Internet-based Unit Operation Laboratories in Membrane Separation Processes

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Outline

- Motivation
- Experiments
- Evaluation
- Conclusions

Motivation

- Internet-labs are attractive alternatives to hands-on labs
- Are Internet-based labs as effective as hands-on labs?
- What aspect of the learning experience is most affected by Internet delivery?

Toledo – Cincinnati Project

NSF DUE-0126910

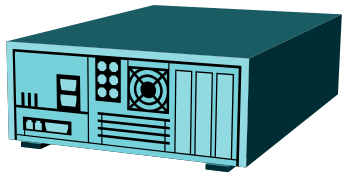
- Develop three experiments:
  Toledo – membrane dialysis/RO and gas separation;
  Cincinnati – non-isothermal fixed bed gas adsorption

- Use in both unit ops labs & evaluate educational effectiveness

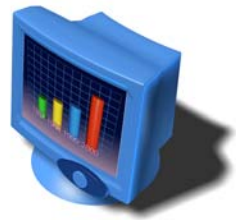
- Currently using dialysis experiment in Lab I at Toledo and Cincinnati (Ben-Gurion)

Experiments

Data Acquisition
and Control



Internet



A/V → NetMeeting
DAQ → LabVIEW → LabVIEW Server → NetMeeting Browser + LabVIEW Plug-in

A/V → Real Helix Server
DAQ → LabVIEW → Database/Server Scripting → RealOne Player Browser

Dialysis Internet Laboratory

Project Engineer :
Jim Dolgoff

Home
Logout
Change Password
Experiment Procedure
View Live Data
Live Video
Dialysis Lab
Calibration Tables
Dialysis Data file
Request Time on Experiment

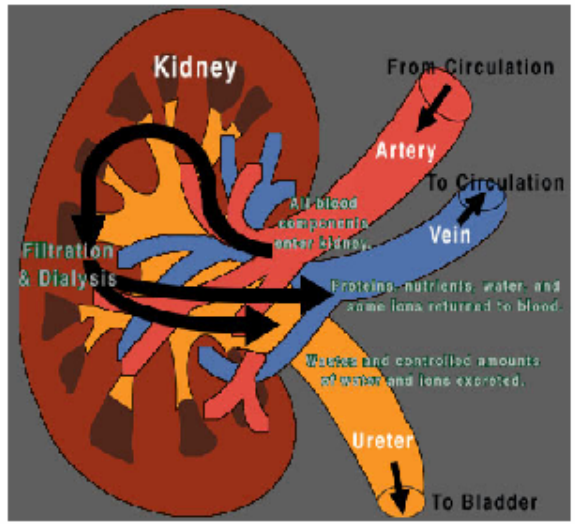
Welcome, Jim!
Friday November 14,2003 13:03

You are scheduled to run the Dialysis Lab :2003-11-14 13:00:00.
Your Lab time will expire :2003-11-14 15:00:00.

This Internet-based Chemical Engineering Unit Operations laboratory was developed to evaluate the effectiveness of Internet learning relative to hands on experience.

Motivations:

1. The use of Internet labs would allow faculty to develop high quality experiments in their area of expertise and share them with the engineering community.
2. Internet labs offer the potential to reduce laboratory costs while increasing the number of experiments available to students.
3. Integration of technology into the classroom.



THE UNIVERSITY OF TOLEDO

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Shell Side Calibration

Pump Setting: Collection Time:

Instructions:

1. Select the pump setting for the calibration.

2. Select the amount of time for collection.

3. Press the **Collect** button. This will take you to the collect page where you can view the balance output.

4. Or Press the **Exit** button. This will return you to the Calibration Menu page.

NOTE: There will be additional options on the collection page once the pumps have stopped.

