Medical Education Through the Lens of Engineering: A Look at the Carle Illinois Curriculum

with
William Pluta, PhD
Carle Illinois Curriculum Pyramid

- Carle Illinois Graduate
- Carle Illinois Mission
- Curriculum Design Principles
- Core Competencies and Objectives
- Assessment
- Carle Illinois Instructional and Scholarly Resources
- Carle Illinois Faculty Expertise and Values
- (Incoming) Student Expertise and Values

Illinois and Carle Foundation Values & Resources
MISSION

We educate exceptional physician-innovators to deliver **high-value, compassionate health care through transformative solutions developed at the intersection of engineering, science and medicine.**
Design opportunities for students to integrate their rapidly growing medical knowledge with existing engineering and quantitative skills.

Design opportunities for students to practice and develop existing engineering and quantitative skills within the context of medicine.
Develop Knowledge Skills and Attitudes of Practicing Physician (First Year Resident)

Apply advanced quantitative skills to understand medical problems.

Apply engineering skills to develop solutions to medical problems.

Apply advanced quantitative skills to evaluate interventions.
Carle Illinois Competencies & Objectives

Understand the operating principles of the instruments generating data used for diagnosis.

Evaluate the reliability and validity of health or physiological data collected from personal health monitoring or measuring devices.

Describe, simulate and quantitatively evaluate the distribution of blood through resistive vascular networks undergoing autoregulation.

Quantitatively describe and model filtration and reabsorption of filtrate in the vasculature due to hydrostatic and oncotic pressures.

Demonstrate negative feedback control of respiration rate through modeling and simulation of sensors and response pathways.
Phase 1

Year 1 (2018-2019)
- Foundational Elements
- Cardiovascular
- Respiratory
- Renal
- Clinical Neuroscience
- Musculoskeletal
- Digestion
- Nutrition & Metabolism
- Discovery Electives

Year 2 (2019-2020)
- Endocrinology
- Geriatric
- Women's Health
- Obstetrics
- Hematology & Oncology
- Intensive Care
- Infection / Immunity
- Clinical Integration II
- Step 1 Review
- Engineering Rounds/IDEA

Year 3 (2020-2021)
- Pediatrics (cont.)
- Electives
- Surgery
- Neurology
- Psychiatry
- Internal Medicine or Surgery Sub-I
- Required Clinical Electives

Phase 2

Year 1 (2018-2019)
- Cardiovascular
- Respiratory
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Phase 4

Year 1 (2018-2019)
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Phase 4
<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
<tr>
<td>8:00-8:50</td>
<td>PBL Case Day 1</td>
<td>Engineering and/or Data Science Lab</td>
<td>PBL Case Day 2</td>
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<td>PBL Case Day 3</td>
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<td>9:00-9:50</td>
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<td>10:00-10:50</td>
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<tr>
<td>11:00-11:50</td>
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<td>Ethics &amp; Humanities</td>
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<tr>
<td>12:00-12:50</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch Innovation Brownbag</td>
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<tr>
<td>13:00-13:50</td>
<td>Clinical Integration w/ faculty mentor</td>
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<td>Physical Diagnosis</td>
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<td>14:00-14:50</td>
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<td>Chest Exam</td>
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<td>15:00-15:50</td>
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<td>Practice w/ Standardized Patient</td>
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<tr>
<td>16:00-16:50</td>
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<td>Assessment (at home)</td>
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PBL cases serve as the hub for all instructional activities for each week.
### Phase 2

<table>
<thead>
<tr>
<th>Week</th>
<th>Pediatrics (cont.)</th>
<th>Electives</th>
<th>Surgery</th>
<th>Elective</th>
<th>Winter Break</th>
<th>Neurrolgy</th>
<th>Break</th>
<th>Psychiatry</th>
<th>Break</th>
<th>OB-Gyn</th>
<th>Pediatrics 5 wks</th>
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<tbody>
<tr>
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<td>10/18</td>
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<td>10/23</td>
<td>10/24</td>
<td>10/27</td>
<td>12/26</td>
</tr>
</tbody>
</table>

