Engineering Textbooks as Reference Source for K12 Age-possible Topics

Additional Research Planning Charts

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The details of research planning for the additional work to determine and select K12 age-possible engineering topics from college-level textbooks are explained in Table 1.

Table 1. Research Planning

Color Codes:

Red: The research on the first and second textbooks ("primary source of reference" and "secondary source of reference") has been completed; a combined list of K12 age-possible topics needs to be compiled; and the earliest possible grade for the inclusion of all age-possible topics in the K12 curriculum needs to be determined. This task will take up to 5 working days to complete; it is of secondary urgency but will be completed first due to the relatively small amount of time needed.

Orange: The research on the first textbook ("primary source of reference") and the partial list of age-possible topics has been completed; research on the second textbook ("secondary source of reference") and supplemental list needs to start. This task could take up to 2 months to complete, and it is of secondary urgency.

Blue: The research on possible substitute textbooks for temporary use has been completed; more vigorous textbooks need to be examined. This task could take up to 3 months to complete (up to 5 weeks for the first selected textbook or the "primary source of data" which is of primary urgency; and up to 2 months for additional textbooks which is of secondary urgency).

Green: The research has been planned with the selection of the first textbook ("primary source of reference"), or both the first and second textbooks. This task could take up to 6 months to complete (up to 4 months for the first selected textbook or "primary source of data," which is of primary urgency; and up to 2 months for the second textbook or "secondary source of data," which is of secondary urgency).

Black: The research has been planned; but textbooks need to be selected and studied. This task could take up to 6 months to complete (up to 4 months for the first selected textbook or "primary source of data," which is of primary urgency; and up to 2 months for the second textbook or "secondary source of data," which is of secondary urgency).

Proposed Course/Subject	Research Planning (Days and Logistic Support Needed)				
	Task of Primary Urgency [Max. Number of Days]	Task of Secondary Urgency [Max. Number of Days]	Acquisition of Textbooks and Solutions Manuals		
			1	2	3
Engineering Foundation					
Statics for K12	N/A	10	N/A	N/A	N/A
Dynamics for K12	20	10	N/A	N/A	N/A
Strength of Materials for K12	20	10	✓	N/A	N/A
Engineering Materials for K12	N/A	1	N/A	N/A	N/A
Probability & Statistics for K12	N/A	1	N/A	N/A	N/A
Engineering Economics for K12	N/A	1	N/A	N/A	N/A
Mechanical Engineering					
Mechanical Design for K12	30	30	✓	✓	N/A
Fluid Mechanics for K12		10	N/A	✓	N/A
Aerodynamics for K12	20	10	✓	✓	N/A
Heat Transfer for K12	20	10	✓	✓	N/A
Thermodynamics for K12	20	10	✓	✓	N/A
Engineering Technology					
Manufacturing Processes for K12	N/A	1	N/A	N/A	N/A
Civil Engineering					
Introduction to Computerized Civil Engineering Design for K12	20	10	✓	✓	N/A
Introduction to Global Positioning System & Land Surveying for K12	N/A	1	N/A	N/A	N/A
Introduction to Structural Design for K12	20	10	✓	✓	N/A

Electrical Engineering					
Introduction to Electrical & Electronics Devices for K12	20	20	N/A	✓	✓
Introduction to Circuit Analysis & Simulation for K12	20	10	N/A	N/A	N/A
Total Number of Days/Months Needed	**210 [Days]** or **10.5 [Months]**	**155 [Days]** or **7.75 [Months]**	10.5 + 7.75 = 18.25 [Months]		

The Maximum Amount of Time and Budget Needed for

The Completion of the Additional Research

The following are details of the maximum amount of time and budget needed for the completion of the additional research:

(1) Based on past experience dealing with the textbooks on the subjects of statics and fluid mechanics, up to 30% of the amount of time needed for the research is spent on typing formulas; the rest of task takes about 70% of the amount of time needed.

(2) The maximum total amount of time needed for the completion of both or either of the Tasks of Primary Urgency and of Secondary Urgency, with an estimate based on either an eight-hour day, five-days per week (or forty hours per week) system, or on a sixty hours per week (or 1.5 times regular workload per week) system, are listed on the Table 2 below.