COLLECT EXIT

Evaluation

- Survey Motivational Constructs
  - –Goal Orientation, Situational Interest, Personal Interest
- Survey Comfort versus Frustration
- Survey Authenticity
- Survey Degree of Collaboration
- Interviews

Focus groups conducted Fall Semester ‘02 in Toledo
(18 hands-on, 18 Internet delivered)

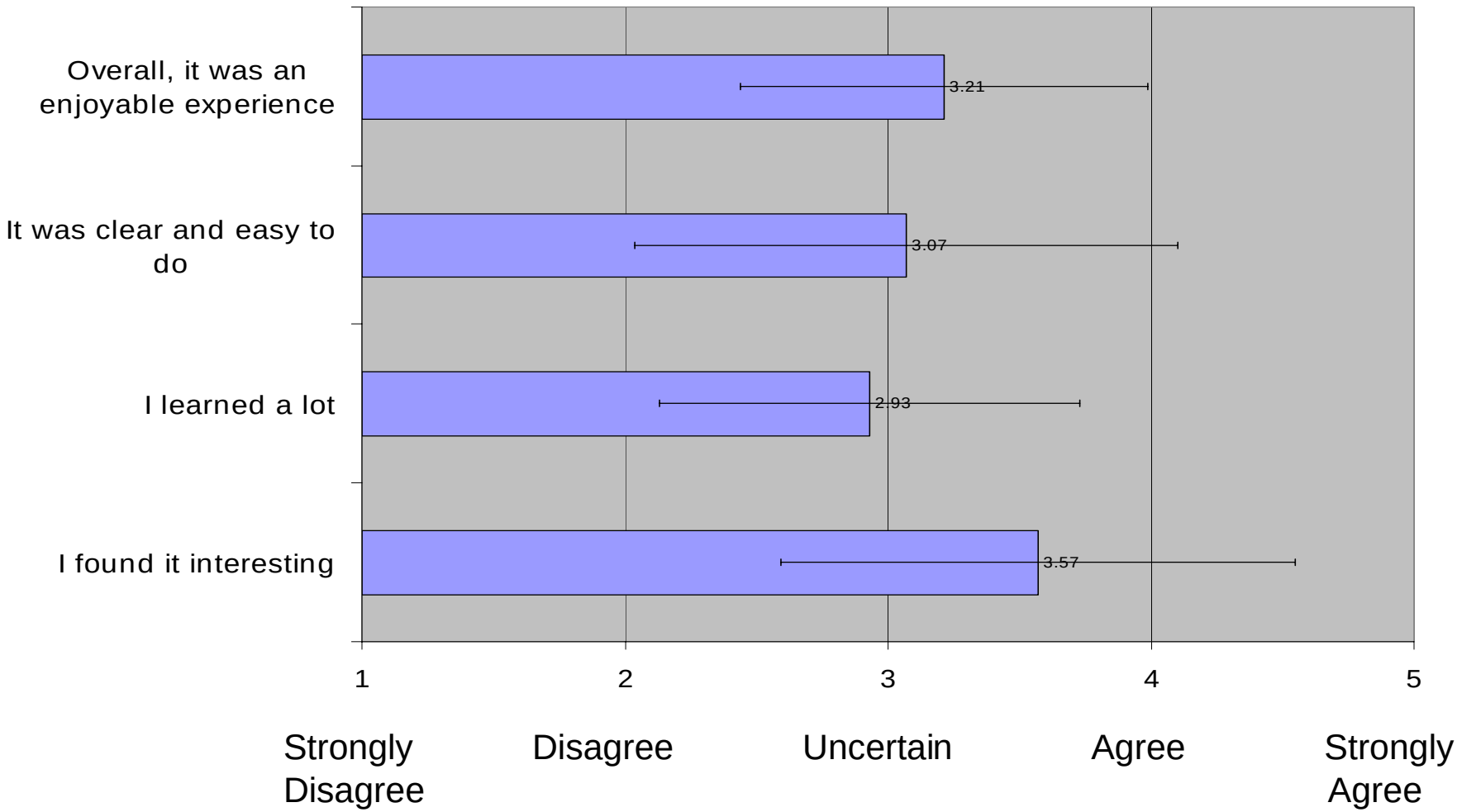
Results used to construct survey for Spring Quarter ‘03 in Cincinnati
(15 Internet delivered)

