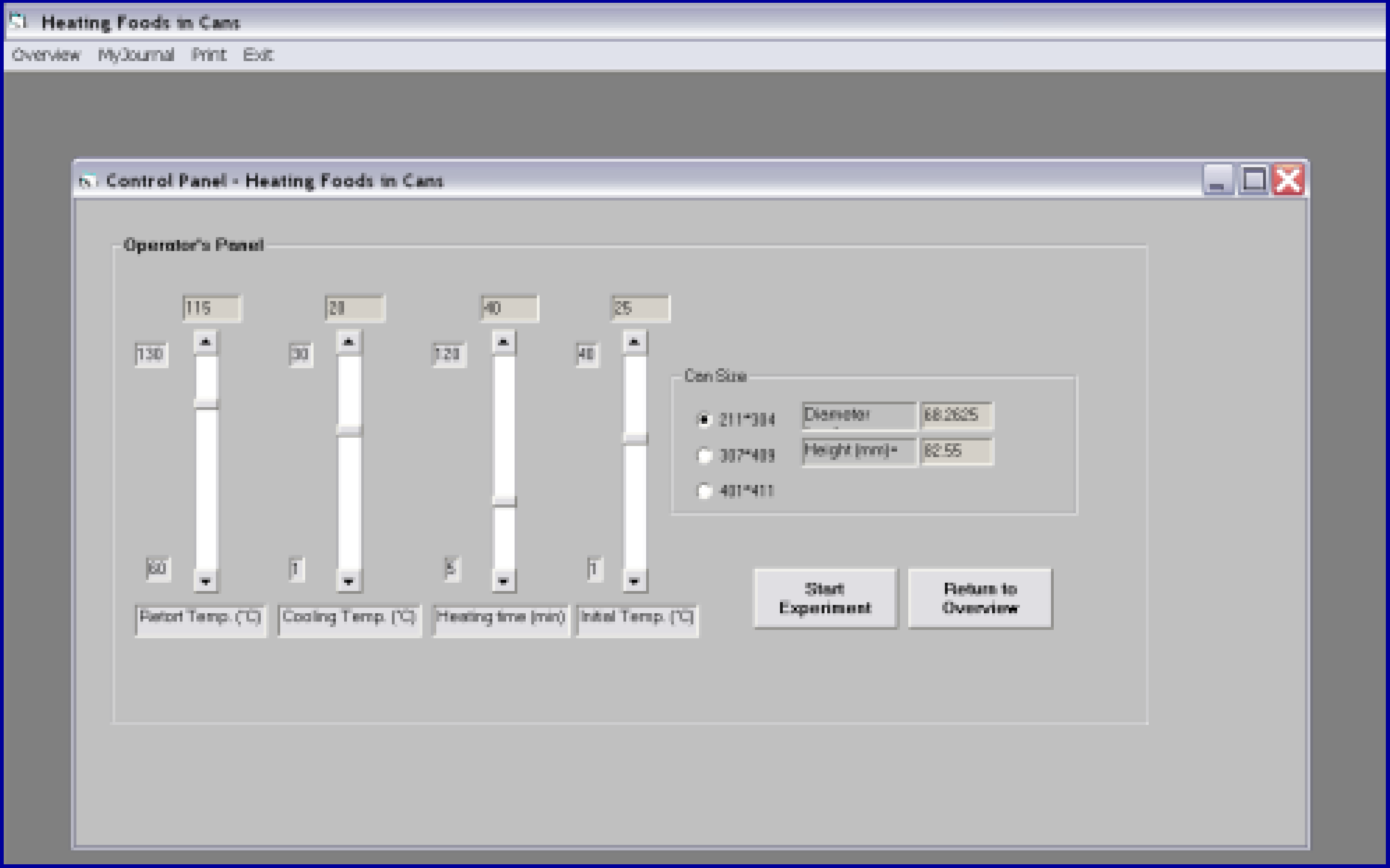
The heating and cooling curves are described by the following equations:

$$\log(T_m - T) = -\frac{1}{f_h}t + \log(T_m - T_{pih})$$

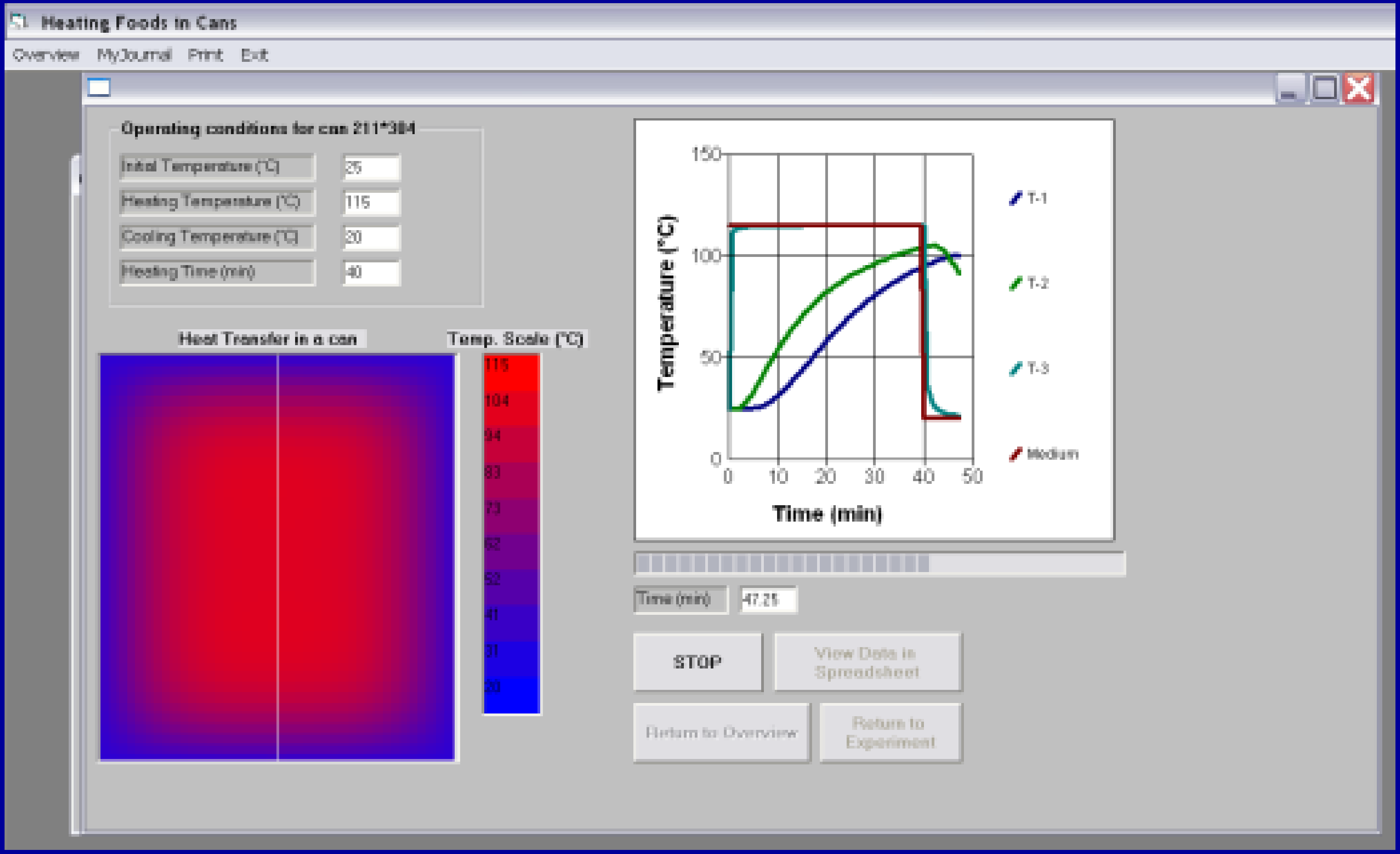
$$\log(T - T_w) = -\frac{1}{f_c}t + \log(T_{pic} - T_w)$$, respectively.

where T_m is the heating medium temperature, T is temperature at any time, t is time, f_h is the heating rate parameter, T_{pih} is the pseudo initial temperature for heating curve, T_w is the cooling medium temperature, T_{pic} is the pseudo initial temperature for cooling curve, f_c is the cooling rate parameter.

