Effect of Industrial & Systems Engineering Course Sequence on Graduation Rate - A Case Study and Surveying Approach

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Abstract

David's version:

Cognitive workload in our study —defined as the mental effort to fulfill academic tasks— has shown to directly impact student burnout, well-being, and academic performance among various other factors. Utilizing a within-subjects designed survey, we assess 13 Industrial & Systems Engineering (ISE) upperclassmen participants on their perceived difficulty, intensity, graduation rate among proposed degree layouts for curriculum reform. Involved are statistical analyses such as Shapiro-Wilk, Friedman and ANOVA; it's revealed that the junior fall semester imposes the highest cognitive workload from our prior research.

Though alternative layouts aim to mitigate burdensome workload by redistributing challenging courses, only perceived graduation rate had varied significance among layouts ($p = 0.023$). Given findings suggest that despite recognizing periods of cognitive workload, students may likely resist curricular reform due to status quo bias or see minimal benefit from subtle curriculum adjustments. These results recognize the complexity of aligning curriculum design, perceived cognitive load and tangible results. Future research prompts exploring cognitive workload using more objective physiological metrics as well as NASA-TLX, and expanding our sample sizes to better incite curriculum reform of the current 2024 degree flowchart for ISE.
Keywords: Cognitive Load Theory, Cognitive workload, Curriculum design, Engineering education, Course Sequence, Burnout, Perceived difficulty, Graduation rate

Maddy's version:

This study investigates the impact of cognitive workload on student perceptions of curriculum structure, academic difficulty, and graduation likelihood within an Industrial & Systems Engineering (ISE) program. Grounded in cognitive load theory and recent literature on educational demands, the research explores how curriculum sequencing affects perceived stress, burnout, and academic outcomes. A quasi-experimental, within-subjects design was employed using a survey of 13 upper-level ISE students. Participants evaluated multiple degree layouts—including the default and three alternatives—on dimensions such as perceived difficulty, workload intensity, graduation rate, and burnout. Quantitative measures were inspired by the NASA-TLX framework, and qualitative responses added context about academic background and external commitments. Results showed the junior fall semester as consistently the most demanding in terms of workload, failure rate, and study hours. Surprisingly, only perceived graduation rate significantly differed among layouts, while perceived workload and burnout remained statistically unchanged. This outcome suggests possible cognitive biases, such as anchoring and status quo preference, influencing participant judgments. Additionally, layout changes may not have sufficiently altered intrinsic or extraneous cognitive load to yield meaningful improvements. Findings highlight the complexity of curriculum design, suggesting that while students recognize workload challenges, redesigns must address deeper cognitive processes to be perceived as beneficial.

Keywords: Cognitive workload, Curriculum design, Cognitive load theory, ISE degree course flow

1 Introduction

1.1 Research Foundation

Cognitive workload refers to the mental effort required to process, store and manage various tasks and information, which is shown to significantly affect academic performance. Due to the prevalent challenges related to burnout and late graduation among Engineering students in the Industrial &

Systems Engineering program, we've found that cognitive and academic workload correlate, and display fatigued levels in published literature.

Prior academic articles support this concern, specifically, Thornby (2023) demonstrates that the exceeding of mental workload in various student learning environments diminished not only performance, but morale and motivation. Another role proposed to also interlink includes curriculum structure as explored by Zuo et al. (2021), who emphasizes that it must synonymously manage workload intensity and the demands of students based on their current developmental stage in learning (e.g., elementary, middle, high school). This study translates to undergraduate engineering programs where independent learning and multitasking are expected.

Our research investigates how course sequence affects graduate rate, focusing on internal strategies for improving cognitive workload—majorly determining student performance and well-being. The main objective of this study is to assess whether the sequence and distribution of ISE courses impose cognitive workloads that affect graduation timing. We hypothesize that there's at least one semester and alternative layout among the curriculum showing statistically significant differences in perceived workload. Such discrepancies may inform the application of cognitive workload theory to incite proper workload balance and reduce the risk of course overload.

2 Literature Review

The following literature review examines the concepts behind cognitive workload to better understand how academic demands impact student engagement, fatigue and overall well-being. Exploring the curriculum structure, learning environment and course load affect students' mental capacity, our review aims to identify the key factors contributing to cognitive workload along with formalized strategies to balance and support the student experience.

Strategizing balance is explored in a recent study from Thornby, Brizzou and Chen (2023). In summary, student workload assessed within health professional education reveals a strong correlation between cognitive workload and institutional demands. Cognitive workload, here, is defined as encompassing mental effort required to process information and fulfill academic tasks—argued to be affected when educational requirements exceed students' cognitive capacities. This state is characterized by overwhelmed working memory, attributed to a lack of deep, critical engagement. Measuring cognitive workload provides valuable insight into examining design of curricula, and other strategies such as implementing flipped classroom learning and setting clear teacher-student expectations. Their results conclude that better managing cognitive demands and deeper learning environments involves systems thinking methods and cognitive load theory to better reform curriculum. This impacts educators, who may better align their educational demands with student cognitive capacity for better learning outcomes.

This applies to online learning environments as well. Literature by Zuo, Liu, Hu, Zhang and Luo (2021) reveals how online learning undermines typical standard developmental regimens among elementary, middle and high school. Studied closely, is the conjunction of academic workload and engagement across various K-12 online students; strong correlations between perceived workload and cognitive development were found. For example, high school students were reported to have the heaviest academic workload and lowest cognitive engagement. In contrast, elementary students benefited greatly from structurally rich curricula, suggesting the highest cognitive engagement with the least workload. This concludes that manageable academic demands, paired with appropriate developmental learning methods output the highest behavioural/emotional engagement. Therefore, online learning environments are recommended to be tailored to specific cognitive development stages for optimal cognition.

Cognitive workload often involves applied methods as well. Das Chakladar and Roy (2024) in their article “Cognitive workload estimation using physiological measures” evaluates cognitive workload as a crucial component in understanding how others allocate mental resources during task performance. This spanned across preventing errors and optimizing both performance and human-machine interaction. Their research breaks down cognitive load into intrinsic, extraneous and germane cognitive load —all reflecting different sources of cognitive demand (task complexity, environment, etc.). NASA-TLX and SWAT tools utilized measures subdivided into brain-based and non-brain-based methods. Their study also explores advances in machine learning for classifying workload intensity using multimodal fusion techniques. Das Chakladar and Roy’s research underlines the ongoing efforts to develop quantified methods that assess nuance to best interpret mental effort in various task environments.

3 Methods

In this study, we followed a quasi-experimental within-subjects survey design to discover the effect of course sequence on graduation rate and graduation-related perceptions. Survey metrics include perceived graduation rate, difficulty, burnout, and workload. Our independent variable is degree design layouts (mentioned below under “Design”). All layout designs were developed based on prior recommendations in ISE course difficulty, which indicated that the junior fall semester was the most challenging semester. This finding is consistent with existing literature that emphasizes the influence of curriculum structure on academic outcomes in engineering disciplines (Litzinger et al., 2011).

Our participants were asked to evaluate each of the designed layouts as well as the default layout based on multiple metrics to provide a comparative basis for better understanding how different degree layout alterations might affect graduation rates and perceived graduation likelihood and associated academic stress.