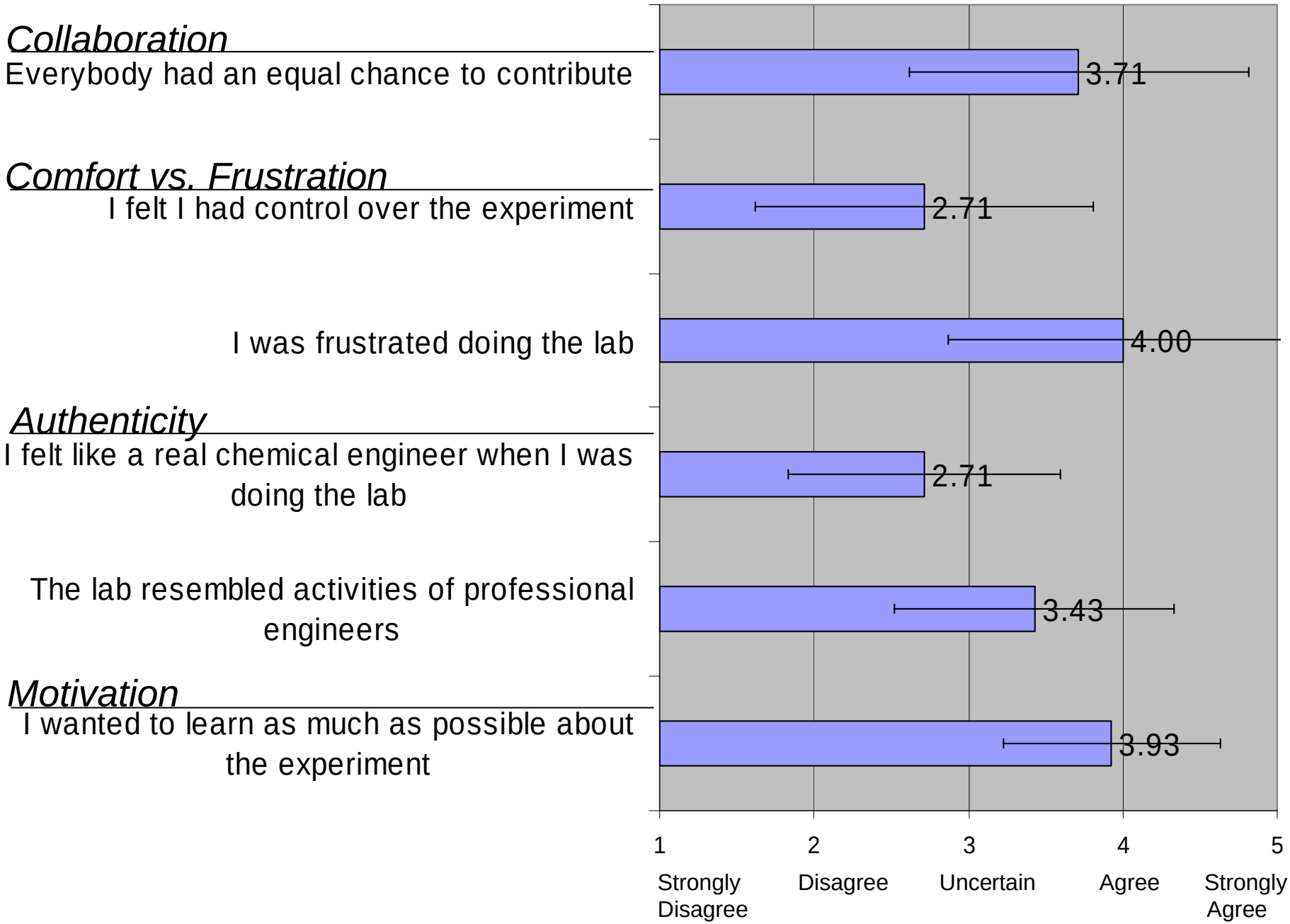
Focus Groups Summary

- Overall, little difference between Internet and hands-on delivery
- Most enjoyed lab - some requested additional ones
- Some enjoyed less, but commented it was important to perform remote labs
- Most were just as comfortable with Internet-delivery as hands-on
- Most felt the Internet experiment was as authentic as any other

