

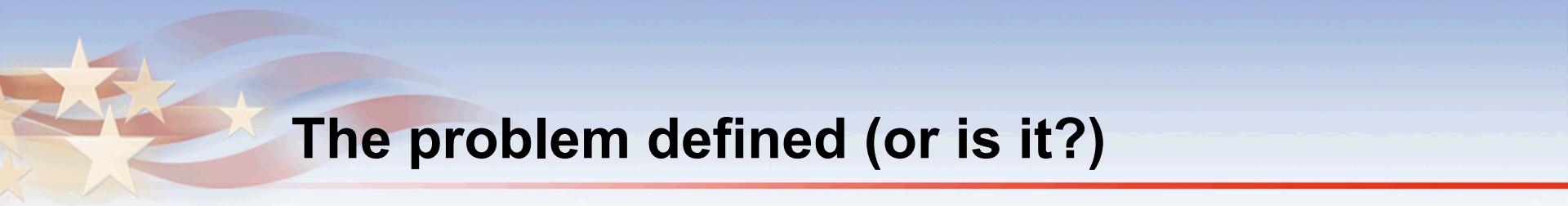
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Michael R. Descour, Ph.D.  
Sandia National Laboratories

# FEASIBILITY DESIGN OF A NIGHT-DRIVING SYSTEM FOR LUXURY AUTOMOBILES AS METAPHOR

**The attached information may (or may not) be useful.**





# The problem defined (or is it?)

## TAKEHOME EXAM INFRARED SYSTEM DESIGN NOVEMBER 1993

Carry out the feasibility design of a night-driving system for a Cadillac, Mercedes or equivalent car. Carry it our far enough to convince me that it can be done and that you know how. Include appropriate calculations and curves as appendices if necessary. Make it an easy to read report.





