

# **Field Application Engineer Training Model**

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## **Executive Statement:**

This practicum is focused on developing a training model for effective instruction and authentic assessment of Field Application engineers within the Power Division of Analog at National Semiconductor. This project is being underwritten by a fellowship grant from IISME, (Industry Initiatives for Science and Math Educators) The ADDIE model is used as a format for this practicum.

## **Corporate Information:**

National Semiconductor is the premier analog company driving the information age. Combining real-world analog and state-of-the-art digital technology, the company is focused on analog-based semiconductor products, which include stand-alone devices and subsystems in the areas of power management, imaging, display drivers, audio, amplifiers and data conversion. The company targets key markets such as wireless, displays, PCs, networks and a broad range of portable applications. With headquarters in Santa Clara, California, National reported sales of \$1.98 billion for its most recent fiscal year.

Analog technologies are the essential link between the digital world of ones and zeroes and real-world phenomena such as light, sound, temperature, speed and pressure. We're the market leader in power management, with a broad portfolio of products ranging from building blocks to application-specific standard products (ASSPs) and sub-systems. Our power products are used in everything from handheld

battery-operated devices to higher-voltage systems such as cars, servers and telecom equipment. For portable devices, National's PowerWise™ initiative promises to quadruple battery life. We're leaders in amplifiers, the critical chips that convert and enhance tiny, delicate real-world analog inputs into signals that can be read and understood by digital systems.

National's chips provide the differentiating features consumers demand in today's cordless and wireless phones. Our leadership in analog and mixed-signal technologies is the key to great sound quality, longer battery life, lighter weight, and smaller size. We're also introducing new innovative solutions, such as our CMOS image capture technology that enables camera/phone combinations. And our white LED drivers enable sharp, full-color, backlit displays.

Thin, light, efficient power are the keys to today's small-footprint flat display screens with unprecedented brightness, color and sharpness. From displays for handheld mobile phones and PDAs, to larger desktop monitors and even flat-panel TV screens, National's analog and mixed-signal components bring bright, high-quality images to the user while saving space and power.

## **Executive Board Job Descriptions/Responsibilities:**

### **CEO: Brian Halla**

The CEO sets financial goals, establishes the core metrics, holds direct reports responsible for performance improvements and dollar savings for investors.

### **Executive VP Central Technology and Manufacturing Group: Kamar Aggarwal**

Mr. Aggarwal runs all of the manufacturing, pre fabrication, fabrication, wafer, and packaging sites. Cost effective measures such as site locations development and production costs are determined by Mr. Aggarwal.

### **CFO: Lewis Chew**

The CFO directly reports to the CEO, board directors, and investors. He is in charge of maintaining and balancing all of the accounting ledgers for the company.

### **Senior Vice President, General Counsel, and Secretary: John M. Clark III**

As National's senior legal officer, Clark's responsibilities include intellectual property, stock administration, worldwide security, government affairs, and community relations.

### **Senior Vice President, Worldwide Marketing & Sales: Detlev Kunz**

The Senior VP of Marketing and Sales is responsible for growing the company by finding sectors within industry that will provide maximal revenue generation.

### **Executive Vice President, Chief Operating Officer and General Manager, Product Lines: Donald MacLeod**

The COO is in charge of all operations with all Senior VP's reporting directly to him.



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**Senior Vice President and Chief Information Officer: Ulrich J. Seif**

The Chief Information Officer is responsible for vision, strategy, direction, guidelines, policies, planning, coordination, and oversight for information technology for all of the executive branch agencies at National. The CIO reports to the CEO, and works with department and IT directors globally.

**Senior Vice President, Worldwide Human Resources: Edward Sweeney**

The senior VP directs the company's human resources programs at all locations for all employees in the areas of recruitment, employment, compensation, classification, performance management, labor relations, training, and organizational development. Mr. Sweeney Oversees employer-sponsored benefit programs for management and employees.