3.1 Participants

Studied participants are currently-enrolled undergraduate junior and senior students in the Industrial & Systems Engineering (ISE) program at The University of Oklahoma. Our objective is to survey a targeted population with significant exposure to the current ISE curriculum, as the demographic provides the most informed evaluations of alternative degree layouts based on their respective experience. We utilized convenience sampling and distributed surveys to pertaining ISE students, as participation was voluntary and anonymous. A total of 17 responses were gathered with only 13 subjects providing completed responses. Our survey included questions regarding academic standing and external commitments to better interpret and provide context for our results. Additionally considered, were participants who might've switched from another major as well as to report their former major along with justification in their transfer to ISE.

3.2 Apparatus

Materials & Measures

We developed a questionnaire consisting of 28 questions on Qualtrics, a university-wide supported survey platform. The survey includes both quantitative and qualitative questions to assess dependent variables such as actual graduation rate for the default degree layout and perceived graduation rate for proposed hypothetical degree layouts. Other factors include anticipated burnout, workload intensity, layout preference and weekly hours worked. We provide visual graphics of each degree layout to our participants (see **Figure 1** through **4**) to aid their comprehension and reduce misinterpretation-induced bias among factor levels.

To ensure robustness in our subjective workload assessment, we benchmarked our survey design closely with the cognitive workload evaluation metric NASA-TLX. Given that the current NASA-TLX tool is designed to measure mental, physical and temporal demand along with effort, performance and frustration levels, we used this framework to better complement our prior research metrics relevant to program evaluation of the ISE degree. Our custom metric instead incorporated graduation rate, workload intensity, failure rate and weekly hours spent on coursework. Similar iterations of this survey structure were conducted respectively for evaluating perceived workload of our alternative layouts and default semesters.

Quantitative Measures

Used, were slider-based scales ranging from 0 to 100 (excluding weekly hours on coursework). The slider-based scales enabled our participants to rate each construct on a scale of 0 to 100, with 100 being the highest score given. We then used this scale for a percentage-based framework.

The constructs included perceived difficulty and burnout, degree layout preferences, perceived graduation rate, workload intensity, anticipated failure rate, and weekly study hours. For perceived difficulty and burnout, we embedded slider-based scale questions ranging from 0 to 100..

Participants were rated on their perceived difficulty of course flow and how much anticipated may occur for each of the proposed layouts (A, B, and C). The slider approach continued for the next construct: degree layout preferences. These multiple-slider questions asked participants to rate each layout (Default, A, B, and C) from 0 to 100 (100 being highest) to rate overall preference. The perceived graduation rate construct also used the same slider scale as the participants estimated the percentage of students they believed would graduate under each degree layout. For workload intensity, we used separate sliders based on four different semesters as we wanted our participants to rate the semester-specific workload intensity for only the default layout.

The semesters were sophomore fall, sophomore spring, junior fall, and junior spring. In the anticipated failure rate construct, participants estimated what percentage of students they believed would fail during each of the same four semesters under the default layout. We conclusively asked participants to report the number of weekly hours spent on coursework semesterly (on a scale from 0 to 40 hours) and limited to concrete study time. All these constructs made up quantitative measures to allow statistical comparison across layout conditions and semesters —facilitating analyses of potential relationships between course sequencing and perceived academic success.

Qualitative Measures

Included are a series of text-entry-based questions to provide context and enrich the quantitative data. These are categorized into three sections: academic background, external influences, and engagement/mood maintenance. In the academic history section, we primarily considered participants who switched to ISE major from a different major by reporting extenuating circumstances. This type of question allowed us to explore whether academic background has an influence on perception of curriculum design. We asked in our external influence section, "What are some external factors that have affected your progress toward your degree?" to identify contextual factors like financial stress, work obligations, and family commitments, etc., impacting graduation or stress levels. Lastly, is the engagement and mood maintenance section designed with a goal to minimize fatigue, and maintain engagement throughout the survey. Here we playfully asked our participants to answer questions such as "If the ISE department had a mascot, what would it be and why?", "Which professor would you want to get drinks with?", and "If possible, which professor would you like to see do the worm at the ISE Banquet?" These were not central to our research, but were designed to enhance participant engagement and may yield insights into departmental culture and student-professor relationships. In a long survey consisting of 28 questions, such whimsical and humor-based questions are well suited as they are increasingly used in survey-based research to reduce participant disengagement or satisficing behaviors in longer instruments (Krosnick, 1991; McDaniel & Gates, 2018).

3.4 Scenarios

We highlighted two quintessential recommendations framing our scenarios: First, to switch the order of "Deterministic Systems Models" and "Probabilistic Systems Models" to alleviate both difficulty and workload for the junior year fall semester, preventing more delays. Second, shifting "Applied Engineering Statistics" and "Data-Driven Decision Making I" back a semester, as they're respectively ranked among the most challenging courses in the degree program. Given those rankings, we propose 4 total ISE degree layouts as candidates for improving graduation rate among various factors for students. We included our "Default" degree layout as a benchmark to compare among our three proposed layouts. Layouts A, B and C are as follow: Layout A (swap Deterministic Systems Models and Probabilistic Systems Models), Layout B (move back Applied Engineering Statistics along with Data-Driven Decision Making I back a semester), and Layout C (dually apply both Layouts A & B).

Assessed next, was the status quo of the "Default" degree layout by measuring various factors that made them difficult. This was broken down among the following semesters: Sophomore Fall, Sophomore Spring, Junior Fall and Junior Spring. Refer to **Figures 1** through **4** for all visualized scenarios in the delivered format.

Figure 1. Default Layout (Control)

