

# SPIRE – A DECISION SUPPORT SYSTEM FOR ADDRESSING COMPLEX/CHAOTIC ENVIRONMENTS

PRESENTED AT

## 2018 DMDU SOCIETY Conference



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# During the next 20 minutes...

- So what's the problem?
- The "Crown Jewels" questions
- What's SPIRE (Systematic Procedure for Identifying Relevant Environments)?
- SPIRE application at FPL
- SPIRE diagram results
- What SPIRE provides
- SPIRE – the neurocognitive conceptual architecture

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- **SPIRE – the neurocognitive conceptual architecture**



From the NYT, April 28, 2004

*“Soon after 9/11, a two-man intelligence team set up shop in a windowless, cipher-proof room at the Pentagon...*


*“By the end of the year... the men had constructed a startling new picture of global terrorism.*



*“The men culled classified material... ‘We discovered tons of raw intelligence’*

So how were these “tons” processed???





*“They recorded and annotated their evidence on butcher paper hung like a mural around their small office.”*

(Accomplished over a period of more than two months!!!)

Is this any way to fight a War on Terror???



# So what's the problem?

The need for a systematic approach to confront structurally changing, complex environments, characterized by

- Instability
- Disappearing “boundaries”
- “Historyless” situations
- Minimal value of analytical forecasting -- that may be and usually is misleading

# So what's the problem?? (cont.)

- Ineffective consideration of large amounts of disparate data
- Where there are multiple decisions or issues to consider
- The need to think outside of the box
- Where a proactive response is needed **AND**

# So what's the problem?? (cont.)

- Ineffective consideration of large amounts of disparate data
- There are multiple decisions or issues to consider
- The need to think outside of the box
- Where a proactive response is needed **AND**
- **MOST IMPORTANTLY, THERE IS NO EXPLICIT "DESIRABLE OUTCOME" IN SIGHT -- OR**
- **NO DISCERNABLE WAY TO GET TO THE OUTCOME!**

... Understanding the complex environment and the numerous competing forces within it"