## **Problem:**

FAE's (Field Application engineers) are merging into Power from other areas. National Semiconductor has eliminated divisions that dealt with digital semiconductor components and are focused on all Analog components. Their biggest revenue generators of revenue are components from the Power division (PC's, notebooks, cell-phones, etc)

There are a total of 35 Field Applications engineers; many have little to no background knowledge of various electrical components that work in tangent with the chips inside PC's notebooks or cell-phones. It has been determined by the VP of marketing, and two level three FAE's that the new hires and reshuffled FAE's acquire a baseline understanding of Inductors, Capacitors and Batteries. The justification for this knowledge beyond the specific knowledge of the workings of the various chips is needed to field questions from current customers and potential customers. If there is baseline knowledge, the current engineers can give advice to customers which specific components produced by National will work in conjunction with the inductors, capacitors and batteries.

There are three levels of FAE's in National's organization. The first level of FAE's is either recently out of college, (five years) and has

just entered the sales end of the company as a Field application engineer. These constitute a majority of the employees. The second level of FAE's have been assigned a specific area for a given amount of time and have extensive knowledge of a specific area of National's product line, operability in various products, and interoperability with other types of components. They can develop data sheets for the specific products and are asked to develop data sheets every two years for at least one product. The third level of FAE's is knowledgeable of all products within the National family, can write up data sheets, and are asked to develop training and do instruction for other FAE's.

Power's revenue has gone up from 200M in 2002 to 400M in 2003, with another 50M added due to reorganization of Automotive into Power. The perpetuation of Power's revenue stream can only continue if instruction is in place for baseline components that are relevant to the Power product line.

Individual interviews and surveys of customers have been used to determine the prior knowledge of the Field application engineers. The types of questions that the customers ask the senior field application engineers along with questions of the Field Applications Engineers has allowed senior management explore the necessity for training. The

optimal goal to have all of the current FAE's be proficient in all of the

Power components and baseline knowledge of the workings of

Capacitors, Inductors, and Batteries. Currently, about 20% of the

current FAE's are proficient with Power components and baseline

knowledge of the workings of Capacitors, Inductors, and Batteries.

There is an 80% discrepancy factor that has to be overcome to

increase revenue stream in the competitive market of semiconductor

chips. 90% of the electronic engineers that are National

Semiconductor customers are digital systems designers. They have

little or no skills in analog design. It is the responsibility of the FAE's

to do the analog design for the average analog customers who rely

heavily on National's FAE's for technical support.

There is currently instruction twice a year and online coursework for

the FAE's. The justification to develop a new training model is to

provide authentic assessment to determine baseline knowledge of the

current FAE's and to help design more effective curriculum at a later

date for their twice yearly trainings based on the knowledge needs of

the engineers. The training will be an enhancement to the FAE's

analog knowledge. This knowledge will help the customer in choosing

the correct analog components that will function with National

components, thus maintaining and increasing revenue.

## Scope:

### Project community:

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**Methods:**

Content/Ease of Use Analysis

The needs analysis will be completed using extent data and interviews of Applications Managers and SME's. This is accomplished with the coordination and needs of the Training Coordinator of Americas and the Vice President of Power. The key focus will be on analysis of the usability/functionality of the current Learning Content Management Software, Web Edit Pro from [Ektron](#) . The criteria based for software functionality is dependent on the training model that will be developed, current architecture of the software, and budget constraints. The functionality/usability of the software will be determined by user analysis from the instructional developer, SME's, Power Management, and Engineering Managers.

## Training Analysis

The Subject Matter Expert/Instructor will run an online beta-test of the training module with a select number of FAE's at a later date. System bugs, ease of use will be noted in the training analysis.

### **Instruments:**

Extent Data check sheets:

Two types of extent data check sheets will be required:

- 1.)Ease of use by engineers, and instructors, overall cost analysis by management and amount allocated within the budget.
- 2.)Internet access at home and at work by employees

Interview questionnaires

Interview questionnaires for each of the groups will be required to focus on the following: 1, not satisfied to 5 very satisfied

Instructors

- 1.)How comfortable do you feel with the following LCMS?
- 2.)How easy was it to navigate for instructional development purposes?
- 3.) How easy was it to use the message board to provide feedback for students?
- 4.)Do you feel that the authentic assessment method is worth the extra time to measure FAE understanding?