INFRARED

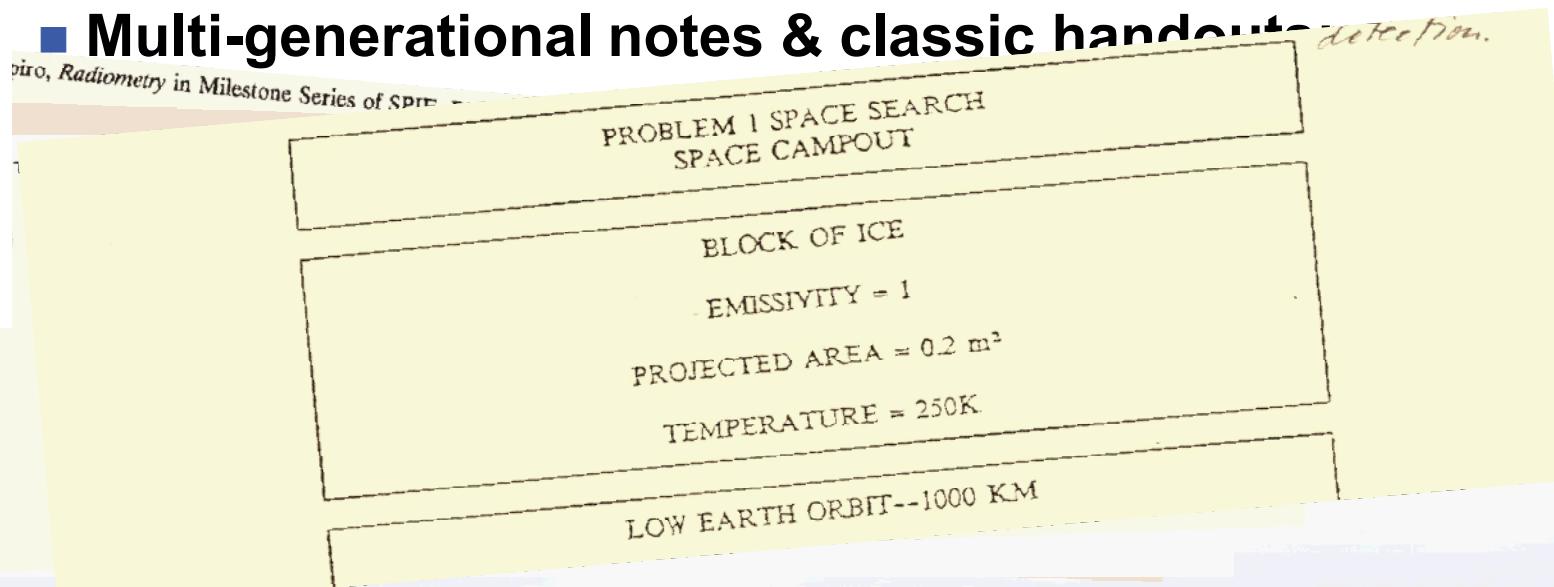
TECHNIQUES

CLASS 559

Professor William Wolfe  
University of Arizona  
Optical Sciences

# The context: Bill's class materials

- **No syllabus**
- **Multi-generational notes & classic handouts**



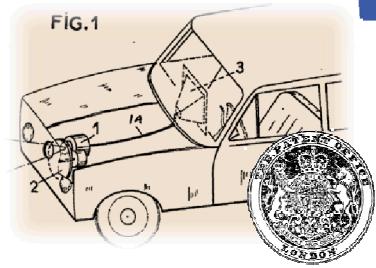
- **The metaphor!**
  - Developing a product;
  - Planning a career;
  - Developing a business plan;
  - Market research, etc.





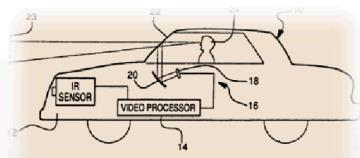
# Early history of night-driving systems

- **1966: Luc Payet patents in France an “Apparatus for improving the visibility in motor vehicles”**

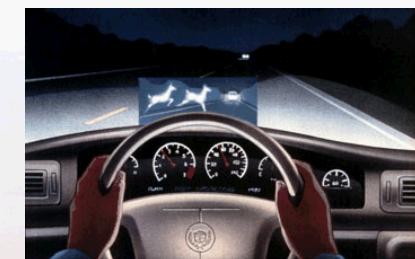


- Not yet specifically aimed at night driving, rather “...*in-clement or foggy weather...*”

- **Mid-1990s: Delco (Groves, Shogren, & Harter) patent “Night vision system for motor vehicles”, “Head up display with night vision enhancement”**



- Contains key elements now:
    - Infrared camera
    - Heads-up display



- **2000 Cadillac DeVille: First commercial roll-out**
  - Discontinued in 2004; only 15,000 units sold



# What is missing?

TAKEHOME EXAM  
INFRARED SYSTEM DESIGN  
NOVEMBER 1993

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- What FOV dimensions?
- What pixel format and IFOV size? Image resolution?
- What sensitivity (e.g.,  $NE\Delta T$ )? What minimum warning distance?
- Active or passive?
  - May affect contrast & thus detection performance
- What band in the EM spectrum to use: SWIR, MWIR, LWIR...?
- Where to mount it? Environmental issues? Coatings? Cooling?
- Display: Dashboard or heads-up
  - All sorts of ergonomic considerations rear their heads
- Software considerations for detection of pedestrians and other obstacles
  - Unusual scenarios: Don't sit down or ride a recumbent bicycle, you might not be detected
  - Warn the pedestrian? How?
- Cost guidance for bill of materials
  - Manufacturing considerations, numbers of systems, economies of scale
- *In short, just about everything...*



# Comparison: Write a business plan

## ■ People

- The specifications: the résumés
  - What do they know? Whom do they know? How well are they known?