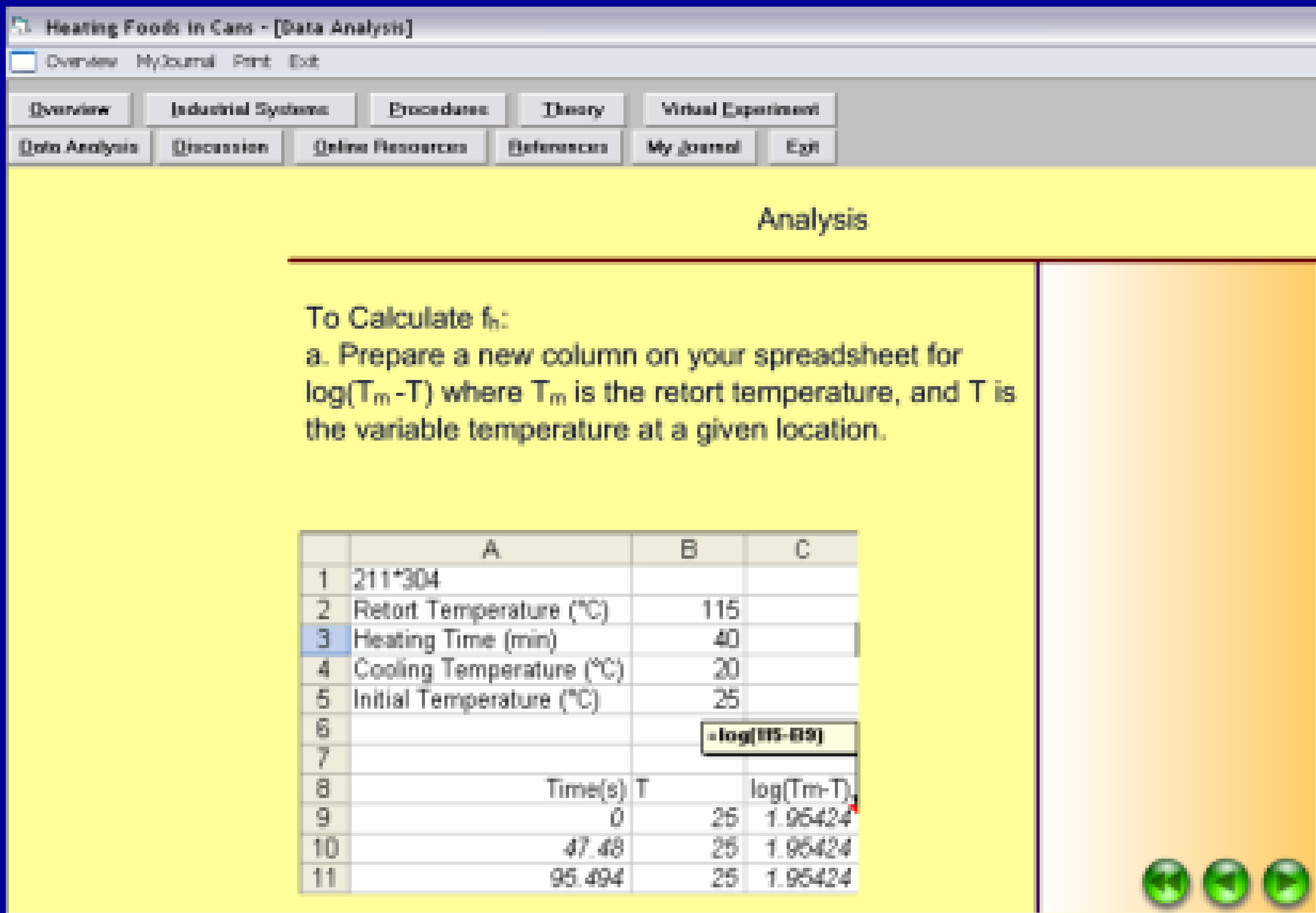
Operator`s panel for users to select operating conditions