#### FAE's

- 1.) How comfortable do you feel using Web Edit Pro?
- 3.) Did the scenarios provide enough knowledge to discuss matters with potential customers?
- 4.) Did the instructor give enough feedback to questions?
- 5.) In comparison to a basic performance based assessment, how satisfied are you with this assessment?
- 6.) How easy was it to access information to answer the questions?
- 7.) Did you feel the Rubric for the assessment prepared you for the assessment?

#### Instructors and Management

Instructors will analyze after doing comparative scores on an overall points basis. Instructors will then assess the usability of the training model and LCMS used to deliver it and will make recommendations. Through fiscal analysis, the VP of Power Management will determine feasibility for using the training model throughout Analog University.

#### **Formats:**

The data collection formats will be constructed in an online survey called, [Zoomerang](#) . The results will be given through the software.

## **Project Plan Goal**

The goal of this project is to develop an effective training model that will deliver engaging and relevant instruction to all FAE's within the Power division. The training will also provide authentic assessment to measure baseline knowledge of engineers. The justification for training is to increase the knowledge base of all Field Applications Engineers, thus aiding in the increase in revenue for the company. The Field Applications Engineers play a pivotal role in the organization with their knowledge base. They secure and increase National Semiconductor's accounts.

## Timeline

Start Date: March 10th, 2004

End Date: July 6<sup>th</sup>, 2004

Schedule:	Start	End
Pre-Planning	March 10 <sup>th</sup>	April 22 <sup>nd</sup>
Development	June 2 <sup>nd</sup>	June 18 <sup>th</sup>
Learning Medium 1.0	June 21 <sup>st</sup>	June 24 <sup>th</sup>
Review Template	June 28 <sup>th</sup>	June 28 <sup>th</sup>
Training Module 1.0	June 28 <sup>th</sup>	July 6 <sup>th</sup>
Web Edit Pro Tutorial	June 29 <sup>th</sup>	June 29 <sup>th</sup>
Software Analysis	June 30 <sup>th</sup>	July 6 <sup>th</sup>
SME Collaboration	July 1 <sup>st</sup>	July 6 <sup>th</sup>

## **Training Model**

The training model has been designed after extensive discussion with Edward Lam, Kerry Hunsaker, David Mishler, and Barry Signoretti.

This model was derived from the Bernie Dodge Web quest model and was tailored specifically for the needs of National Semiconductor.

Authentic assessments and the Rubric for the assessment of the training module will be developed at a later date. These components were added to the instructional design process after agreement from management as a best practices format that replaces what currently exists for the online training at National/analog University.

**Intro: (Replaces Online Seminar)** This will involve relevant information about Inductors, something that will grab the attention of the FAE's. For WBT it would be useful to use an Intro in the style of [Bob Pease](#) using National TV, the seminars are too dry and static, not engaging hearing a PPT presentation and just someone speaking, that is not visual learning. Bob Pease does exemplify visual learning for complex material.

Justification for **Intro**: You always need a lead in to grab the audience attention and curiosity. While you have their attention, you can then go over the background of information that they need to know. For the background information, it can be divided up into smaller portions, so the learner/reader can go back and reference it.

**Goal: (Replaces Reading Assignment. This is directly related to the Objective)** The FAE will be given two tasks to accomplish. Task

1: Given a specific product from one of National's top three customer's that contains a new Inductor, from that Inductor, make recommendations of what will be used. Task 2: A potential customer asks the FAE to come in and meet their design engineers, the engineer, from his knowledge in Inductors sees a flaw in the current design. The FAE will make a recommendation on the type of Inductor used that will work with a specific product of National's that they are interested in using. (This was the Task portion of Web quests that I developed.) Example [Human body Webquest](#)

[California Endangered Animals](#)

Here there should be an inclusion of the specific concepts/parts links.

(Product Data Sheets)

Justification for **Goal**: The goals are going to be the measured outcomes of the objective. The reason for using Tasks is to show that they will actually be **doing** something; they have already received their Intro and brief lecture. Extensive research has shown that a good way to actually engage the learner is to have them do a related task.