Figure 2. Layout A

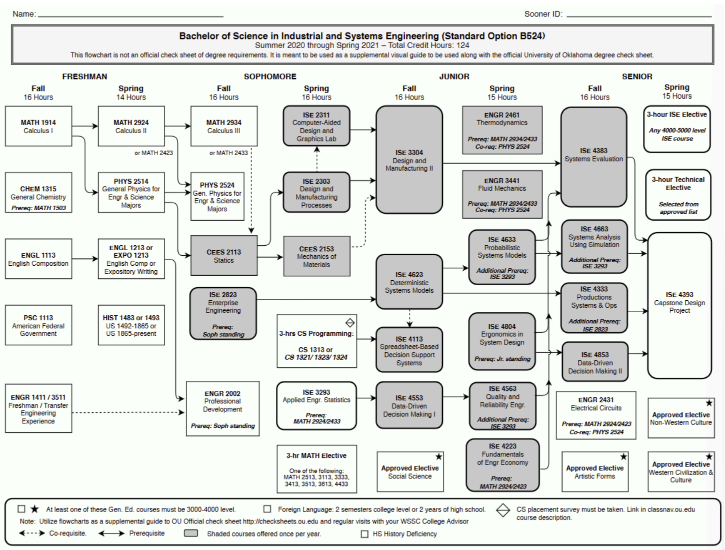


Figure 3. Layout B

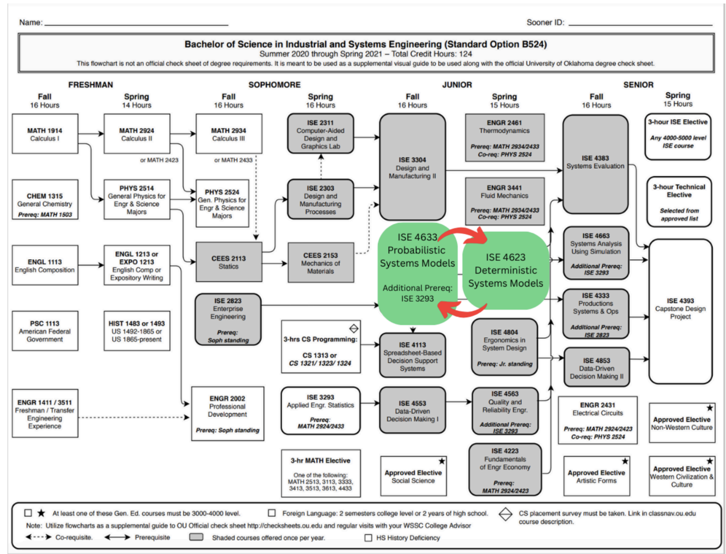
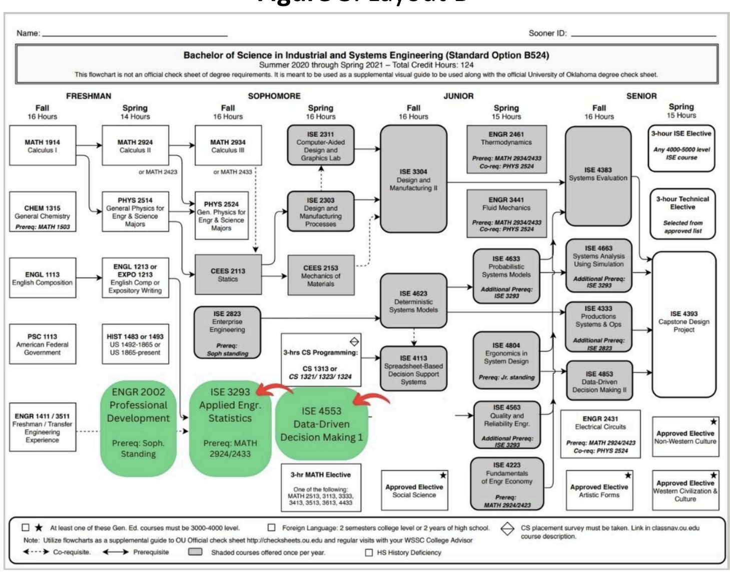
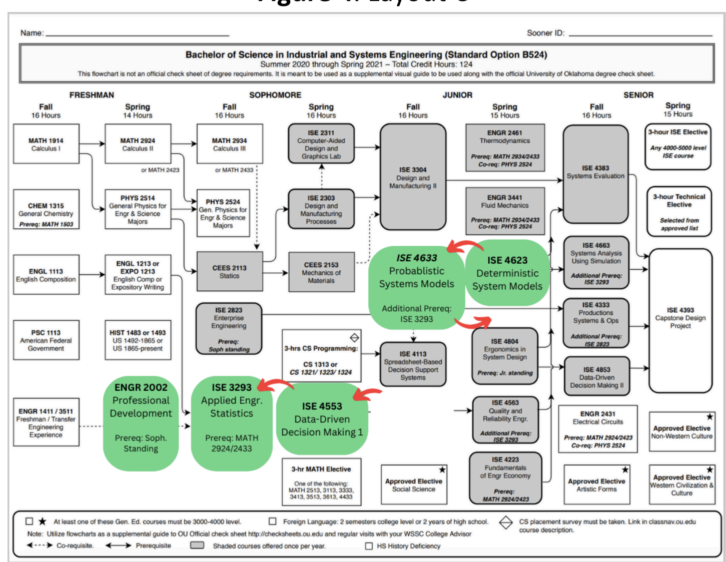


Figure 4. Layout C





A Qualtrics survey was established to measure the various factors contributing to difficulty. The surveys were conducted and distributed online and for ISE junior and senior students.

Refer to ***Appendix B*** *for all questions in the delivered format.*

3.5 Task & Procedure

As priorly discussed, participants were shown graphical representations of alternative degree layouts including the control. Layout differences were highlighted in red and green to assist with recognition. Following these layout graphics, were the survey questions exploring background and academic standing questions, followed by our designed experimental constructs related to perceived layout difficulty, burnout, preference, and graduation rate metrics. Other constructs included workload intensity, failure rate, and study hours. Qualitative text-entry questions were embedded into the survey for engagement, helping aid the researchers in relevant contextuality. The survey was designed for 10-15 minute completion; data was exported from Qualtrics to Excel for analysis and was analyzed in R.

3.6 Variables

The decision to use subjective measures is grounded in our existing literature, which emphasizes the value of perceived workload in order to understand cognitive demand. For example, Thornby, Brizzou, and Chen (2023) highlighted that reporting the experiences of students and their workload, rather than solely considering the scale of an objective task, is essential to keep students balanced and engaged. In Zuo's et al. (2021) research, perceived academic workload correlated to cognitive engagement and performative outcomes, especially in online learning. Chakladar and Roy (2024) mentioned the importance of tools, such as NASA-TLX for gathering self-reported, subjective data. The articles overall emphasize the importance of utilizing survey data to capture the nuanced ways in which students interpret and experience difficulty among the current ISE degree flow plan. Two main genres of variables were used in this study: layout and semester variables. The four layout variables included layout difficulty, layout workload intensity, layout preference, and layout graduation rate. All layout variables had the same four treatment levels; namely, Default Layout, and Layout A, B, and C. See **Figures 1** through **4** for visuals of these layouts.

Similarly, the three semester variables were workload intensity, failure percentage, and weekly hours worked during the semester; the same four treatment levels were used, being sophomore fall, sophomore spring, junior fall, and junior spring. These semesters only applied to the control. Furthermore, all data collected were related to the participants' subjective ratings of each of the variables as outlined in **Table 1** and **2**.

Table 1. Layout and Semester Variables

Layout Variables	Semester Variables
Difficulty	Difficulty
Workload Intensity	Preference
Preference	Graduation Rate
Graduation Rate	

Table 2. Layout and Semester Treatment Levels

Layout Treatment Levels	Semester Treatment Levels
Current State	Sophomore Fall
Layout A	Sophomore Spring
Layout B	Junior Fall
Layout C	Junior Spring

3.7 Data Analysis

Experiment Design

A within-subjects design was used over 13 participants. Due to Qualtrics limitations, counterbalancing was negated, and two mathematical models were made in accordance with our two variable genres: degree layouts and degree semesters shown in **Figures 5a** and **5b**.

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij} \qquad \forall\ k$$

Y_{ij} = The rated $Layout\ Variable_k$ of this degree layout by participant i for proposed layout j

μ = The overall average of $Layout\ Variable_k$

τ_i = Participant effect

ε_{ij} = Random unattributable error

$Layout\ Variable_k$ = {Difficulty, Workload Intensity, Preference, Graduation Rate}

i = Participant index $\quad i \in \{1, 2, \dots, 13\}$

j = Degree layout index $\quad j \in \{1, 2, 3, 4\}$

k = Layout Variable index $\quad k \in \{1, 2, 3, 4\}$

Figure 5.1. Mathematical Model for Layouts

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij} \qquad \forall\ k$$

Y_{ij} = The rated $Semester\ Variable_k$ of this semester participant i for semester j

μ = The overall average of $Semester\ Variable_k$

τ_i = Participant effect

ε_{ij} = Random unattributable error

$Semester\ Variable_k$ = {Workload Intensity, Est. Percent Fail, Weekly Hours Worked}

i = Participant index $\quad i \in \{1, 2, \dots, 13\}$

j = Semester index $\quad j \in \{1, 2, 3, 4\}$

k = Semester Variable index $\quad k \in \{1, 2, 3, 4\}$

Figure 5.2. Mathematical Model for Semesters

Statistical Tests

To investigate statistical significance, Shapiro Wilk, Friedman, and ANOVA tests were used, and the statistical testing pipeline is shown in **Figure 6**. All treatment levels from every variable were initially tested for normality via the Shapiro-Wilk test.