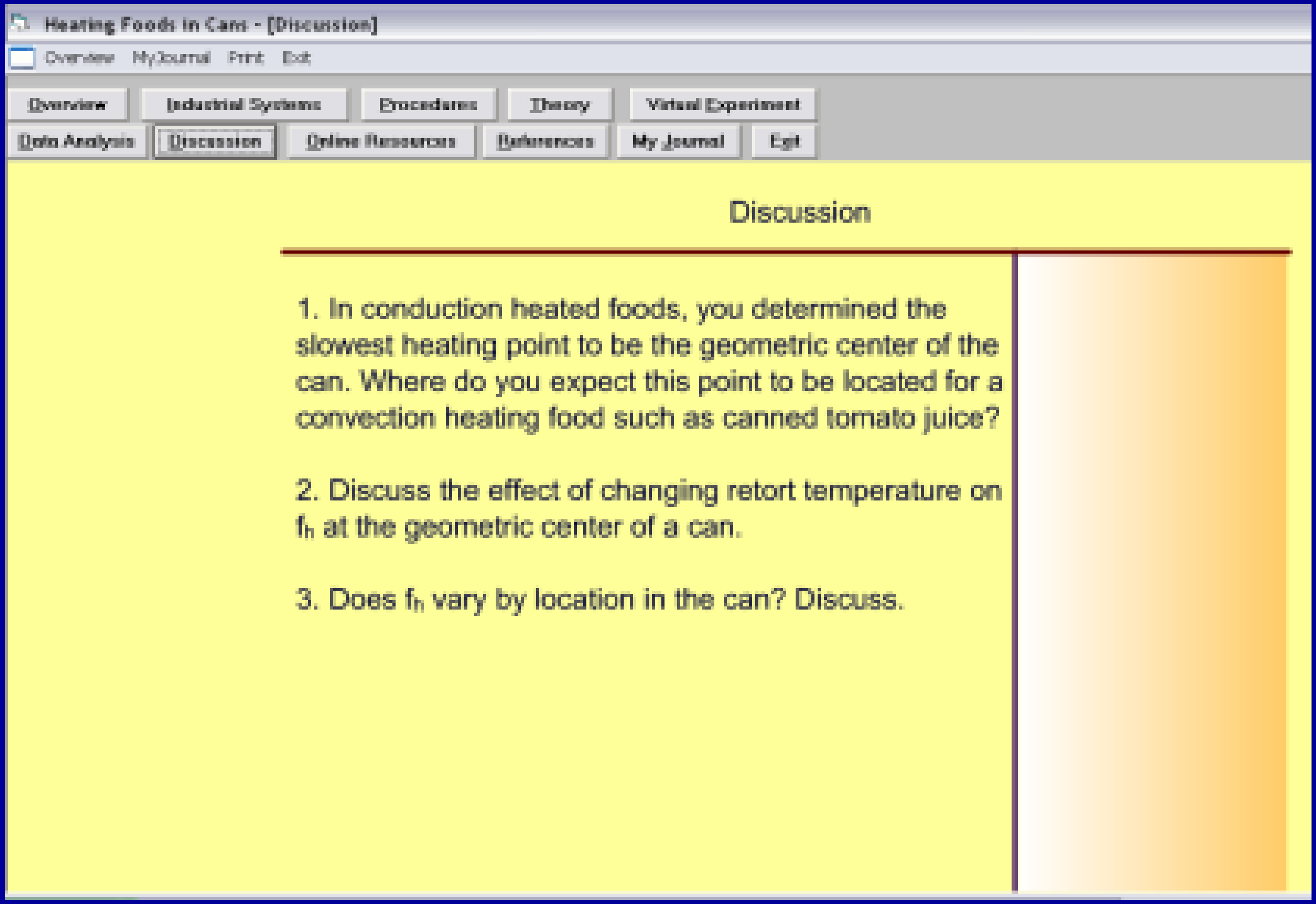
The virtual experiment



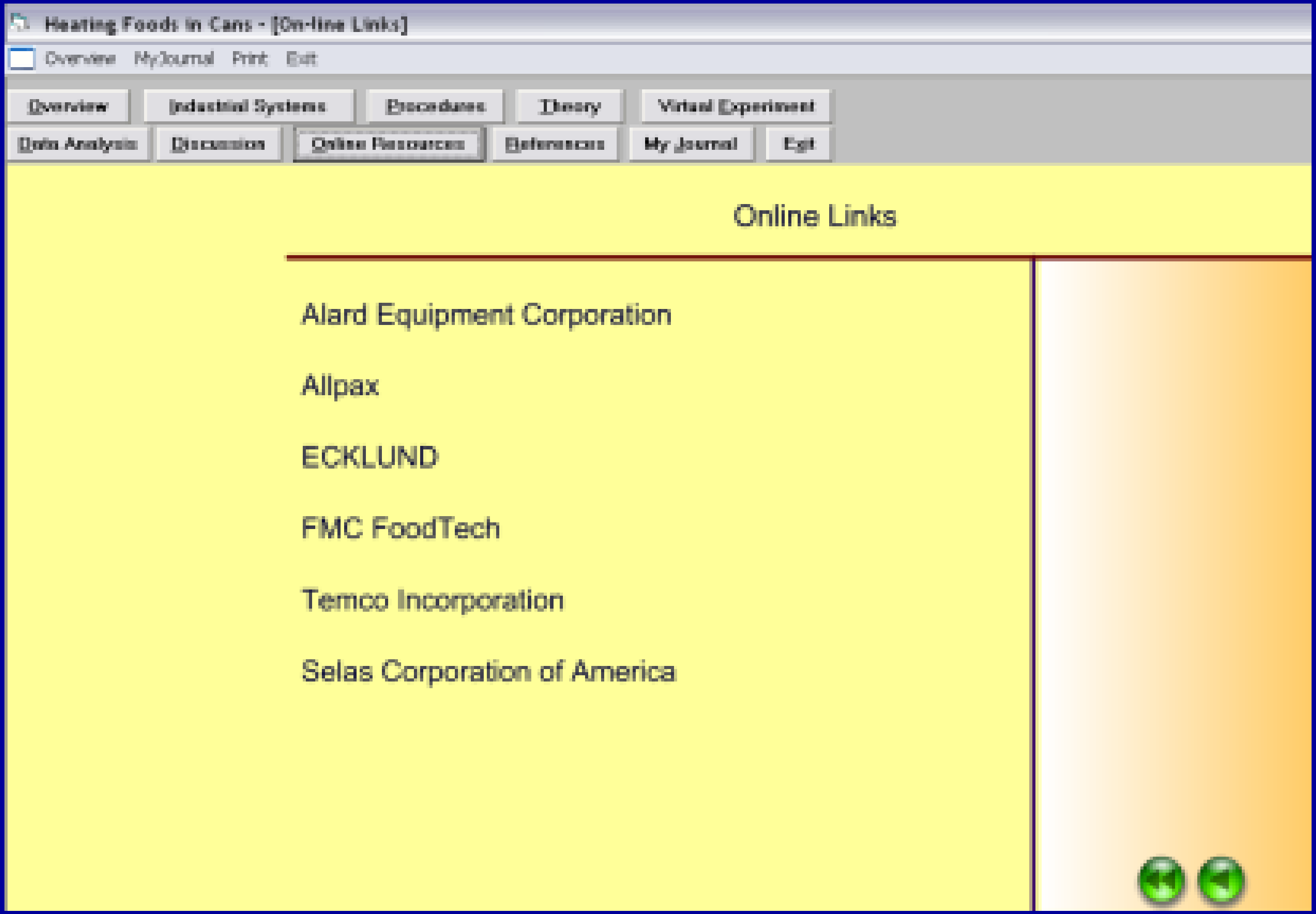
Description of how to analyze results



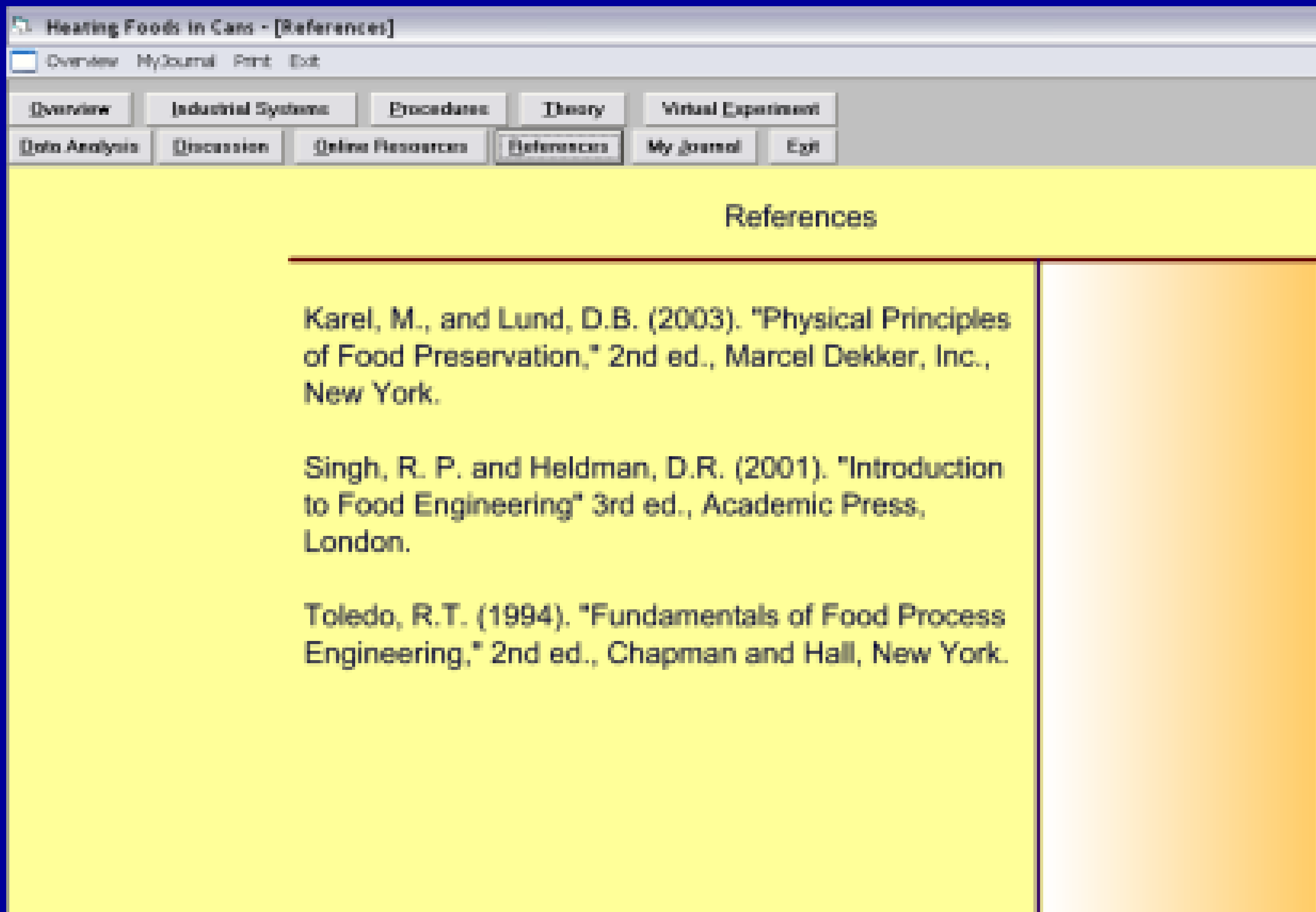
Discussion questions



Links to industrial sites for more information

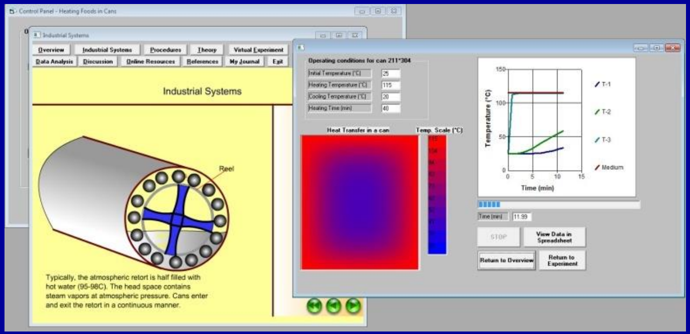


References to consult for writing a report



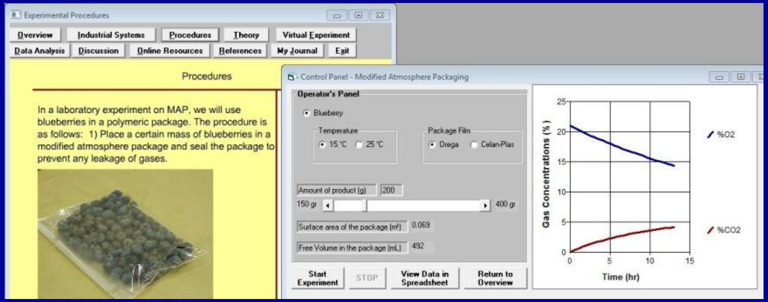
Examples

- Canning

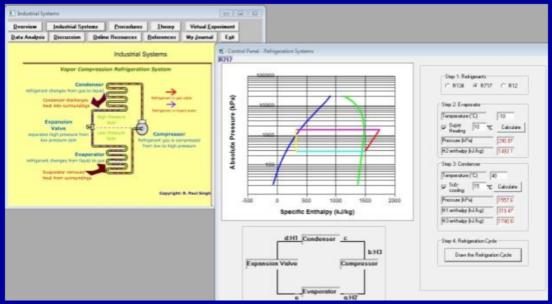


- MAP

(modified atmosphere packaging)



- Refrigeration cycle



Use of virtual experiments in the universities

Virtual experiments have been routinely used in different universities for the past decade.

The following universities have introduced new courses/ laboratory exercises using the `Virtual Experiments` described in this webinar:

Use of virtual experiments in the universities

- University of California, Davis
- Ankara University
- Mersin University
- Ohio State University
- University of Illinois
- Oregon State University

Use of virtual experiments in the universities

- Purdue University
- California State University, Pomona
- University of Newfoundland, Canada
- Iowa State University

In addition, instructors from (over) 30 countries have acquired the computer software from us to enhance their teaching.

Conclusions in summary

- **Personal observations revealed that the virtual labs**
  - **led students get engaged more in the hands-on lab experiments,**
  - **encouraged the students to explore what-if scenarios,**
  - **eliminated the obstructive effect of not having the appropriate equipment to conduct various experiments, and**
  - **allowed students to develop higher level cognitive skills to analyze and evaluate processing parameters.**

Virtual Experiments in Food Processing

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