**Scenario: (Replaces Research assignment)** the material on the Analog U site is fine as it is non-proprietary. For the training of Power FAE's, there will be additions besides Product links, Web Bench, and Product data sheets for Power's Product line. There will be links providing extensive background on [Inductors](#) for example, [specific customer product links](#), (internal with company permission) and specific [customer links](#) for accompanying components. This part was worked on with David Mishler and Sanjay Maniktala. (The writing of the scenarios) It is the [Process](#) portion from the [webquest](#).

Eventually, there should be a total of 10 scenarios, five for Task 1, and five for Task 2. These scenarios could be used for the FAE onsite training. Task 1 will be more difficult, as it is the challenge. The

instructor will aid the students in this task, ask questions and solicit answers within the specific timeline that engages the participants.

Task 2 will be more of a baseline type of task to check student knowledge. See **Assessment** below.

For the online training, each FAE is responsible for one scenario to be completed on his/her own. They will post their results on a message board to be assessed by a Senior FAE. The Senior FAE will serve as their Instructor/Host at the message board site. An example of a message board to be used is: [Pro Boards](#) (it is free of charge) There are [others](#) that can be used, but there is a cost involved.

Upon completion of the two tasks, and the preliminary assessment, the FAE's will be put into collaborative groups, where they will share their results with each other.

This is done on the internal site for the FAE's only.

Justification for **Scenario**: First, a scenario is used to give the learner, whether he/she is a potential hire, existing employee, or somebody transferred into Power a chance to apply their newfound knowledge in a real world situation. Why? If the learner is able to

think critically and achieve the goal of solving the task, it will prepare him/her better to answer questions to the customer.

Being able to show knowledge to the customer will gain customer trust and give the FAE a chance to gain more revenue for the company. All of the accompanying links here will provide the learner quick access to information that will help him/her solve the problem efficiently.

The Message board is used (online and in class) for the learner to answer the assigned scenario in narrative form. This will show the instructor the learner's ability to think on his/her feet and apply what they know for authentic assessment. The instructor will then be able to look at the message board answers and advise in relation to the thought process of the learner. The instructor can also check in and give hints along the way, (1<sup>st</sup> task)

Why two different tasks? The first task will be more difficult to engage and challenge the learner. It will also show a real-world worst case scenario for exposure to all that can happen. This challenge is done to hopefully save time and money at a later date.

The second task is to test baseline competency of the learner. It is simplified to see what the learner has been able to grasp from this lesson.

Why collaborative groups to share results? Extensive research has been done linking productivity to collaboration in the workplace. Open knowledge sharing provides a comfortable and stimulating learning environment whether it is online or in the classroom being facilitated by the instructor.

**Assessment: (Evaluation)** (Not included in analog U, no need as the analog U site is provided for DFAE's and customers.) Assessment could be considered for DFAE's if there is a plan to have a DFAE certification process.

Two types of assessment could take place here. The first type of assessment, which is called real assessment, will be on the results of the 2<sup>nd</sup> task done by the FAE's. The assessor will be the Senior FAE. This assessment can be done with a specific Rubric. A Rubric is set up to measure the expected outcome of the FAE's. There is a free Rubric Generating Site called [Rubistar](#) used by educators. This site

can be used in an industry setting. The template has to be created from scratch. David Mishler will develop the template at a later date. It is possible that part of the following [criteria](#) can aid in the establishment of the rubric.

The second type of assessment is a traditional type of assessment. Give the FAE's an exam on Inductors and determine what the pass level is needed. (This does not have to be used, if "real assessment" is being done.) Also, tests could be considered threatening to the FAE's and produce negative overall performance results. See extension below for an unobtrusive method of assessment where data could be gathered.

Justification for **Assessment**: Two reasons for this kind of assessment. Authentic assessment instead of test-based assessment can measure the learners' ability levels in a real world situation. With the proper software, the training with the assessment combined can replace yearly performance evaluations, thus saving lots of money and time by combining the two. (All that has to be done is have the instructor and manager set up the combined criteria to be measured, Performance (revenue generation) and assessment combined.) This kind of assessment can be done twice a year.