If even one treatment level within that variable was shown not to be normally distributed ($p < .05$), then the entire variable was subjected to the Friedman test. This is in order to test the equality of the medians between the treatment levels of that variable with its hypothesis shown in **Figure 7.1**.

However, if all of the treatment levels within the variable were assumed to be normally distributed ($p > .05$), then the entire variable used ANOVA. This is in order to test the equality of the means between the treatment levels of that variable. The formal hypothesis for this test is shown in **Figure 7.2**.

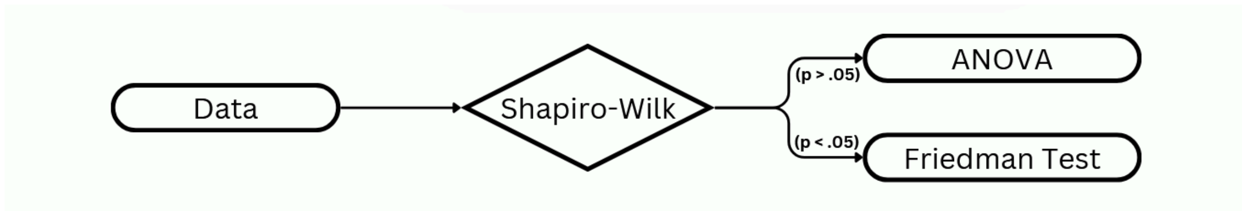


Figure 6. Statistical Testing Pipeline

$$Ho: \ \mu_{Current} = \mu_{Layout\ A} = \mu_{Layout\ B} = \mu_{Layout\ B} \quad \forall\, k$$
$$Ha: \ \mu_{Current} = \mu_{Layout\ A} = \mu_{Layout\ B} = \mu_{Layout\ B} \quad \forall\, k$$

Figure 7.1. Parametric Data Hypothesis (ANOVA)

$$Ho: \ m_{Current} = m_{Layout\ A} = m_{Layout\ B} = m_{Layout\ B} \quad \forall\, k$$
$$Ha: \ m_{Current} = m_{Layout\ A} = m_{Layout\ B} = m_{Layout\ B} \quad \forall\, k$$

Figure 7.2. Nonparametric Data Hypothesis (Friedman Test)

4 Results

Before running the statistical testing pipeline, descriptive statistics were generated and plotted using boxplots. These are shown in **Figures 8** and **9**.