## ■ Opportunity

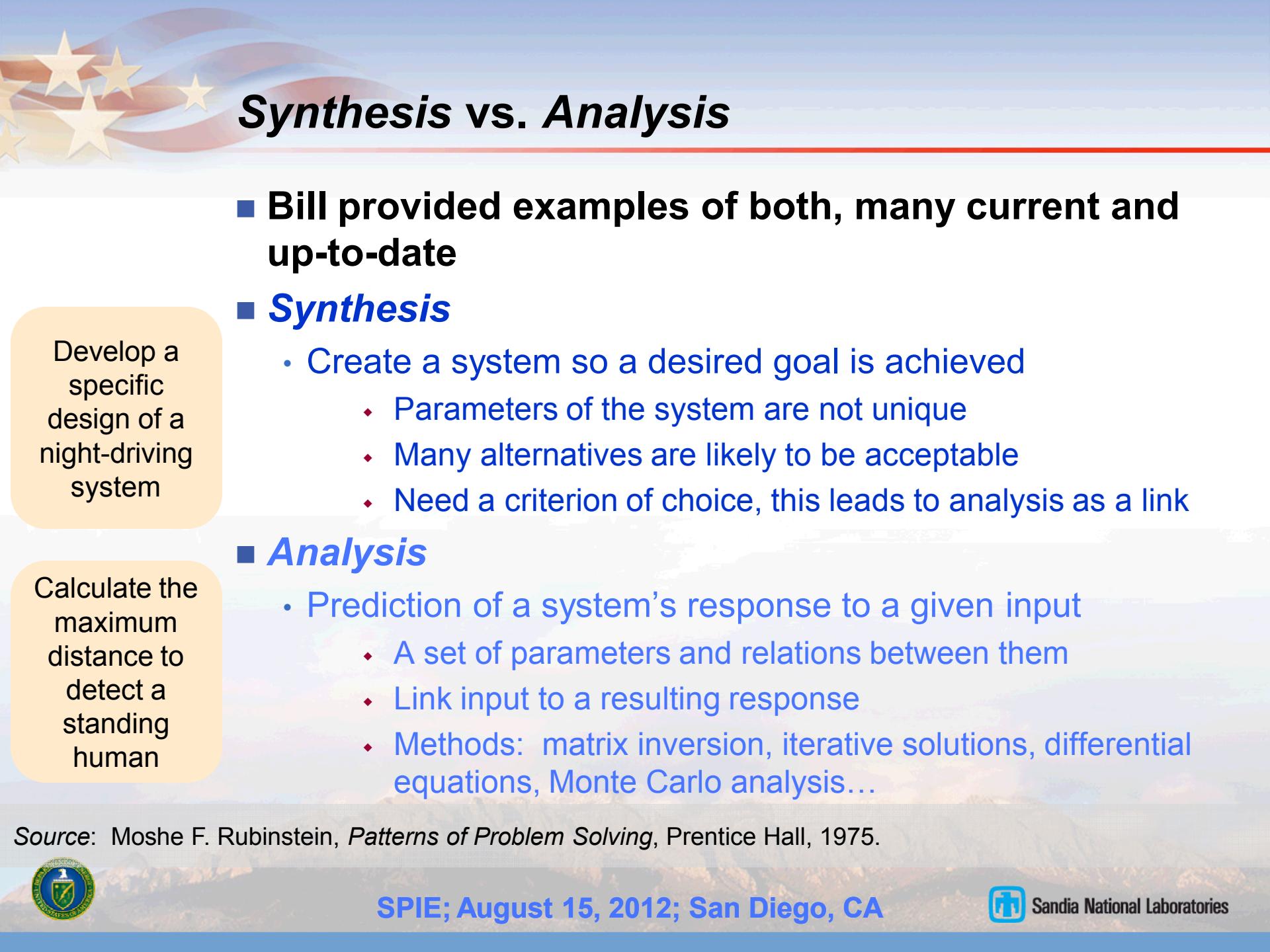
- Large and/or growing industry
- Structurally attractive
- Difference between revenues and costs to produce & market the products



- When does cash flow turn positive?

Source: William A. Sahlman, "How to write a great business plan," *HBR*, July-August 1997.





# Synthesis vs. Analysis

- Bill provided examples of both, many current and up-to-date

- **Synthesis**

Develop a specific design of a night-driving system

- Create a system so a desired goal is achieved
  - Parameters of the system are not unique
  - Many alternatives are likely to be acceptable
  - Need a criterion of choice, this leads to analysis as a link

- **Analysis**

- Prediction of a system's response to a given input
  - A set of parameters and relations between them
  - Link input to a resulting response
  - Methods: matrix inversion, iterative solutions, differential equations, Monte Carlo analysis...

Source: Moshe F. Rubinstein, *Patterns of Problem Solving*, Prentice Hall, 1975.