**Required Clinical Electives**

- Pediatrics (cont.) 10 weeks
- Surgery 10 weeks
- Electives
- Neurology 4 weeks
- Psychiatry 4 weeks

**Breaks**

- Winter Break
- Break
- Break

**Clinical, Research, & Engineering**

- Family Medicine Student Clinic
- Engineering Rounds/DEA
- Family Medicine Student Clinic

**Phase 3**

- Internal Medicine 10 weeks
- OB-Gyn 5 weeks
- Pediatrics 5 weeks

**Breaks**

- Winter Break
- Graduation

**Capstone Project**

- Deep Dive/IDEA
- Spring Break

**Electives**

- Family Medicine Clerkship
- Clinical Integration I
- Physical Diagnosis I
- Clinical Neuroscience
- Clinical Integration II
- Physical Diagnosis II
- Clinical, Research, & Engineering
- Phase 3

**Breaks**

- Thanksgiving
- Thanksgiving

**Phase 1**

- Engineering Innovation
- Phase 1
- Phase 2
- Phase 3
Opportunities to Apply Engineering & Data Science Skills Across Curriculum

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Rounds</td>
<td>Capstone Project</td>
</tr>
<tr>
<td>Integrate Engineering Prompts into PBL Cases</td>
<td>Engineering Grand Rounds</td>
<td>Data Science Project</td>
</tr>
<tr>
<td>Data Science &amp; Engineering Laboratory Exercise</td>
<td>IDEA (Innovate, Design, &amp; Engineering Analysis)</td>
<td>Engineering Electives</td>
</tr>
<tr>
<td>Innovation Brown Bags</td>
<td>Engineering Electives</td>
<td></td>
</tr>
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<td>Engineering Electives</td>
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</table>
## Opportunities to Apply Engineering & Data Science Skills Across Curriculum

<table>
<thead>
<tr>
<th>Example Lab Exercises</th>
<th>Example PBL Prompts</th>
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<tbody>
<tr>
<td><strong>Cardiovascular</strong></td>
<td><strong>Cardiovascular</strong></td>
</tr>
<tr>
<td>EKG vectors, ROC Analysis</td>
<td>What inputs and outputs</td>
</tr>
<tr>
<td>of Fluorescent Signal</td>
<td>govern blood pressure?</td>
</tr>
<tr>
<td><strong>Respiratory</strong></td>
<td><strong>Respiratory</strong></td>
</tr>
<tr>
<td>PFT Flow Volume Loops</td>
<td>Deposition of inhaled medications?</td>
</tr>
<tr>
<td><strong>Renal</strong></td>
<td><strong>Renal</strong></td>
</tr>
<tr>
<td>Dialysis Models</td>
<td>Acid/base balance equations</td>
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</tbody>
</table>

**Example Lab Exercises**

- Cardiovascular: EKG vectors, ROC Analysis of Fluorescent Signal
- Respiratory: PFT Flow Volume Loops
- Renal: Dialysis Models

**Example PBL Prompts**

- Cardiovascular: What inputs and outputs govern blood pressure?
- Respiratory: Deposition of inhaled medications?
- Renal: Acid/base balance equations
<table>
<thead>
<tr>
<th>Carle Illinois Resources</th>
</tr>
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<tbody>
<tr>
<td>elective time across curriculum</td>
</tr>
<tr>
<td>capstone &amp; data science resources</td>
</tr>
<tr>
<td>sim center, vr packages</td>
</tr>
<tr>
<td>engineering library and computer labs</td>
</tr>
<tr>
<td>maker lab</td>
</tr>
<tr>
<td>deep dive program</td>
</tr>
<tr>
<td>pioneering health scholars program</td>
</tr>
</tbody>
</table>
Carle Illinois Faculty Expertise & Values

Course/clerkship design teams include an:

- Engineer
- Basic Scientist
- Physician
Advising Structure

Innovation Pods

Suite of advisors representative of our mission

Academic Skills Specialist – proactive, not reactive

Career Preparation boot camp – may not be residency focused!