Figure 8. Layout Boxplots

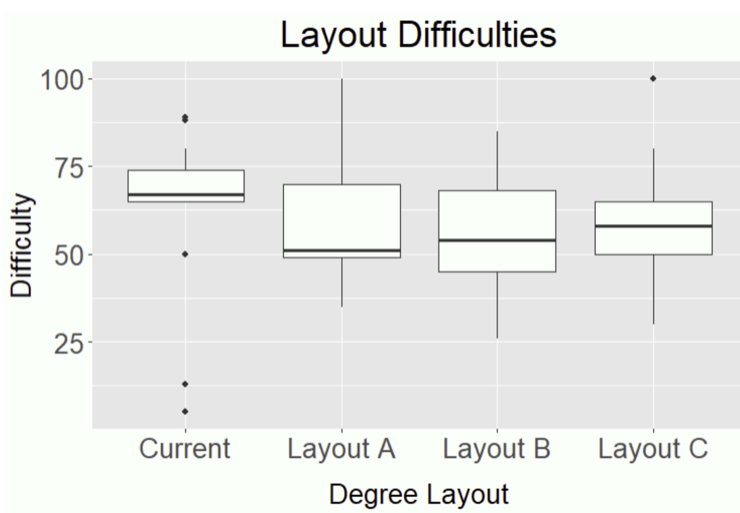


Figure 8.1. Layout Difficulties

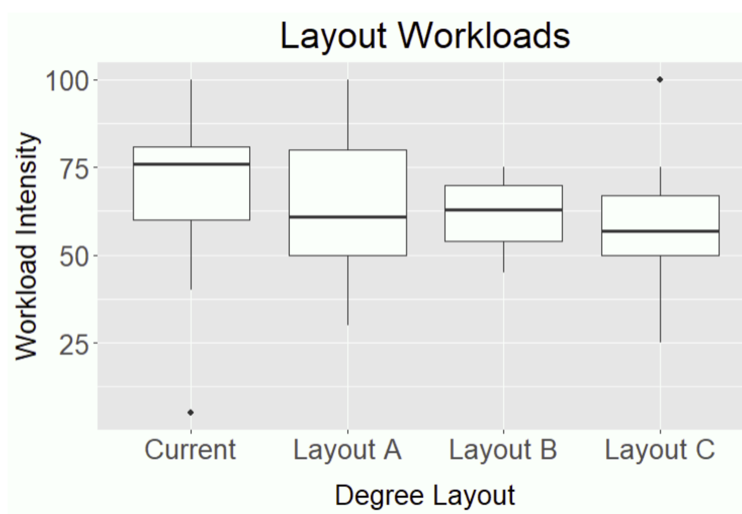


Figure 8.2. Layout Workloads

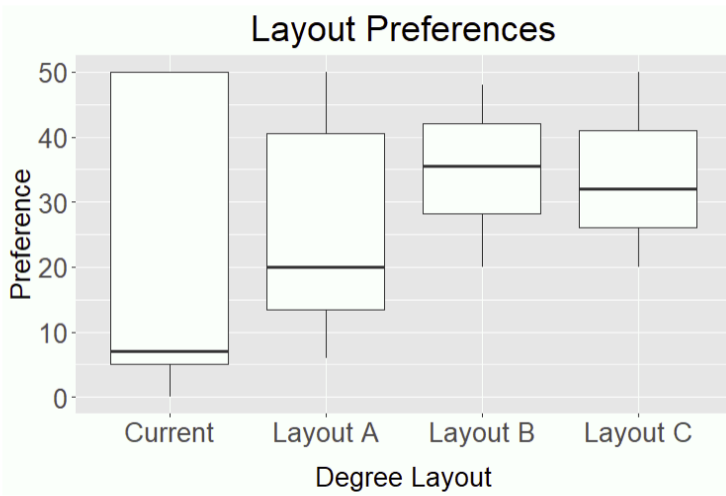


Figure 8.3. Layout Preferences

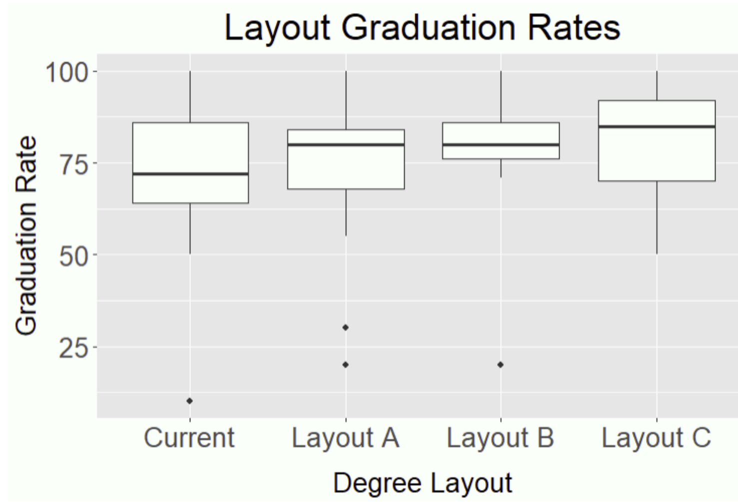


Figure 8.4. Layout Graduation Rates

Figure 9. Semester Boxplots

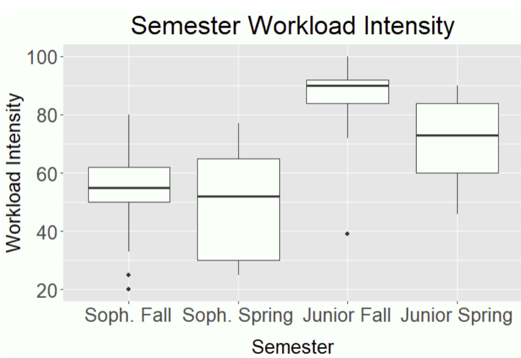


Figure 9.1. Semester Work Intensity

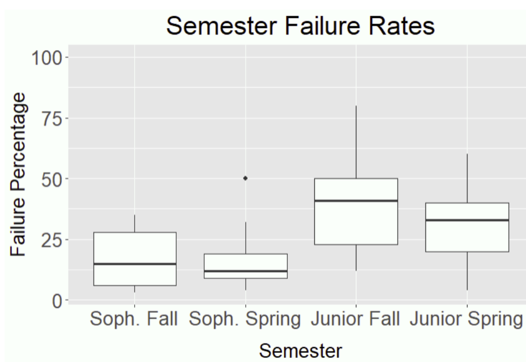


Figure 9.2. Semester Failure Rates

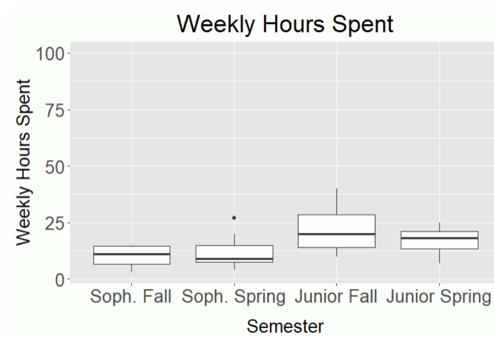


Figure 9.3. Semester Weekly Hours

After, the statistical testing pipeline was followed (see **Figure 6**) by testing for normality first using the Shapiro-Wilk test. Found, were the following variables to be non-parametrically distributed below.

Table 3. Nonparametric Treatment Levels

Variable	Specific Treatment Level	Shapiro-Wilk p Value
Layout Difficulty	Current Layout	0.008
Layout Graduation Rate	Layout A	0.030
Layout Graduation Rate	Layout B	0.001
Semester Workload Intensity	Junior Fall	0.003

Student Percent Fail	Sophomore Spring	0.010

This list forms the basis for knowing which variables to apply the Friedman's test in (see **Table 4**), distinct from ANOVA (see **Appendix A**). Upon applying the appropriate statistical test, the final results are shown below.

Table 4. Layout and Semester Results

Variable	Test	P Value	Significant (P<.05?)
Layout Difficulty	Friedman's	0.207	No
Layout Workload Intensity	ANOVA	0.704	No
Layout Preference	ANOVA	0.146	No
Layout Graduation Rate	Friedman's	0.023	Yes
Semester Workload Intensity	Friedman's	< 0.001	Yes
Semester Percent Fail	Friedman's	< 0.001	Yes
Semester Weekly Hours Worked	ANOVA	0.002	Yes

This suggests some semesters are more difficult than others, yet all of the proposed layouts for mitigating this problem have been rated by the students to be essentially the same. With this paradox, a detailed discussion is needed.

5 Discussion

As previously noted, the junior fall semester is deemed to be the most challenging semester. In terms of workload intensity, anticipated percent failure, and weekly hours worked, our semester-level results showed that this aligns with our previous observations. Specifically, junior fall consistently emerged as the most demanding period, with statistically significant differences found in workload intensity ($p < .001$), percent fail ($p < .001$), and weekly hours worked ($p = .002$) (see **Table 4**). Our findings also align with what Thornby, Brizzou, and Chen (2023) described about cognitive workload contrasting cognitive capacity and external demands, potentially leading to memory overload and decreased learning engagement.

As a response, we designed four different layouts of the course chart, first being the Default Layout and the alternative layouts A, B and C. Our goal was to distribute student workload evenly, as we expected to see differences in layout's difficulty, workload intensity, preference, and graduation rate.

Surprisingly, only the graduation rate showed a significant difference among all the layouts (p = .023); other layout-related outcomes such as layout preference, layout workload intensity, and layout difficulty, were not statistically different (see **Table 4**).

Multiple interpretations can be derived from the results. The first explanation is that while our participants have priorly acknowledged the challenges entailing junior fall semester, they may be incapable of seeing our proposed layouts as resolving the issue. Their layout evaluations might be affected by anchoring, status quo bias, or personal preference of the participant unrelated to workload. Due to anchoring cognitive biases, participants may tend to rely heavily on the first pieces of information: here the default or control layout would be the anchor, for decision making purposes. Dually, due to status quo bias (another cognitive bias), participants may prefer to keep things how they are rather than positively replacing them with alternatives. The "better" potential alternatives include Layouts B, C and D. Another interpretation is that redesigned layouts may not significantly decrease cognitive load given that workload intensity was translated directly to earlier semesters, or that minor adjustments in the course flow don't yield high significance.

This result is shown in Das Chakladar and Roy's (2024) differentiation of intrinsic, extraneous, and germane cognitive load. It's likely our redesigned layouts prioritized intrinsic load (course difficulty) while failing to promote germane load (e.g., scaffolding for understanding) or successfully minimize extraneous load (e.g., presentation or timing of information). Similarly, Zuo et al. (2021)

pointed out how crucial it is to match workload to developmental readiness. Participants would have thought that sequencing and learning scaffolds were just as challenging if our layouts had not addressed them visually.

We consider methodological limitations such as our smaller sample size (n = 13) as our power to detect detailed, subtle differences among different layouts remains limited. Counterbalancing was not utilized, potentially introducing order effects or response biases. Given these possibilities, it's interesting that participants rated all different layouts similarly in difficulty and other measures but regarding graduation rate, our participants perceived some differences between degree layouts. We consider there's a distinction between perceived burden and outcome feasibility. Therefore, participants might be open to tolerating a difficult course flow if they believe it can lead to timely graduation. This translates into a complex trade-off between workload and perceived benefit.

Overall, our results revealed a tension between identifying curriculum challenges and evaluating alternative layouts. Participants are aware of junior fall's difficulties but are unwilling to accept new layout designs that might decrease the burden. This may or may not reflect ineffective layout designs or participant's judgment biases. Future research should incorporate larger sample sizes, objective workload indicators, and validated cognitive load instruments such as the NASA-TLX (Das Chakladar & Roy, 2024) to more rigorously evaluate curriculum design and its impact on the student experience.

6 Limitations & Future Research

The following limitations of our research would be the relevancy to apply our data towards degree reform and Cognitive Load Theory. Specifically, our survey responses apply to the student experiences of an outdated degree flowchart, and doesn't consider the addition of newer courses such as "Systems Thinking" (ISE-4302) and the removal of "Physics for Engineers II" (PHYS-2524), “Electrical Circuits” (ENGR-2431), “Thermodynamics” (ENGR-2461), and “Fluid Mechanics” (ENGR-3441). Hence, it conflicts with future perceived workload as well as other metrics observed —developing other biases potentially negating the necessity for degree reform given the addition of a new ISE course.

