THE EDUCATIONAL APPROACH TO INDUSTRIAL VENTILATION

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INTRODUCTION

- Industrial ventilation is regularly included in the health and safety curricula
- Versatile option for controlling airborne hazards
- Expected graduation outcome of many IH academic programs
- Knowledge of this topic rated as “essential” in employers’ surveys
DRAWBACKS

- Limited exchange of information on the educational approach
- Need for exchange more relevant today
- Demanding curriculum, critical evaluation of:
  - Objectives
  - Means and methods
  - Breadth and depth coverage
  - Format of the offerings
  - Emerging areas of interest
STUDY APPROACH

- Survey study
  - How do we teach industrial ventilation?
  - Identify differences and similarities among courses of industrial ventilation
  - Shed light on
    - Novel pedagogical means
    - Perceived emerging areas of need
    - Use of non-traditional methods
    - New teaching resources
- E-submission and gathering of data
DATA SOURCE

- Academic programs in occupational health, safety, environmental, or industrial hygiene
- Bachelors or graduate level programs
- Limited to U.S. academic institutions
- Continuing education offerings excluded
IDENTIFICATION OF PARTICIPANTS

- ABET accredited programs in safety and industrial hygiene
- NIOSH grant recipients (ERCs and TPGs)
- ASSE listings
- Internet search
  - Focus on programs with courses of controls including engineering or environmental controls and industrial ventilation
SUBMISSION

- 55 academic were identified and invited to participate
- Survey and research method approved by the Institutional Review Board
- Method of collection allowed forwarding survey and instructions
- Two mail-outs, the second as a reminder
SURVEY DESIGN

- Electronic type with questions of a mix format
- Six sections
  - Course structure: 9 questions
  - Breath and depth: 9 questions
  - Laboratory and experimental: 2 questions
  - Teaching methods: 3 questions
  - Course evaluation: 2 questions
  - Emerging areas: 4 questions
## Breadth and depth

Questions 12 to 18 are related to course components and the extent at which these components are treated.

### 10. At what level is this course offered?
- Undergraduate
- Graduate
- Both, undergraduate and graduate

### 11. At what level do students enroll in this course?
- First year (graduate students)
- Second year (graduate students)
- Freshmen (undergraduate)
- Sophomore (undergraduate)
- Junior (undergraduate)
- Senior (undergraduate)

### 12. Please rate the level of coverage of unit components related to basic principles

<table>
<thead>
<tr>
<th>Component</th>
<th>No coverage</th>
<th>Minimum coverage</th>
<th>Sufficient coverage</th>
<th>Extensive coverage</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic properties of airborne contaminants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dispersion mechanisms of air contaminants</td>
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<tr>
<td>Airflow and fluid dynamics concepts</td>
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<tr>
<td>Pressure and pressure losses</td>
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<tr>
<td>Density corrections for non-standard conditions</td>
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</tr>
</tbody>
</table>
Teaching methods

Questions 21 to 23 are concerned with the methods by which the course materials are delivered.

21. The course materials are delivered by which of the following options?
   - Traditional lecture
   - Combination of lecture and distant learning
   - Distant learning exclusively
   - Independent studies with guided tutoring
   - Self study with assigned projects
   - Other (please specify)

22. In addition to the textbook, the course makes use of the following additional materials. More than one option may apply.
   - Internet resources
   - Specialized software
   - Computer models
   - Ventilation mock-ups and models
   - Other (please specify)

23. If specialized software and/or computer models are used, which are they?
RESPONSE

- 30 programs responded (56% cooperation rate)
- Only one responder explicitly refused to participate
- Apparent interest in survey results
COURSE STRUCTURE: Ventilation

Objective

- Health protection (100%)
- Safety controls (48.3%)
- IAQ assurance (41.4%)
- Comfort (37.9%)
- Compliance with regulations and standards (34.5%)
- Other
  - Material recovery
  - Engineering principles
COURSE STRUCTURE: Subject Hierarchy, an Exclusive Topic?

60%
30%
10%

Stand Alone Course
Component of a More General Subject
Other
COURSE STRUCTURE: Outcome Performance Expectations

- General Principles: 10%
- Comprehensive, Excluding Design: 26.7%
- Comprehensive, Including Design: 53.3%
- Other: 10%
<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Source</td>
<td>40%</td>
</tr>
<tr>
<td>Combination</td>
<td>13%</td>
</tr>
<tr>
<td>ACGIH &amp; McDermott</td>
<td>17%</td>
</tr>
<tr>
<td>AIHA Whitebook</td>
<td>10%</td>
</tr>
<tr>
<td>Own Materials</td>
<td>7%</td>
</tr>
<tr>
<td>Burton's Vent. Workbook</td>
<td>3%</td>
</tr>
<tr>
<td>ACGIH Vent. Manual</td>
<td>4%</td>
</tr>
<tr>
<td>Web Sites</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
</tr>
</tbody>
</table>
COURSE STRUCTURE: Additional