Table 2. The maximum amount of time needed

Task to be Completed	**Total Maximum Amount of Time Needed**			
	Including Typing Formulas		**Without Typing Formulas**	
	Estimate Based on a 40 Hours per Week System	**Estimate Based on a 60 Hours per Week System**	**Estimate Based on a 40 Hours per Week System**	**Estimate Based on a 60 Hours per Week System**
Both Tasks of Primary Urgency and of Secondary Urgency	18.25 [months] or 1.5 years	18.25 [months] ÷ 1.5 = 12.16 [month] ≈ 12 [months] or 1 year	18.25 [months] × 0.70 ≈ 12.78 [months] or approximately 1 year plus 1 month	12.78 [months] ÷ 1.5 = 8.52 [month] ≈ 9 [months]
Task of Primary Urgency only	10.5 [months]	10.5 [months] ÷ 1.5 = 7 [month]	10.5 [months] × 0.7 ≈ 7.5 [months]	7.5 [months] ÷ 1.5 = 5 [months]
Task of Secondary Urgency only	7.75 [months]	7.75 [months] ÷ 1.5 = 5.16 [month] ≈ 5 [months]	7.75 [months] × 0.7 ≈ 5.5 [months]	5.5 [months] ÷ 1.5 = 3.67 [month] ≈ 4 [months]

From the above Table 2, the budget for the completion of the entire or part of the additional research will correspond to the scope of research and could be based on the salary of a full-time curriculum development specialist or a college professor. Please note that the estimate of the time needed is the "maximal" amount comfortable enough for the completion of the research work; and the actual amount of time needed might be as low as 75% of the estimate amount, and will be billed upon completion of the research. A request for a research grant will be made based on the "maximal" amount; and the remainder of the budget could be spent on

(A) **Additional research**: On college-level engineering textbooks related to some subjects such as (a) Introduction to Electrical & Electronics Devices for K12 and (b) Introduction to Robotics & Programming for K12, and/or others if deemed necessary, in order to make the research more comprehensive. These textbooks might include those used in the following courses taught at California State University, Los Angeles, to extract additional

K12 age-possible topics: (a) Electrical Engineering 304 (Electric Machines), (b) Electrical Engineering 336 (Electronics), (c) Electrical Engineering 244 (Digital Engineering), and (d) Electrical Engineering 345 (Microcomputer Engineering).

(B) **The development of a separate K12 engineering and technology instructional materials website**: This new website could be temporarily called K12EngineeringDeal.com, which could include (a) development of the interface; (b) selection and recommendation of K12 age-appropriate engineering and technology textbooks already available in the marketplace; (c) construction of the links to carefully selected and codified FREE online instructional materials on websites related to K12 engineering and technology curriculum, (d) development of supplementary instructional materials as appendages to selected FREE online K12 engineering and technology instructional materials; and (e) development of a few standard or "model" sets of FREE Online K12 engineering and technology instructional materials, using similar formats as those used in standard high school physics and chemistry textbooks, with "plain English" and technical illustrations, PowerPoint classroom presentations, test banks with homework assignment and step-by-step solutions, online graphical user interfaces for engineering computations, manuals for hands-on engineering activities, videos and other materials suitable for K12 students, for the subjects for which no K12 level age-appropriate engineering instructional materials are available.

(3) For the task of typing formulas in the research data tables, based on the rough estimate of the numbers of formulas to be typed from several college-level engineering textbooks, and on a timed typing exercise, it takes about 2 minutes for typing and checking one formula, and an average of about 8 working days for one textbook in the "Task of Primary Urgency" category, and about 4 working days for one textbook in the "Task of Secondary Urgency" category. For the completion of the additional research, there are 10 textbooks in the "Task of Primary Urgency" category in need of 40 student volunteers, and 12 textbooks in the "Task of Secondary Urgency" category in need of 30 student volunteers; each student volunteer will contribute 2 days to work on typing formulas; in exchange, participating students could be given credit in the Acknowledgment page of the SCHOLAR STEAM K12 Plus website, issued a Certificate of Research Participation together with a Letter of Recommendation, attend a three-day FREE workshop to learn how to type formulas in Microsoft Word, to build a portfolio website using the Weebly hosting service and to use Adobe Photoshop software to create digital photographic works artistic enough for the purpose of engineering and technology design presentations with high professional quality comparable to those found in the SCHOLAR STEAM K12 Plus website; in this case, I will request a local community college in Southern California to provide a computerized classroom with Microsoft Word and Adobe Photoshop software programs and Internet access. Student volunteers' websites will also be linked from the SCHOLAR STEAM K12 Plus website. In addition to research credit, FREE professional training, and website linkage, student volunteers will be given a stipend of $200 (for a total maximum amount of $14,000) if a grant is made available for the completion of the additional research. The Table 3 below lists the amount of time needed for typing formulas from several textbooks.