Another limitation concerns participant recruitment and communication. For example, after reaching out to 35 participants (a majority of the current ISE juniors and seniors in their respective cohort), only 13 responded and fully completed the survey properly. There were a total of 17 responses, with four responses left incomplete under our Qualtrics ‘Results’.

Future research prompts clearing the disparity of data collection to not only a larger sample size, but for gathering relevant, dated survey responses of future ISE upperclassmen and their perception of cognitive workload of the current 2024 degree flow plan. Additionally, rather than modeling a survey after the NASA-TLX, directly administering the validated NASA-TLX tool may yield more precise and relevant subjective workload data.

7 Reference List

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8 Appendices

Appendix A. Shapiro Wilk showing Normally Distributed Variables

Variable	Specific Treatment Level	Shapiro-Wilk p Value
Layout Difficulty	Layout A	0.259
Layout Difficulty	Layout B	0.999
Layout Difficulty	Layout C	0.604
Layout Workload Intensity	Current	0.0758
Layout Workload Intensity	Layout A	0.583
Layout Workload Intensity	Layout B	0.403
Layout Workload Intensity	Layout C	0.796
Layout Preference	Current	0.118
Layout Preference	Layout A	0.353
Layout Preference	Layout B	0.434
Layout Preference	Layout C	0.313
Layout Graduation Rate	Current	0.108
Layout Graduation Rate	Layout C	0.358
Semester Workload Intensity	Junior Spring	0.496
Semester Workload Intensity	Sophomore Fall	0.283
Semester Workload Intensity	Sophomore Spring	0.213
Semester Percent Fail	Junior Fall	0.391
Semester Percent Fail	Junior Spring	0.772
Semester Percent Fail	Sophomore Fall	0.0766
Semester Weekly Hours Worked	Junior Fall	0.545
Semester Weekly Hours Worked	Junior Spring	0.789
Semester Weekly Hours Worked	Sophomore Fall	0.147

Semester Weekly Hours Worked	Sophomore Spring	0.123

Appendix B. All Survey Questions in Delivered Order

The UNIVERSITY of OKLAHOMA

Current standing?

- ○ Freshman
- ○ Sophomore
- ○ Junior
- ○ Senior
- ○ Other

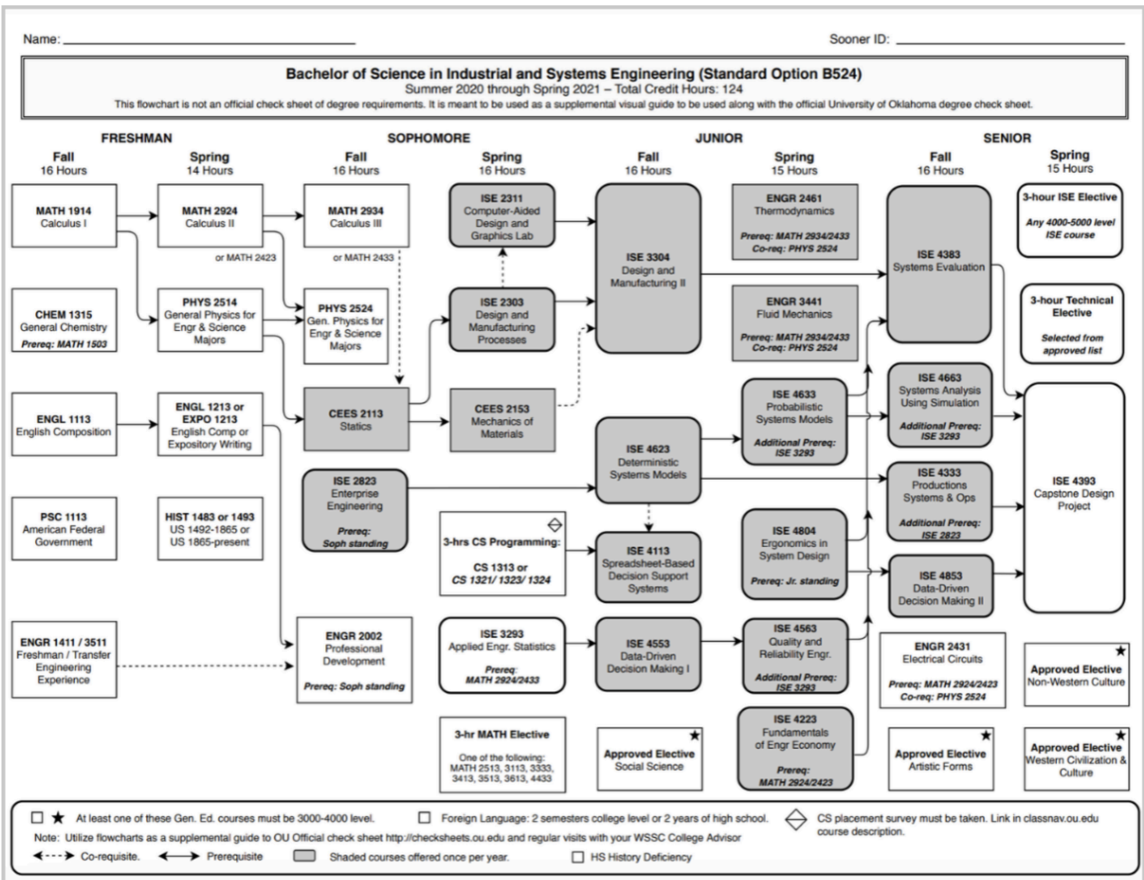
Rate your competence in ISE.

Very incompetent		Somewhat incompetent			Neither competent nor incompetent		Somewhat competent			Very competent
0	10	20	30	40	50	60	70	80	90	100

Competence

What major did you switch from (if any)?

Default Layout



How difficult is the **Default Layout**?

Extremely easy		Somewhat difficult		Neither easy nor difficult			Somewhat difficult			Extremely difficult
0	10	20	30	40	50	60	70	80	90	100

Difficulty

Rate your overall level of burnout: **Default Layout**

0	10	20	30	40	50	60	70	80	90	100

Workload Intensity

Rate your anticipated level of burnout: **Layout A**

0 10 20 30 40 50 60 70 80 90 100

Workload Intensity

What would you expect the graduation rate to be for **Layout A**?