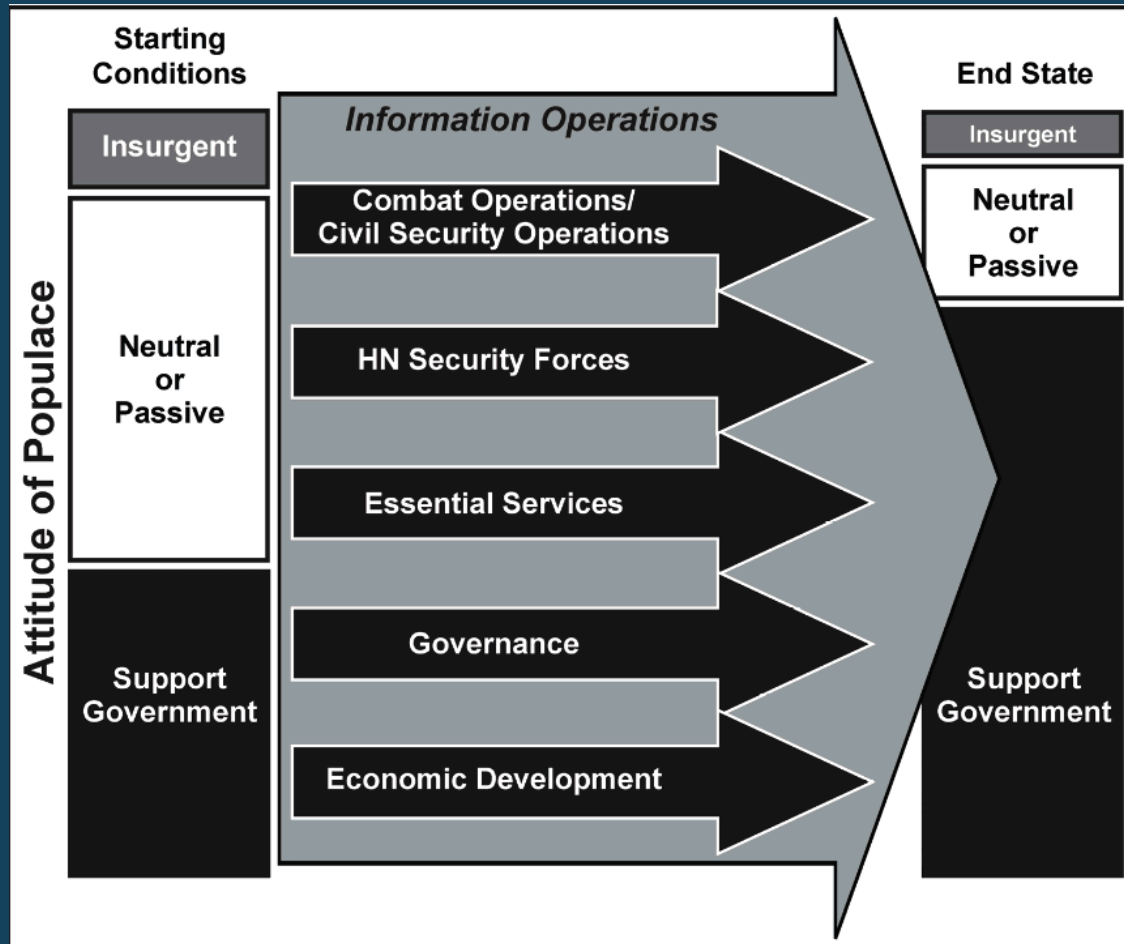
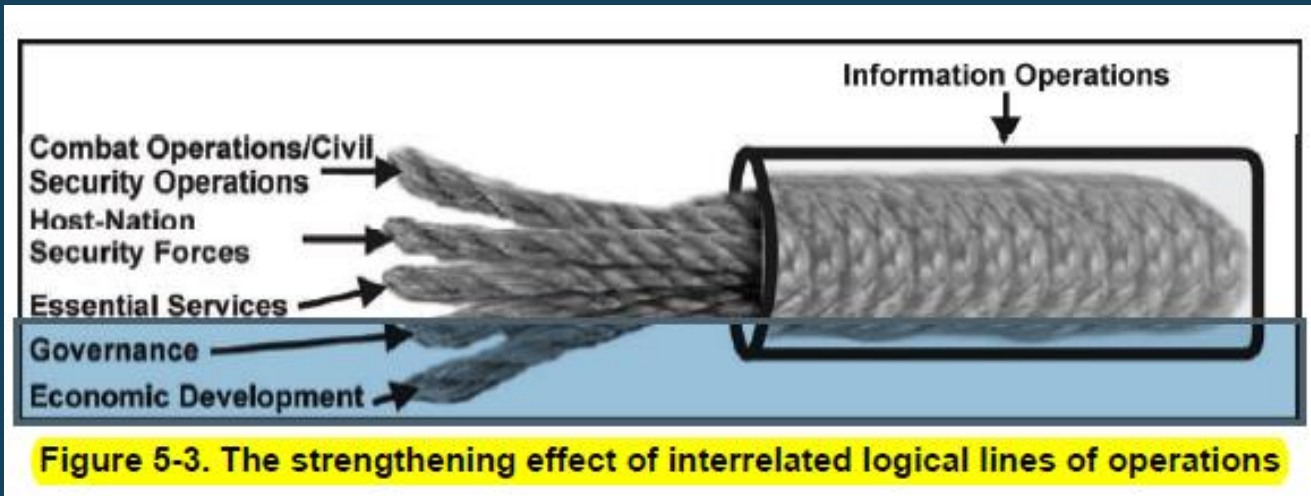