**Extension:** (Replaces Quiz) It is always good to do some sort of extension, other products from Power could be used here. Have them consider other product arenas that can be explored with their new knowledge of inductors and the relationship to the Power Products. Also, some form of soft assessment can be accomplished through [e-games](#) on all of the content relating to the subject at hand. (The e-games calculate and show the scores.)

Justification for **Extension:** The e-games can be used as an unobtrusive empirical assessment in the guise of being fun. One must make the games fun to the target audience though. This is also there for review in case the instructor decides to have the FAE's meet up at later date to be determined to do more tasks in a real world scenario fashion.

## The Training Module (Pre-Beta)

The photos below are web snapshots of the training module.

This snapshot is the current representation of the Intro

**Objective:** FAE's and DFAE's gain a baseline knowledge of power inductors for switching regulators.

**Length:** 120 minutes

### Step(s) to complete

1. View online seminar
2. Complete the suggested assignments
3. Complete the required test for course certification

### Online Seminar: Magnetics: Filling the Gap

**About the Presenter:** Sanjaya Maniktala has over 15 years industry experience, having worked professionally in India, Singapore, Germany and the US for several well-known power supply and semiconductor companies like Artesyn and Siemens. He received his Masters in Physics from the Indian Institute of Technology at Bombay, and from Northwestern University, Evanston in Illinois. He is currently Principal Applications Engineer with National's Power Management Group at Santa Clara.



The "Online Seminar" is the current terminology for the Intro. Here is the representation of the Online Seminar



This snapshot is the current representation of the Task

### **Task**

The task set out will enable you to understand inductor basics with the intent of allowing vendor flexibility choosing Power Magnetics.

**Use the following links to manufacturers:**

- [Wilco](#)
- [CoilCraft](#)
- [Tyco Electronics](#)
- [Würth Electronics](#)

**Use the following link for Switching Regulators:**

- [Switching Regulators](#)

The links for the manufacturers are for various inductors. The link for the Switching Regulators is from National's website. The task has been written to show what the FAE will accomplish.

**Scenario #2:**

**I am designing a buck regulator for 5V output at 0.75A load current using the LM2672. The input voltage range is 9V to 16V. I decreased the inductance in an attempt to reduce the physical size of the inductor. However now my output regulation suffers and I don't seem to get the right output voltage as I approach the high input voltage end. What is amiss?**

*Hint: See the electrical characteristics tables in the device datasheet at <http://cache.national.com/ds/LM/LM2672.pdf>.*

**Answer:**

We know that reducing inductance will decrease the size of the inductor. But for ensuring a certain power throughput, the calculated peak inductor current must always be less than the *lowest* possible value of the current limit (the spread over temperature). So in this case, reducing the inductance too much will conceivably increase the peak current beyond the maximum permissible value of 1.2A for this device. Since the peak current increases at high input voltage, we will see the problem surface first at the higher input voltage. Using the design table in AN-1246 we can thus calculate the lowest possible inductance for a given application. Note that we are assuming continuous conduction mode here.

This snapshot is a representation of one of the scenarios posted.

This snapshot is from the previously designed lessons. Note the difference in vernacular and the style of the questions. Instead of **Task** and **Scenario, Reading Assignment** and **Research Assignment** are used. With careful examination, the questions are also formatted in a research mode instead of a scenario based mode.

#### Reading Assignments:

To understand how the three types of regulators provide control for the regulated output voltage, and to see how the differences in control method affect the frequency response of the regulators, read [AN-1148](#), "Linear Regulators: Theory of Operation and Compensation."

For additional information, consult the [Knowledge Base](#) using the following queries:

- [LDO](#)
- [Quasi-LDO](#)
- [Efficiency](#)
- [Thermal Resistance](#)
- [Linear Regulator](#)

#### Research Assignments:

Using the datasheets for [LP3985](#) (150mA), [LM3480](#) (100mA), and [LM340L](#) (100mA), compare their performance and limitations (for the 5V output versions) -

- Identify which is the standard (NPN) regulator, which is the quasi-LDO regulator, and which is the LDO regulator.
- Which packages are the devices available in?
- What type of pass device is used in each?