0 10 20 30 40 50 60 70 80 90 100

Graduation Rate

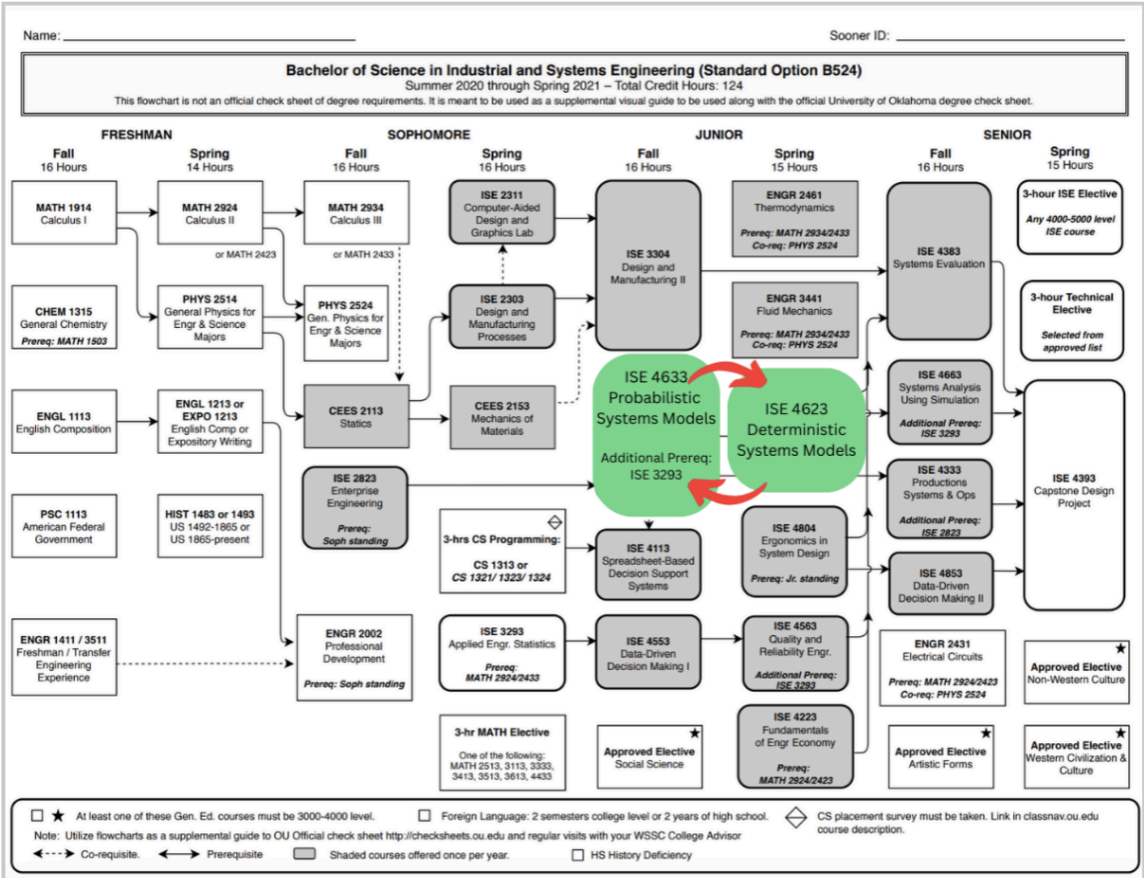
Layout B - AES → DDDM1 moved back a semester

Name: ________________________ Sooner ID: ____________________

Bachelor of Science in Industrial and Systems Engineering (Standard Option B524)
Summer 2020 through Spring 2021 – Total Credit Hours: 124
This flowchart is not an official check sheet of degree requirements. It is meant to be used as a supplemental visual guide to be used along with the official University of Oklahoma degree check sheet.

FRESHMAN SOPHOMORE JUNIOR SENIOR

Layout A - Swap DSM & PSM



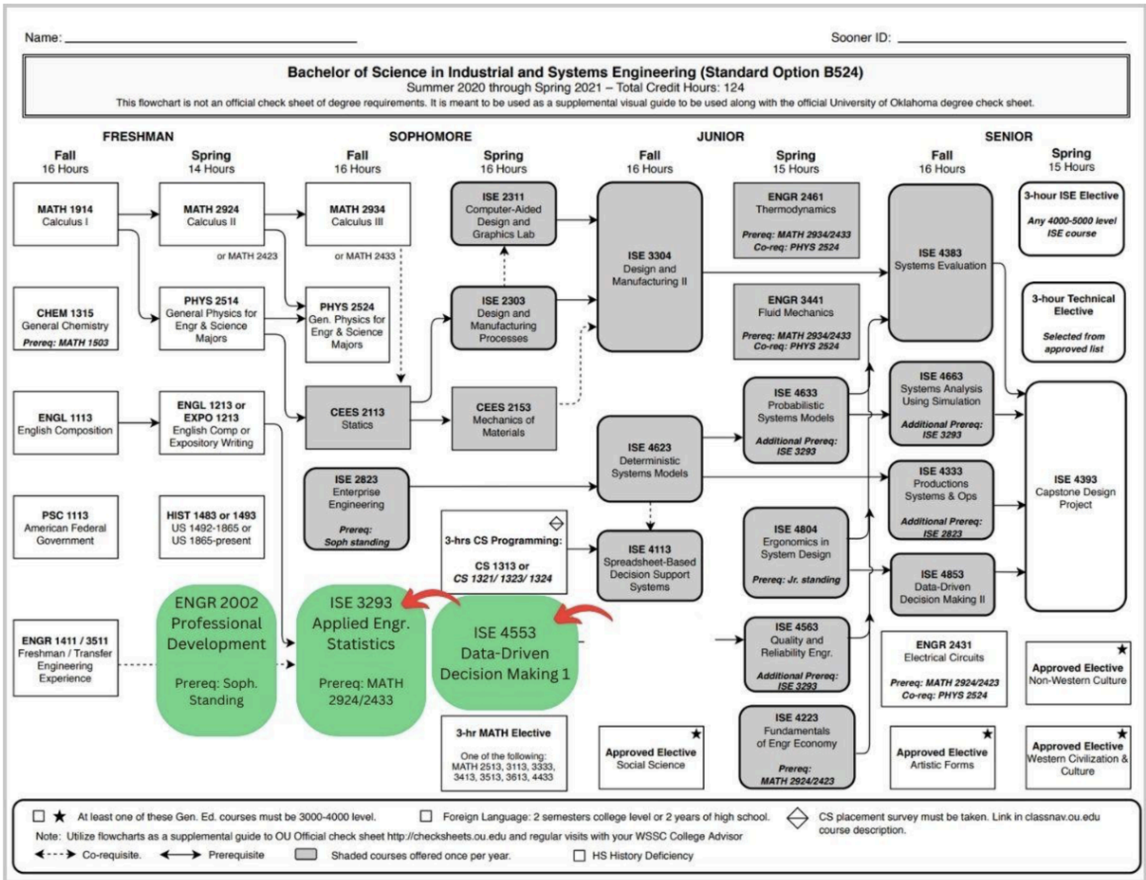
How difficult do you anticipate **Layout A**?

Extremely easy		Somewhat easy		Neither easy nor difficult			Somewhat difficult			Extremely difficult
0	10	20	30	40	50	60	70	80	90	100

Difficulty

Graduation Rate

Layout B - AES → DDDM1 moved back a semester



How difficult do you anticipate **Layout B**?

Extremely easy		Somewhat easy		Neither easy nor difficult			Somewhat difficult			Extremely difficult
0	10	20	30	40	50	60	70	80	90	100