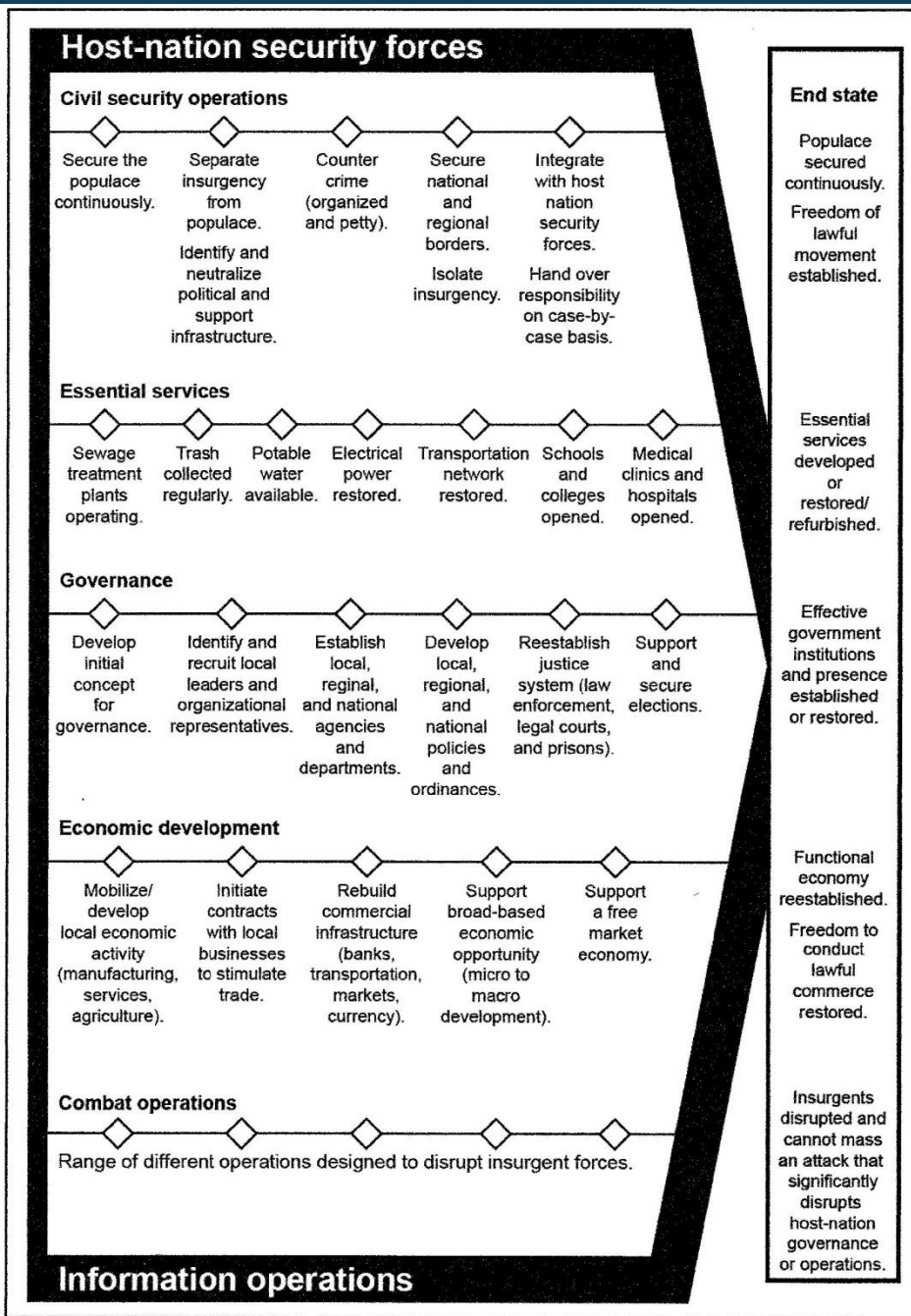
Figure 5-1. Example logical lines of operations for a counterinsurgency