All of the links are internal links.

## **Evaluation**

This project will continue until q4 2005. Profits from incoming revenue will determine the future budget allocation for this project.

Some parts of the training model could already be applied using the current software. As seen in the previous snapshots, the tasks, and the scenarios can be posted. At present the answers were posted in anticipation of feedback generated by the Design Managers, Barry Culpepper, Jon Cronk, and Ed Lam, VP of Power. The rollout of the pre-beta training module will involve hints and answers for the first scenario only.

Assessment and Rubric tools were not developed yet. The development of the Assessment with the message board software is dependent upon the existing architecture of the LCMS. Rich Levin will be able to determine if the architectural structure of the software can handle the changes. Other factors to determine if the Assessment and Rubric tools can be utilized are time factors for involvement of

instructors, ease of use factors for instructors and students, and budget for purchase. Edward Lam will be able to determine if time for instruction will be a problem. Anticipated is the concern for the system architecture and time involved for instructors to develop the curriculum. The instructors developing the curriculum are senior FAE's. Their expertise is needed to provide input to existing customers and will inhibit how much time will be allocated to spend on instructional development and delivery.

The extension has not been developed. This factor depends on the architecture being able to accommodate a different software application, and the budget to support it.

## **Recommendations**

### Train the Trainer

Instructors need training within the following areas to maximize time usage: Analog U Website, and Internal Engineering Site, locating Online Seminars and My Videos, Analog University LCMS (WEBEDITPRO) and it's integration with Online Seminars and assessment tools, and assessment tools including [Blackboard](#) Rubric software similar to [Rubistar](#).

Train the trainer will be accomplished through web-based training. The reasons why web-based training should be used instead of instructor led training are: Availability factors, Flexibility, Cost saving benefit, and varied ability levels. Engineers will be working on developing instruction at various times during the year. For flexibility, engineers can enter into the WBT Portal at any time. You can address the learner (Trainer) at different ability levels, the learner can do this at his/her own pace. Front end software applications are more effective with Web-based training for an intelligent population than instructor led training. It really depends on the type of software used for the web based training and it's

ability to integrate with the applications that the learner will be trained on.

The time factors involved for training the trainer are estimated as follows: Analog U Website, and Internal Engineering Site, locating Online Seminars and My Videos (1 hour), Analog University LCMS (WEBEDITPRO) and it's integration with Online Seminars and assessment tools (2 hours), assessment tools including [Blackboard](#) (2 hours) and rubric software similar to [Rubistar](#) (1 hour), Reporting tools for Assessment (To be determined with further inquiry) (2 hours)

After inquiry, these are the following vendors that are recommended for use for WBT: **Internal software already available, [Knowledge Impact](#) , [Carson Media](#), [Intellinex](#), [Knowledge Anywhere](#), [Knowledge Pool](#), [Skill Soft](#), [Digital Think](#), [Provant](#), [Prosofttraining](#).** If there is internal software already available, it would be recommended to utilize it.

## Instructor Concerns

Other concerns that need to be addressed are the time factors involved in instructional development of these specific courses, and the logistics of setting times and availability for the instructor. Ed Lam might want to examine if it is viable to take away the FAE's for given periods of time to develop instruction. Here is a rough estimate of time involved for development: Online seminar (Involves pooling specific slides from data sheets (2-4 hours) and giving the presentation) (1-2 hours), Online Instruction development (4-8 hours), Rubric Development for assessment (2 hours), Post Information on Message board, (1 hour) provide student feedback, (1-3 hours total) and assess student work (15 minutes per student). Instructors post hours of availability for "Live Instruction" (No more than two hours per week, Justifies Cross Training)

## Assessment

The authentic assessment designed through rubrics and used by the instructor will drive the needs of Instruction for Instructor Led training at National University. Assessment can be used for Certification, if student passes certain measured outcomes. All FAE's are required to prove their competencies by taking the course. Instructor assessment will determine which areas of instruction will be provided at National University.

Instructors decide who will be enrolled in the specific courses. If a student has shown proficiency, he/she will not be required to take the course at National and will be certified accordingly.



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