Constraint Engineering for PCB Design
SYLLABUS

INSTRUCTOR INFORMATION

Instructor: Filbert Arzola

Email: justonerib@yahoo.com

Phone: 626-391-3695

Best time to call: Usually available between 6 p.m. and 9 p.m., Pacific Standard Time. You may leave a message anytime.

PROGRAM DESCRIPTION

Printed circuit board design and engineering is an artform, as well as a booming and promising career opportunity in the world of electronics. Engineering communities and electronic companies around the world are hungry for solutions to unique PCB design issues, which is why just "knowing the basic" isn't always enough. Anyone in this field should strive to continuously build upon and improve their skill sets.

Taught by a process-driven PCB design engineer with more than 30 years of experience in the electronic and aerospace industry, this three-week program aims to improve the board designs from engineers of varying levels of proficiency. Beginning with the history of PCB design methodologies and the unification of both electrical and mechanical models, this course will teach you how to define, develop, utilize, and maximize a rigorous design constraint process, resulting in easily producible and yield-worthy printed circuit boards suitable for the diverse needs of this vast industry.

LEARNING AND PERFORMANCE OBJECTIVES

This four-week course is developed to allow semi-experienced to senior-level PCB design engineers to improve their ability to organize and properly constrain specific routing, metal and non-metal features of the PCB design to control and improve the unification of electrical and mechanical models and properly engineer your PCB board designs through constraint management. Upon completion of this course, participants will be able to:

- Understand the history of previous PCB design methodologies.
- Understand, develop, and unite both electrical and mechanical models.
- Embrace the producible provided board stack-up.

- Define an SRI for your design to enable the beginning of the constraint process.
- Utilize PCB design "visions" to enable process constraint management practices.
- Identify the design features that need various types of constraints.
- Establish local and global constraint management tools to engineer your PCB designs.
- Develop a methodology of eliminating DRC errors at the start of your PCB design.
- Build and produce non-metal board features to match-model mechanical interface.
- How the PCB fabrication and assembly processes maximize your design constraint process.
- Utilize and apply constraint methodologies for all the defined board design types.
- Use a sample design model to help understand constraint management ideals.

COURSE STRUCTURE

- Instructor and participants meet online twice per week from the comfort of their own home.
- Participants can view recorded online sessions to review course content and class discussions.
- All required materials are included in the course. Participants may utilize a PCB design authoring software program of their choice. If participants do not have access to PCB design authoring software, IPC will provide complimentary access to Altium.
- Course materials are accessible 24/7 on the new IPC Edge Learning Management System.
- The course can be accessed on virtually any device with an Internet connection and major web browser, including Chrome, Firefox, Safari, Edge, and Internet Explorer.

SUPPLEMENTAL MATERIALS

- *Printed Circuits Handbook* (Clyde F. Coombs, McGraw-Hill)
- *Right the First Time* (Lee W. Ritchey, Speeding Edge)
- *Signal Integrity Issues and Printed Circuit Boards* (Douglas Brooks, Prentice Hall)

IPC STANDARDS COVERED (PROVIDED WITH COURSE)

- IPC-2152: *Standard for Determining Current Carrying Capacity in Printed Board Design*
- IPC-2221: *Generic Standard on Printed Board Design*
- IPC-2222: *Sectional Design Standard for Rigid Organic Printed Boards*
- IPC-2611: *Generic Requirements for Electronic Product Documentation*
- IPC-2612: *Sectional Requirements for Electronic Diagramming Documentation (Schematic and Logic Descriptions)*
- IPC-2612-01: *Sectional Requirements for Electronic Diagramming Symbol Generation Methodology*

COURSE SCHEDULE

WEEK 1

Lecture #1: Baseline Understanding of PCB Design Methodologies, Board Types and Model Development

- Previous outdated constraint methodologies
- Current state of constraint engineering
- Introduction to our electrical and mechanical models
- A sample model to show and set your design constraint goals
- Proactive design stack-up ideals and interface to routing features
- Develop SRI plans to meet electrical and mechanical requirements
- Utilize CM tool and set constraint values to initial values
- Organize and visualize models' unification
- Develop producibility concerns and move to review with producibility SMEs
- Preview all board types and how they make a difference in constraint settings

ASSIGNMENT:

- Review today's lecture and list any questions for the next lecture.