# Specifications

- **Analysis**
- **Example: Inconsistent or questionable specifications...**

	PRIMARY TGT	SECONDARY TGTS 1&2	
Target source		same as primary	why is this needed want to know what radiance we actually have
Target source temperature	Planck radiator with NIST certified thermocouple	same as primary	use a radiometer instead
Target source emissivity	100-1200 degrees Celsius	same as primary	if one wants to use < 0.6
Spectral filter holder	0.95 (min)	same as primary	
APPENDIX (PAGE 6):	one	one	is this really necessary?

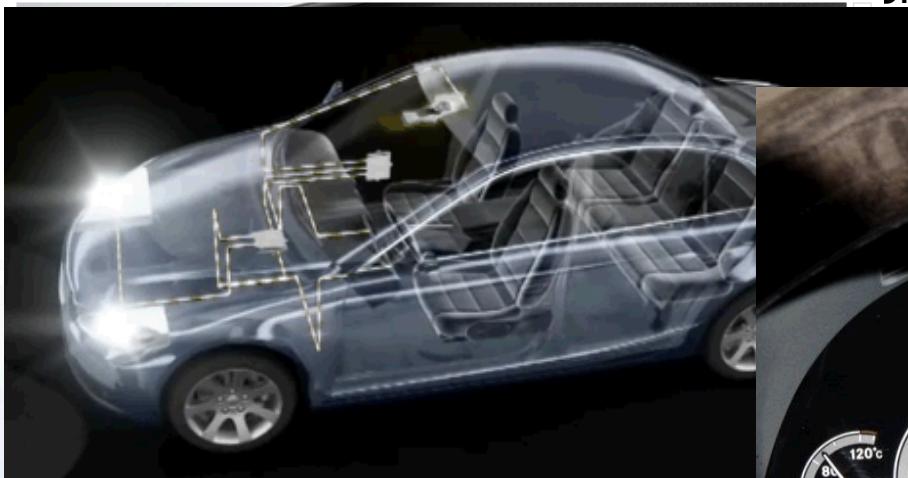




# The return of the night-driving systems

## ■ Current offerings:

- Audi, BMW, Lexus, Mercedes-Benz, and Rolls-Royce high-end models
- Passive systems are embedded in the grille of



Sources: *Car & Driver*, Autoliv, BMW, BoschAutomotive, WardsAuto

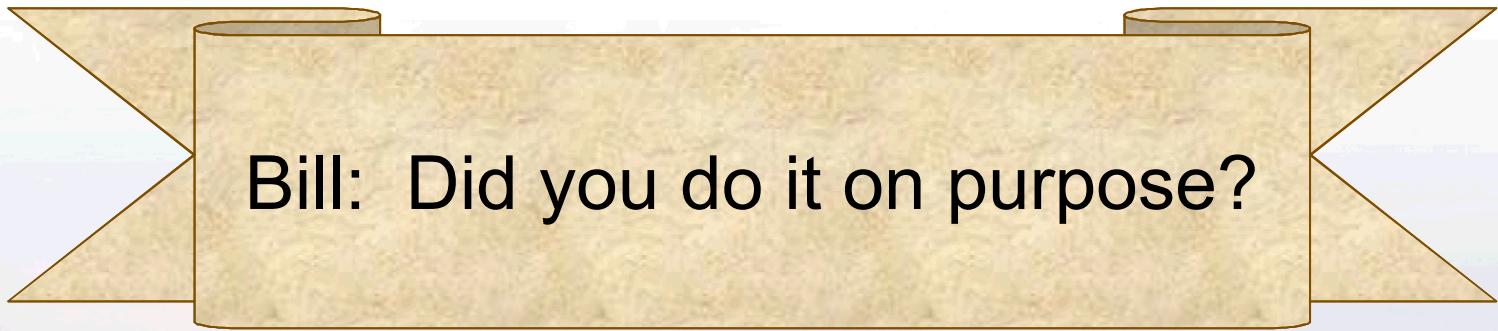




# In the final analysis...

## ■ OPTI 559

- Professional life lessons disguised as infrared EO system synthesis and analysis problems
- Difficult to teach, much appreciated



Bill: Did you do it on purpose?