Source: Counterinsurgency Manual, 2006

# Wishful thinking



Source: Counterinsurgency Manual, 2006



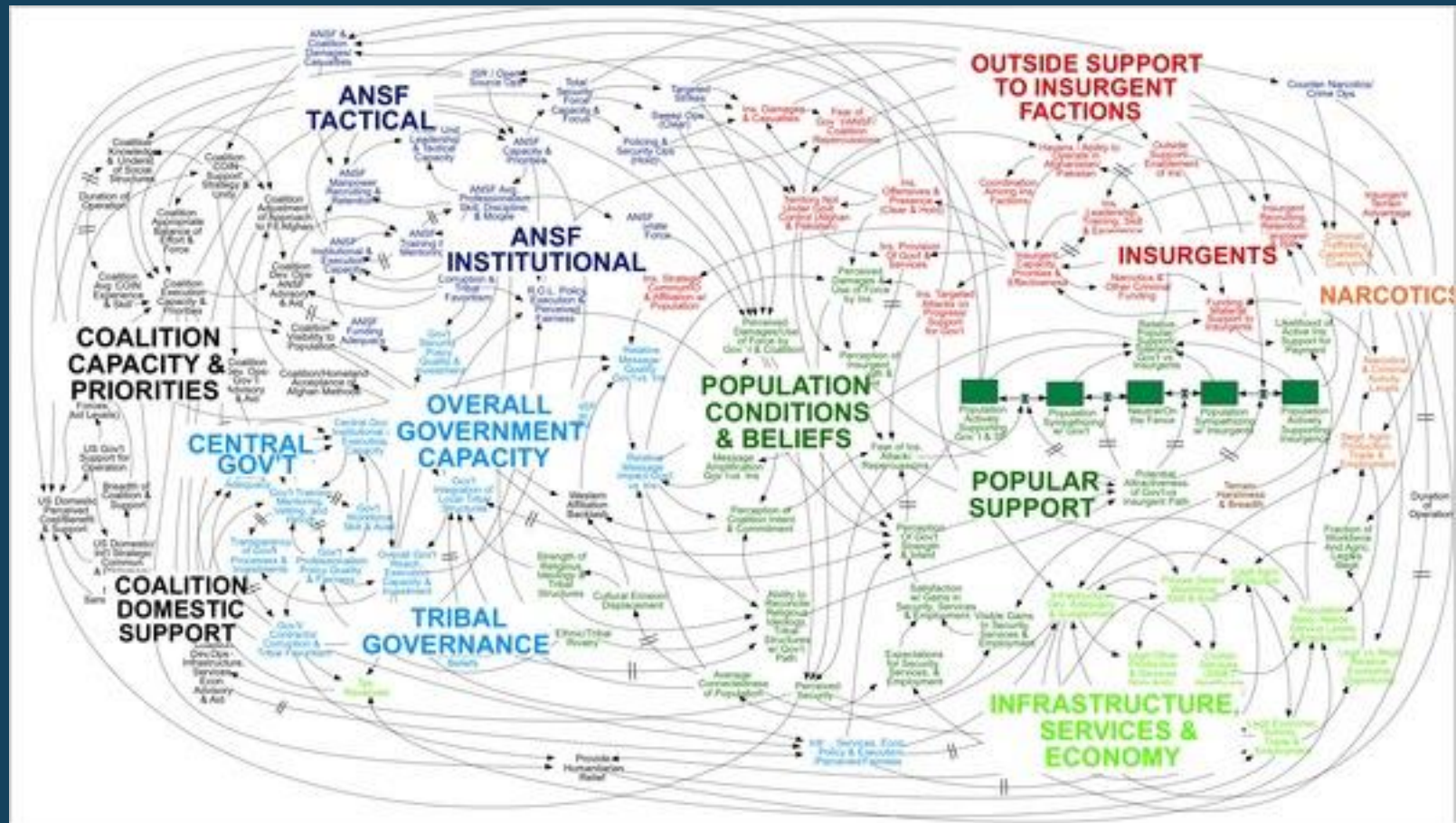
Where are the “interrelationships” among the “individual lines of effort?”

Metaphorical braided rope is gone!

Source: Insurgencies & Counter-insurgencies, 2014

Figure 7-2. Sample of individual lines of effort

“When we understand that slide, we'll have won the [Afghan] war” – Gen. S.A. McChrystal



A systems dynamics interpretation of Gen. Petraeus' Counterinsurgency Manual





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			OFFICE OF TECHNICAL COLLECTION	OFFICE OF MEDICAL SERVICES
			OFFICE OF TECHNICAL INTELLIGENCE OFFICER DEVELOPMENT	OFFICE OF PERSONNEL RESOURCES
			OFFICE OF TECHNICAL READINESS	OFFICE OF SECURITY
			OFFICE OF TECHNICAL SERVICE	RESOURCE MANAGEMENT GROUP