Difficulty

Rate your anticipated level of burnout: **Layout B**

0	10	20	30	40	50	60	70	80	90	100

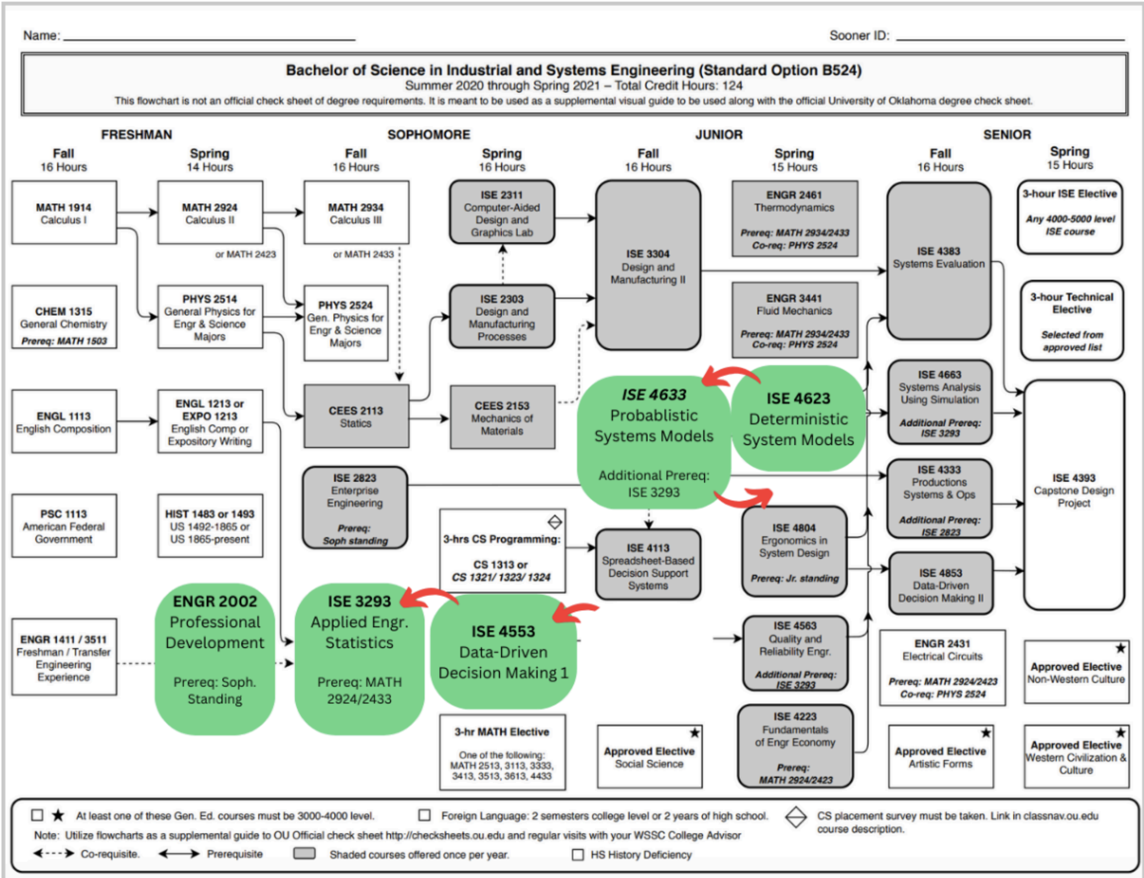
Workload Intensity

What would you expect the graduation rate to be for **Layout B**?

0	10	20	30	40	50	60	70	80	90	100

Graduation Rate

Layout C - Both A & B



How difficult do you anticipate **Layout C**?

Extremely easy		Somewhat easy		Neither easy nor difficult			Somewhat difficult			Extremely difficult
0	10	20	30	40	50	60	70	80	90	100

Difficulty

Rate your anticipated level of burnout: **Layout C**

0 10 20 30 40 50 60 70 80 90 100

Workload Intensity

What would you expect the graduation rate to be for **Layout C**?

0 10 20 30 40 50 60 70 80 90 100

Graduation Rate

Which layout do you prefer?

Percentage

0 10 20 30 40 50 60 70 80 90 100

Default Layout

Layout A

Layout B

Layout C

What would you expect the graduation rate to be for each of the proposed degrees?

Percentage

0 10 20 30 40 50 60 70 80 90 100

Default Layout

Layout A

Layout B

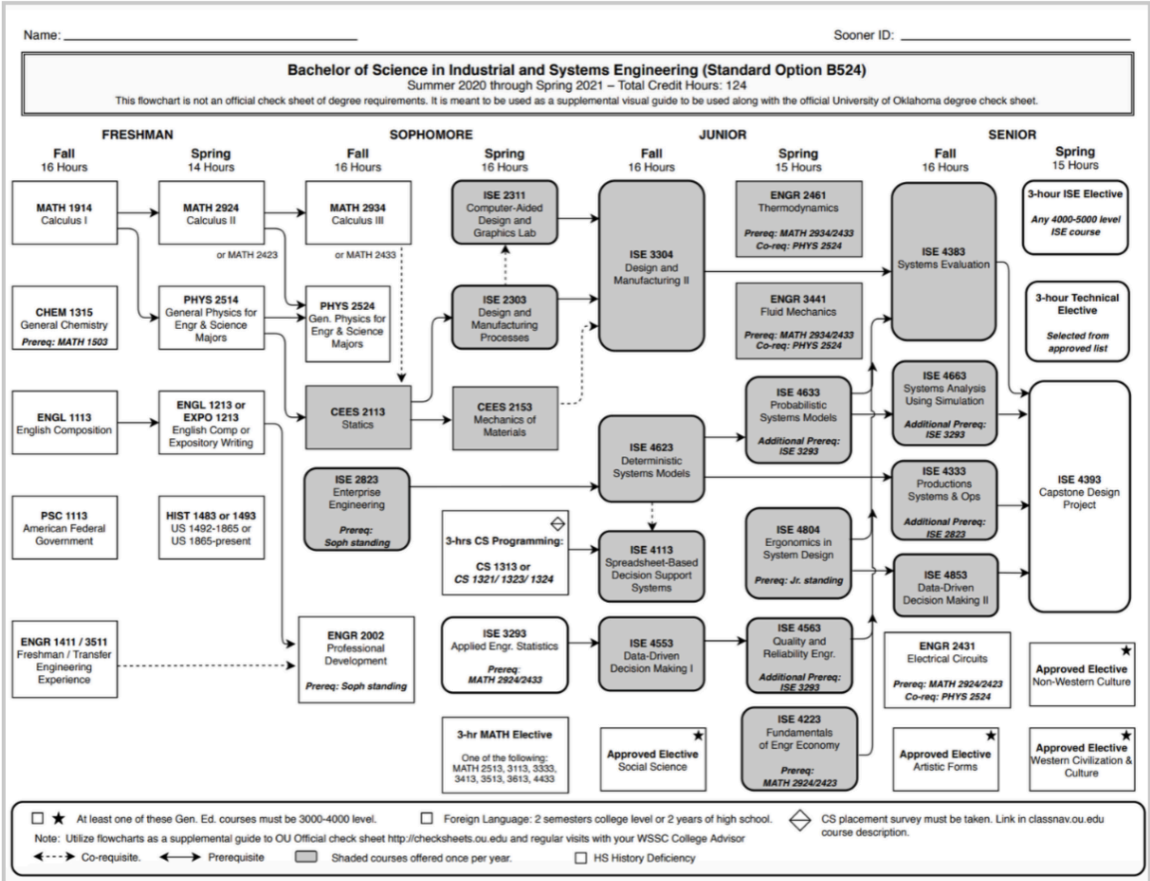
Layout C

If ISE had a mascot, what would it be and why?

Which professor would you want to get drinks with?

If possible, which professor would you like to see do the worm at the ISE Banquet?

Answer the remaining questions using the **Default Layout**.



Rate the intensity of your workload:

0 10 20 30 40 50 60 70 80 90 100

Sophomore Fall

Sophomore Spring

Junior Fall

Junior Spring

What percentage of students do you anticipate failing?

0 10 20 30 40 50 60 70 80 90 100

Sophomore Fall

Sophomore Spring

Junior Fall

Junior Spring

How many hours did you usually work per week?

0 4 8 12 16 20 24 28 32 36 40

Sophomore Fall

Sophomore Spring

Junior Fall

Junior Spring

What are some external factors that have affected your progress toward your degree?

→

Appendix C. Raw Data for Case Study & Survey