Since one of the primary goals of the Vision Paper is to solve the problem of under-representation of some minority group as well as women of all ethnic groups, affirmative

action policy will be applied in the recruitment of student volunteers to make sure that all under-represented ethnic groups and both genders are represented.

Table 3. The amount of time needed for typing formulas

Subject	Textbook	Number of Days Needed for Typing Formulas
Engineering Foundation		
Dynamics for K12	Vector Mechanics for Engineers Dynamics by Ferdinand P. Beer, Russell Johnston, Jr., and William E. Clausen, McGraw-Hill Higher Education, 2003 (ISBN 0-07-293079-9)	$(695[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) \approx 2.90[\text{days}]$ Adding a margin for double-checking: $(2.90[\text{days}])(150\%) = 4.34[\text{days}] \approx 5[\text{days}]$
	Engineering Mechanics Dynamics, 6th Edition by J. L. Meriam and L. G. Kraige, and published by Wiley, 2006(ISBN 0-471-73931-6)	$(1085[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) \approx 4.52[\text{days}]$ Adding a margin for double-checking: $(4.52[\text{days}])(150\%) = 6.75[\text{days}] \approx 7[\text{days}]$
Strength of Materials for K-12	Mechanics of Materials, 4th Edition, by Ferdinand P. Beer, E. Russell Johnston Jr., and John T. DeWolf, McGraw-Hill Higher Education, 2005 (ISBN-13: 978-0-07-298090-5)	$(840[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.5[\text{days}]$ Adding a margin for double-checking: $(3.50[\text{days}])(150\%) = 5.25[\text{days}] \approx 5[\text{days}]$
	Mechanics of Materials, 6th Edition, by R. C. Hibbeler and published by Pearson Prentice Hall, 2004 (ISBN 0-13-191345-X)	$(780[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.25[\text{days}]$ Adding a margin for double-checking: $(3.25[\text{days}])(150\%) = 4.875[\text{days}] \approx 5[\text{days}]$
Mechanical Engineering		
Aerodynamics for K12	Introduction to Aeronautics A Design Perspective, 2nd Edition, by Steven A. Brandt, Randall J. Stiles, John J. Bertin, and Ray Whitford, American Institute of Aeronautics and Astronautics, 2004 (ISBN 1-56347-701-7)	$(775[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.23[\text{days}]$ Adding a margin for double-checking: $(3.23[\text{days}])(150\%) = 4.84[\text{days}] \approx 5[\text{days}]$
Mechanical Design for K12	Fundamentals of Machine Elements, 2nd Edition, by Bernard J. Hamrock, Steven R. Schmid, and Bo Jacobson, McGraw-Hill Higher Education, 2004 (ISBN 0-07-297682-9)	$(1600[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 6.67[\text{days}]$ Adding a margin for double-checking: $(6.67[\text{days}])(150\%) = 10[\text{days}]$
	Machine Design An Integrated Approach by Ansel C. Ugural, McGraw-Hill Higher Education, 2003 (ISBN 0-07-242155-X)	$(1250[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 5.21[\text{days}]$ Adding a margin for double-checking: $(5.21[\text{days}])(150\%) = 7.81[\text{days}] \approx 8[\text{days}]$
	Design of Machine Elements, 8th Edition, by M. F. Spotts, T. E. Shoup, and L. E. Hornberger, Pearson Prentice Hall, 2003 (ISBN 0-13-048989-1)	$(910[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.79[\text{days}]$ Adding a margin for double-checking: $(3.79[\text{days}])(150\%) = 5.69[\text{days}] \approx 6[\text{days}]$
	Mechanical Engineering Design, 7th Edition, by Joseph E. Shigley, Charles R. Mischke, and Richard G. Budynas, McGraw-Hill Higher Education, 2003 (ISBN 0-07-292193-5)	$(1750[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 7.29[\text{days}]$ Adding a margin for double-checking: $(7.29[\text{days}])(150\%) = 10.93[\text{days}] \approx 11[\text{days}]$
	Shigley's Mechanical Engineering Design, 8th Edition, written by Richard G. Budynas and J. Keith Nisbett, McGraw-Hill Higher Education, 2006 (ISBN 978-0-07-312193-2)	$(1790[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 7.46[\text{days}]$ Adding a margin for double-checking: $(7.46[\text{days}])(150\%) = 11.19[\text{days}] \approx 11[\text{days}]$
Electrical Engineering		