Lecture #2: Local and Global Constraint Management Techniques and Clearing Early Design Rule Errors

- Quick Q&A exchange
- Review the sample PCB Design and discuss constraint opportunities
- Develop actual sample design SRI and constraints
- Stack-up discussion to help visualization of PCB design requirements
- Set the layer routing priorities
- Develop initial via structures and transitions
- Organize constraint features into low, medium, and high groups
- Finalize model unification
- Preview all board types and how they make a difference in constraint settings

ASSIGNMENT:

- Review today's lecture and list any questions for the next lecture.

WEEK 2

Lecture #3: A Review of All Board Types and How Their Design Characteristics and Features Make a Difference in Constraint Settings

- Quick Q&A exchange
- Board types have a basic grouping ranging from simple to complex

- The Basic types include one-, two- and multi-layer "CCA" designs
- The complex types include RF, chip-on-board, wire-bond, and mixed-signal designs
- Organize, specify and restrict constraint settings/ideals per board types
- Build overlapping and specialized constraints
- Utilize electronic design notebook and constraint settings output files
- Producibility drives constraint methodologies
- Stack-up features and requirements are the main difference drivers of board type designs
- Consider locking down board type groupings with respect to model unification

ASSIGNMENT:

- Complete Lecture #3 Questionnaire. Discuss solutions during Lecture #4.

Lecture #4: Understanding Constraint Management Features and Importance of Solid Initial Settings and Routing Priorities

- Questionnaire discussion
- Discussion of constraint management features to define routing priorities
- Examine the Bill of Materials for possible constraints issues
- Forecast local/global/hot zone constraint settings
- Define mechanical model routing constraint O&M features
- Define electrical model grounding features and constraint requirements
- Baseline specific component and component areas for individualized constraint rules
- Finalize initial constraint settings and review with producibility SMEs
- Live sample board development

ASSIGNMENT:

- Complete Lecture #4 Questionnaire. Discuss solutions during Lecture #5.

WEEK 3

Lecture #5: Routing Features per Constraints and Robust Elimination of Design Rule Errors

- Questionnaire Discussion
- The reason why constraints can either stop or cause major design errors
- Review and understand BGA-type component constraints (Hint: Red Zone Area)
- Use of thermal ties (wagon wheels) versus constraints ideals
- Understanding power plane routing and power integrity analysis (PIA) requirements to meet power constraint requirements (*Not* a trivial discussion)
- Solder masking methodologies to finalize metal constraints
- Finding errors is not just on the PCB Design Engineer (Design Meetings)
- Schedule a mid-route vendor review of preliminary design data and drawings
- Understanding how all of this affects each board design type (First Look)

ASSIGNMENT:

- Complete Lecture #5 Questionnaire. Discuss solutions during Lecture #6.

Lecture #6: Understanding All Board Type Design Rule Errors While Constraining the Design

- Questionnaire Discussion.
- Understand design rule errors that occur in all board types
- Review of first board and second board grouping design rule errors
- Understanding power plane routing for all board types
- Constraint management is a board saver in terms of time and production
- Document your constraint management strategies for reuse
- Live sample board development

ASSIGNMENT:

- Complete Lecture #6 Questionnaire. Discuss solutions during Lecture #7.

WEEK 4

Lecture #7: Our Model in Action – Let's Review and Work Routing Priorities and Changes to Initial Plan – Part 1

- Questionnaire Discussion
- Review our sample board design as an EE has issued an ECO update
- Focus on CM changes and how to simplify production updating methodologies
- Oh no, the ME now issued an ECO, and it conflicts with the EE ECO
- Focus and work on the issues and set meetings to finalize changes and updates
- Live updates and better understanding of production constraint workings
- Proactive design team meeting to discuss and confirm changes before actual re-work
- Routing is completed so what is the next step?
- Perform final metal and non-metal checks for production release
- Final mechanical model check, including final 3-D check
- Oh no! We have a 3-D issue!

ASSIGNMENT:

- Complete Lecture #7 Questionnaire. Discuss solutions during Lecture #8.

Lecture #8: Our Model in Action – Let's Review and Work Routing Priorities and Changes to Initial Plan – Part 2

- Questionnaire Discussion
- Mechanical 3-D issue
- Further review shows three possible changes and updates to solve the mechanical issue
- Possible Solution #1: Use a different component and remove height and air gap issue

- Possible Solution #2: Move the component (possible development of other routing issues which means more component updates).
- Possible Solution #3: Supply chain issues and assembly kit issues (Now what?).
- The design team must review and decide how updates will be done.
- Finalize the changes and push to release for production.
- Final thoughts

ASSIGNMENT:

- As this is the final class for this course, there is no questionnaire to be completed. However, if there are any specific questions or concerns, please ask or place into the Class Forum and I will review and get you answers and solutions.