- A required component of the curriculum (82.8%)
- Mainly offered at the graduate level (63.3%)
- Frequency of course offering
  - Once a year (62.1%)
  - Once every other year (20.7%)
- Enrollment size
  - Average enrollment of less than 10 students (62.0%)
<table>
<thead>
<tr>
<th>Basic Principles (5)</th>
<th>Pressure &amp; Pressure Loss</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Airflow and Fluid-dynamics</td>
<td>93%</td>
</tr>
<tr>
<td></td>
<td>Properties of Air Contaminants</td>
<td>66%</td>
</tr>
<tr>
<td>Gen. Vent. (5)</td>
<td>Dilution Ventilation Principles</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Dilution for Health</td>
<td>87%</td>
</tr>
<tr>
<td>Local Exhaust Ventilation (9)</td>
<td>Hood Loss &amp; Pressure Control and Capture Velocity</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Flow Rate Enclosing Hoods</td>
<td>97%</td>
</tr>
<tr>
<td></td>
<td>Flow Rate Exterior Hoods</td>
<td>96%</td>
</tr>
<tr>
<td></td>
<td>Hood Design</td>
<td>93%</td>
</tr>
<tr>
<td></td>
<td>Design of ducts and fittings</td>
<td>86%</td>
</tr>
</tbody>
</table>

Note: Important = Sufficient to Extensive Coverage
## BREADTH AND DEPTH: Important Coverage

<table>
<thead>
<tr>
<th>Make-up Air (3)</th>
<th>Purpose</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Components</td>
<td>60%</td>
</tr>
<tr>
<td>Air Cleaning Devices (4)</td>
<td>Pressure Loss</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Separation Principles</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Design Characteristics</td>
<td>48%</td>
</tr>
<tr>
<td>Air Moving Devices (4)</td>
<td>Selection</td>
<td>94%</td>
</tr>
<tr>
<td></td>
<td>Fan Laws</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Principles of Operation</td>
<td>87%</td>
</tr>
<tr>
<td>Design (4)</td>
<td>Single-Branched</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Multi-Branched</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>Balancing Methods</td>
<td>90%</td>
</tr>
</tbody>
</table>

Note: Important = Sufficient to Extensive Coverage
# BREADTH AND DEPTH: Limited Coverage

<table>
<thead>
<tr>
<th>General Ventilation</th>
<th>HVAC use</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System components</td>
<td>59%</td>
</tr>
<tr>
<td>Make-up Air</td>
<td>Supply sizing and distribution</td>
<td>56%</td>
</tr>
<tr>
<td>Air Moving</td>
<td>Fan maintenance</td>
<td>67%</td>
</tr>
<tr>
<td>Air Cleaning</td>
<td>Rating Principles</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
<td>70%</td>
</tr>
</tbody>
</table>

Limited = None to Minimum Coverage
COURSE STRUCTURE: Experimental Portion

- Part of Lecture Component: 72.4%
- Separate Offering: 17.2%
- Not Included: 10.3%
EXPERIMENTAL: Practices

- Duct velocity
- Static and velocity pressure
- Face velocity
- Flow rate
- Pressure loss in fittings
- LEV systems
EXPERIMENTAL: Resources

- Pitot tubes
- Manometers, fluid
- Manometers, aneroid
- Anemometers, thermal
- Anemometers, vane
- LEV models
- IAQ monitors
- Balometers
TEACHING METHODS: Delivery Mode

- The most frequent option is traditional lecture (75%) or a combination of classroom and online delivery (17.9%)
- Online or distant learning as an exclusive option is not available among responders
- Other options include:
  - Seminars and reading assignments
  - Black board holdings
  - Field work
TEACHING METHODS: Software Resources

- Internet resources (76.2%)
- Specialized software (19%)
- Computer models (23.8%)
  - Spreadsheets
  - Personal programs
- Software listed
  - HeaVent
  - Fan Selector
  - IVE AutoCalc CAD Design System
EMERGING AREAS

- One-third of responders recognize a need for addressing new areas
- Emerging areas
  - Control of nano-particles and biohazards including infectious agents
  - IAQ beyond outdoor air exchange rates
  - Computer modeling
  - Energy efficiency, especially in GVS
  - Engineering diversity for a comprehensive hazard control approach
DISCUSSION

- Many offerings have been subjected to change, from minor to extensive
- Among these changes
  - Merging into a more general subject
  - Deleting the design component
  - Increasing emphasis on measurements activities
  - Decreasing emphasis on specific technologies and expanding on multifaceted solutions
CONCLUSIONS

- Courses containing industrial ventilation present more similarities than differences.
- There is an incipient tendency towards deleting the design aspects as content topic.
- Experimental and field activities represent an important part of the educational process.
- Courses make use of a variety of resources including hardware and software.
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- The participants who took the time to complete the survey

THANKS