Survey Results

I would recommend the lab to others because:




Collaboration
Everybody had an equal chance to contribute
3.71
Comfort vs. Frustration
I felt I had control over the experiment
2.71
I was frustrated doing the lab
4.00
Authenticity
I felt like a real chemical engineer when I was doing the lab
2.71
The lab resembled activities of professional engineers
3.43
Motivation
I wanted to learn as much as possible about the experiment
3.93
1
Strongly Disagree
2
Disagree
3
Uncertain
4
Agree
5
Strongly Agree

Conclusions

- I-labs appear as effective as hands-on labs in terms of motivation, authenticity, comfort, and collaboration

- Identified areas for improvement
  - Improve video signal
  - User interface
  - Data collection
  - Model of apparatus

- Use of LabVIEW web server has been problematic

Acknowledgments

- Chemical and Environmental Engineering Department University of Toledo

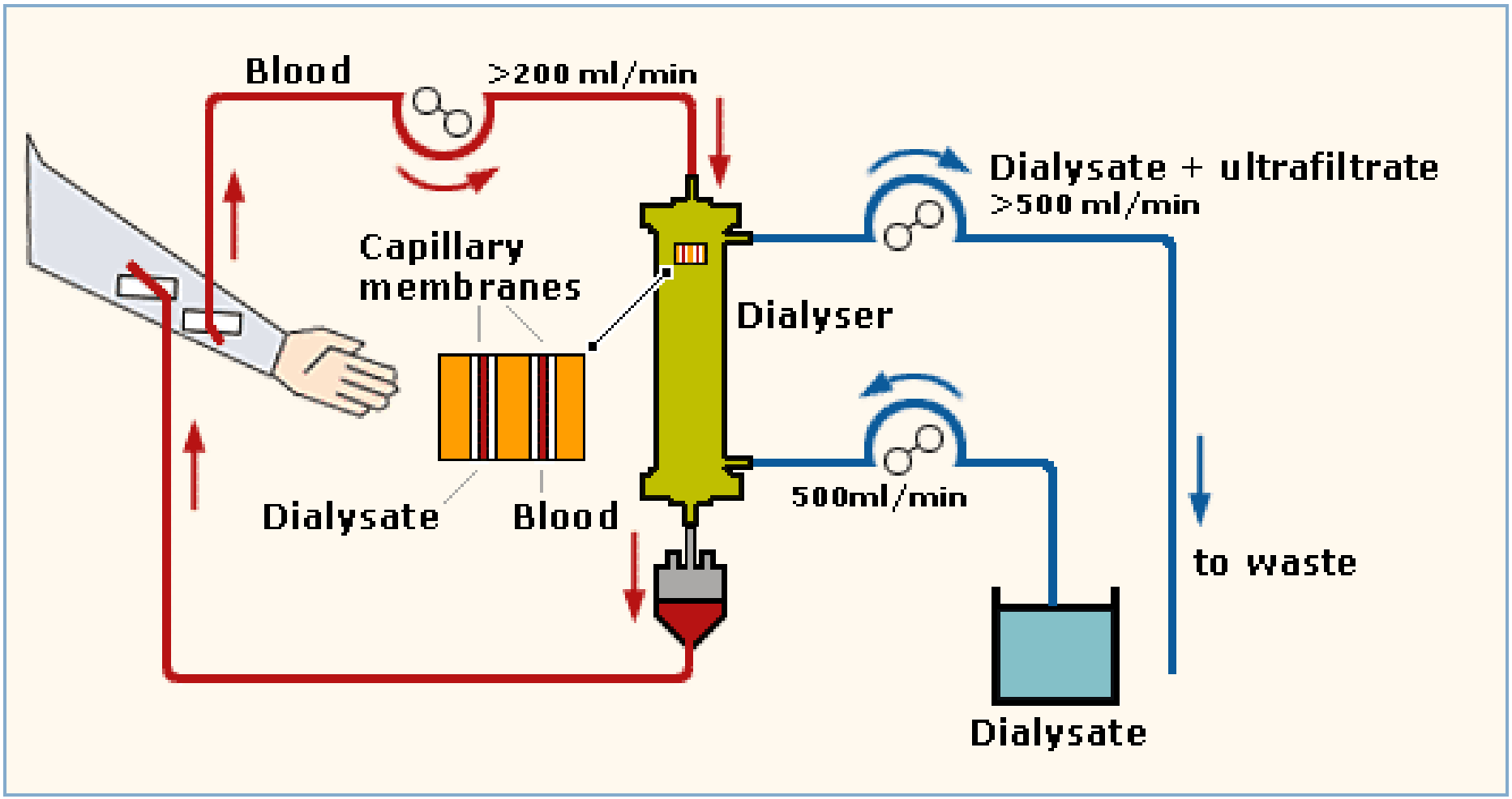
- National Science Foundation
  DUE-0126910