Introduction to Circuit Analysis & Simulation for K12	Basic Engineering Circuit Analysis, 8th Edition, by J. David Irwin and R. Mark Nelms, Wiley, 2004 (ISBN 0-471-48728-7)	$(817[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.40[\text{days}]$ Adding a margin for double-checking: $(3.40[\text{days}])(150\%) = 5.1[\text{days}] \approx 5[\text{days}]$
	Electric Circuit Analysis, 3rd Edition, by David E. Johnson, Johnny R. Johnson, John L. Hilburn, and Peter D. Scott, Prentice Hall, 1997 (ISBN 0-13-252479-1)	$(1830[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 7.63[\text{days}]$ Adding a margin for double-checking: $(7.63[\text{days}])(150\%) = 11.43[\text{days}] \approx 12[\text{days}]$
Introduction to Electrical & Electronics Devices for K12	Electric Machinery, 6th Edition, by A. E. Fitzgerald, Charles Kingsley, Jr., and Stephen D. Umans, McGraw-Hill Higher Education, 2003 (ISBN 13: 978-0-07-366009-7)	$(862[\text{formulas}])\left(\frac{2[\text{minutes}]}{[\text{formula}]}\right)\left(\frac{1[\text{hour}]}{60[\text{minutes}]}\right)\left(\frac{1[\text{day}]}{8[\text{hour}]}\right) = 3.59[\text{days}]$ Adding a margin for double-checking: $(3.59[\text{days}])(150\%) = 5.39[\text{days}] \approx 6[\text{days}]$
$\text{Average Amount of Time Needed} = \frac{(5+7+5+5+5+10+8+6+11+11+5+12+6)[\text{days}]/[\text{book}]}{13}$ $= 7.38[\text{day}] \approx 8[\text{days}]/[\text{book}]$		

(4) Upon completion of the research on each subject, a second professor will review the data table to make sure that all mathematics, physics and chemistry pre-requisites are correctly and fully identified for all formulas listed under each section or subsection of the selected textbooks. For the textbooks under the "Mixture of Pre-calculus and Calculus" category, up to 4 days are needed to review one subject; a $1,000 honorarium is proposed for each subject, and a total amount of $13,000 is needed for 13 subjects. For the textbooks under the "Heavily Pre-calculus" and "Heavily Descriptive and Informational" categories, up to 2 days are needed to review one subject; a $500 honorarium is proposed for each subject, and a total amount of $5,500 is needed for 11 subjects. Therefore, the total budget for honorarium is $18,500.

Table 4. Peer review by other professors

Subject in Need of 2 Days for Review by a Second Professor (For)	**Subject in Need of 4 Days for Review by a Second Professor (For "Mixture of Pre-calculus and Calculus" Textbooks)**
Engineering Foundation	
Introduction to STEAM for K12	Statics for K12
Engineering Materials for K12	Dynamics for K12
Probability & Statistics for K12	Strength of Materials for K12
Engineering Economics for K12	
Mechanical Engineering	
Mechanical Design for K12 (engineering technology textbooks)	Mechanical Design for K12 (engineering textbooks)
	Fluid Mechanics for K12
	Aerodynamics for K12
	Heat Transfer for K12
	Thermodynamics for K12
Engineering Technology	
Engineering Graphics, CADD & Product Design for K12	
Manufacturing Processes for K12	
Engineering Programming for K12	
Civil Engineering	
Introduction to Computerized Civil Engineering Design for K12	Introduction to Structural Design for K12
Introduction to Global Positioning System & Land Surveying for K12	
Electrical Engineering	
Introduction to Electrical & Electronics Devices for K12	Introduction to Electrical & Electronics Devices for K12 (Electric Machine and Electronics textbooks)
Introduction to Robotics & Programming for K12	Introduction to Circuit Analysis & Simulation for K12

Capstone Engineering Design and Research	
Capstone Engineering Design and Research	
Total:	
13 subjects	11 Subjects