Motivation

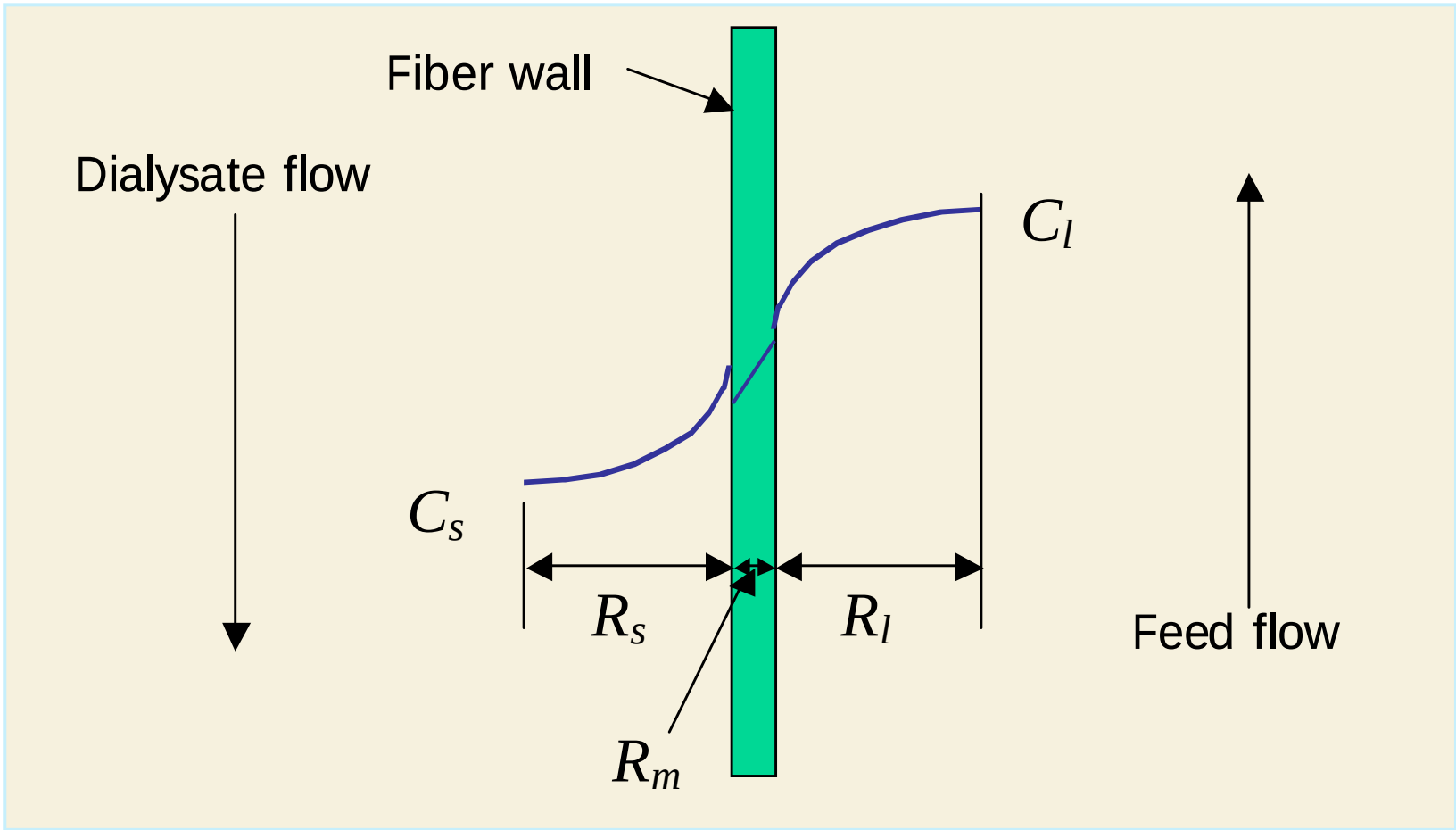
Internet-based labs potentially offer:

- Access to modern, relevant experiments developed by faculty with expertise in area
- Reduced cost and increased numbers
- Use of labs in class-room settings

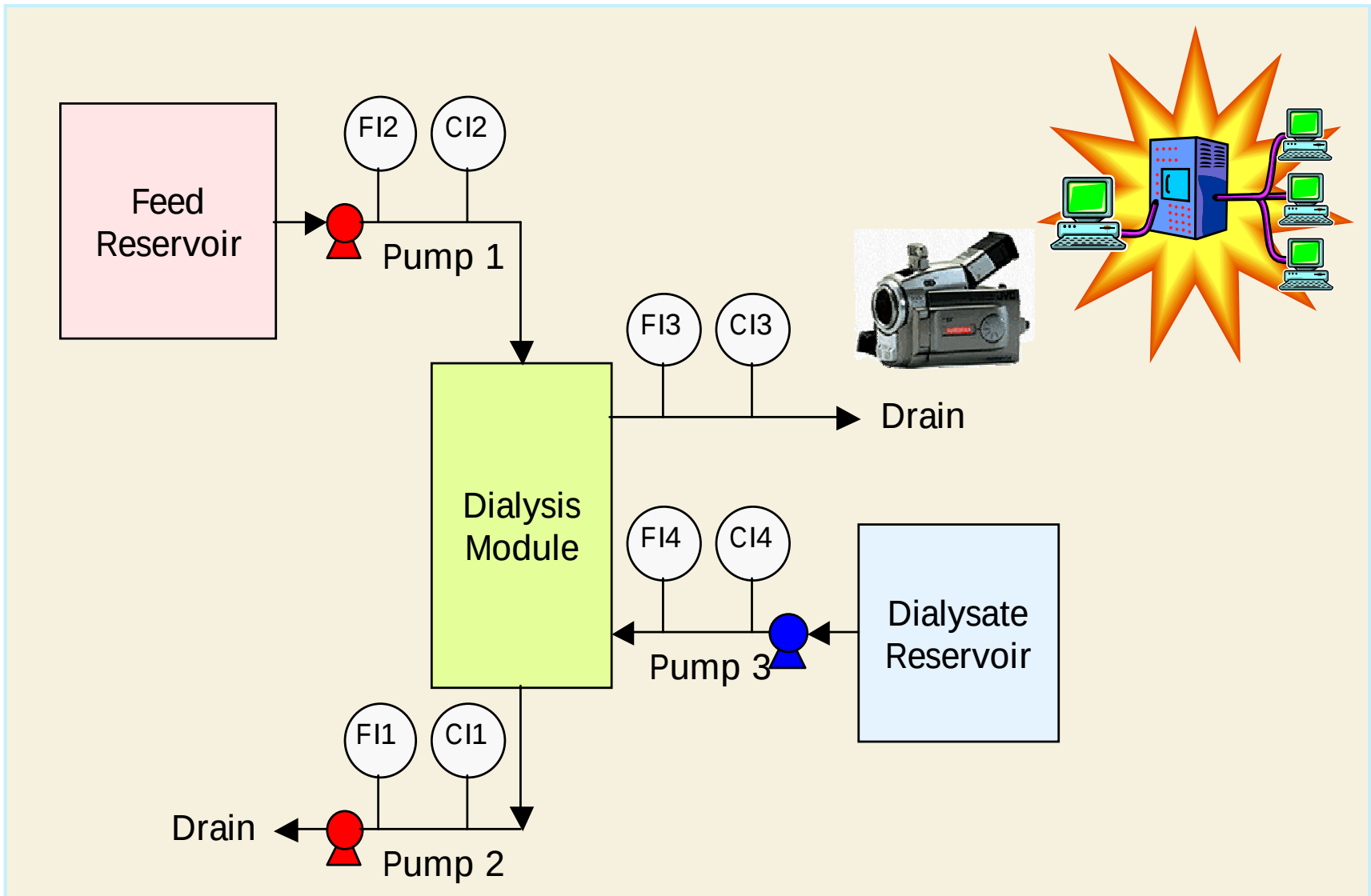
Hemodialysis



Mass Transfer Resistances



Experimental Schematic



Experiment Objectives

- Measure the *overall mass transfer coefficient* for a hemodialyzer
- Determine the individual contributions of the *lumen*, *membrane*, and *shell* mass transfer resistances.

Experimental & Data Analysis

- Design a set of experiments to measure overall mass transfer coefficient (k_o)
- Use data to calculate:
  - Experimental values of k_o as a function of feed & dialysate flow rate
  - Predicted values of k_o using theoretical correlations for k_{lumen} & k_{shell} in randomly packed fiber bundles
  - Experimental correlations for k_{lumen} & k_{shell}

Equipment List

Item (Quantity)	*Manufacturer*	Model
Peristaltic Pump (3)	*Master Flex*	77521-40
Pump Head (3)	*Master Flex*	77200-6
Flow Meter (4)	*McMillan Company*	S-111
Conductivity Controller (4)	*Cole-Parmer*	U-19300-10
Conductivity Cell (flow thru)(4)	*Cole-Parmer*	U-19500-30
Multifunction I/O NI-DAQ (1)	*National Instruments*	PCI-6023E
Analog Output NI-DAQ (1)	*National Instruments*	PCI-6703
Shielded Connector Block (2)	*National Instruments*	SCB-68
Shielded Cable (1)	*National Instruments*	SH68-68-EP
Shielded Cable (1)	*National Instruments*	SH68-68-D1
Dialysis Module (1)	*Fresenius Medical Care NA*	F80A
Video Capture Card (1)	*ViewCast Corporation*	Osprey-2
Video Camera (1)	*JVC*	GR-DVL9800
Computer	*Virtual PCs*	

Pentium 4 1.8 GHz, 1GB DDR RAM, Windows 2000 Server, LabVIEW 6.1

Video Options

Option	Video Image Quality	Network Delay Time	Cost
RealNetworks: RealOne Player, Helix™ Universal Basic Server, Helix™ Producer Basic	Clear and crisp video image	10-15 sec	Free
NetMeeting	Somewhat fuzzy	1-2 sec	Free
Polycom ViewStation FX	Superior	0-1 sec	$15,000
Polycom ViaVideo Desktop (host and client require similar equipment)	Clear and crisp	1-2 sec	$599