**MISSION CENTERS**

- AFRICA
- COUNTERINTELLIGENCE
- COUNTERTERRORISM
- EAST ASIA AND PACIFIC
- EUROPE AND EURASIA
- GLOBAL ISSUES
- NEAR EAST
- SOUTH AND CENTRAL ASIA
- WEAPONS AND COUNTERPROLIFERATION
- WESTERN HEMISPHERE

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Last updated on 09 October 2015





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# The “Crown Jewels” questions:

- Which strategic decisions need to be made?
- In what sequence or priority should these decisions be addressed or acted upon?
- Which activities/organization units need to take action?
- Which organization units/decisions/tasks need to be coordinated (e.g. lateral or network arrangements)?

# The Crown Jewels questions

## (cont.):

- Where are the most appropriate environmental intervention points?
- How can organization actions potentially alter the prospective environment? and
- Which organization units/activities/ tasks should be involved in taking such actions?

# So what's needed?

**Focus on DSS** – not D (i.e., The Crown Jewels)

DM only possible if “desired outcome” is known

**Communicable** – preferably visual and/or short narratives (but with explicit link to decisions/policies to ensure relevance)

**Credible to analysis “customers”** (i.e., policy/decision makers (IOW, the “buy in”)

Bottom-up protocol is best

Outside in – easily challenged or disbelieved

**Confrontation** – encourage with prospective situation  
-- discourage/neutralize with individuals and  
intra- & interorganizational entities

# These needs triggered SPIRE (Systematic Procedure for Identifying Relevant Environments)

- Originally designed for L/R strategic planning for an extraordinarily large oil company
  - Proved generalizable approach for strategic planning, knowledge mgt., intelligence analysis, etc.
  - Next applied at IBM & Celanese
  - Later at Douglas A/C, ATT & FPL

# THE SPIRE APPROACH

- A pc-based protocol for representing the organization's relevant environment in a unique causal mapping format of immediate use to strategic decision-makers.
- SPIRE inputs are individual verbal statements of hypotheses, conjectures, forecasts, analyses concerning the prospective organization/environment interface
- SPIRE utility is best shown by example...

# Florida Power & Light Co. SPIRE application – the most extensive one to date

(performed under a grant from the Electric Power Research Institute)

- FPL selected for SPIRE demonstration project because of company's bellwether status
  - as leading edge corporation in utility industry management style, and
  - in the midst of reinventing itself

# FPL's environmental reassessment

Under guidance of large, international consulting firm, at a cost of \$millions:

- Organized 12 cross functional, cross hierarchical committees (10-20 per)... working for six months
- Each committee focusing on a major SDI (e.g., generating capacity, fuel supply, transmission, regulation), producing forecasts, scenarios, etc.
- Consultant distilled and synthesized committee results into several hundred pages of cross referenced text, tables and graphs



# Use of FPL Env. Assessment Results



# Use of FPL Env. Assessment Results



(Announcement of new strategy in < two weeks after env. assessment results made available didn't indicate broad usage)

## SPIRE application at FPL (performed by HEK & one FPL planner)

- FPL committee data summaries were inputs to the SPIRE approach
- Distilled down to **50 verbal statements** of environmental dynamics with relevance for FPL SDIs
- Consisting of **64 specific environmental factors and 35 strategic decision issues (SDIs)**
- Verbal statements transformed into SPIRE input notation protocol

50 External environmental factors ("E" List) – with direct or indirect relevance for strategic decision issues (C List)

E LIST	
E01.01	= UTILITY UTILITY INDUSTRY COMPETITIVE STRUCTURE
E01.05	= CONSORT "CONSORTIUM" UTILITY ENTERPRISE
E01.06	= COSTSTUR UTILITY COST STRUCTURE
E01.08	= W/SCOMP WHOLESALE COMPETITION
E01.10	= MKTSEGMT SELECTIVE COMPETITION FOR TARGET MARKET SEGMENTS
E01.11	= ELEC/GAS ELECTRICITY/GAS MIX
E01.12	= UNBUNDLING UNBUNDLING
E02.01	= CS/OSMIX CENTRAL STATION/ON-SITE GENERATION MIX (RATIO)
E02.04	= REMOTE REMOTE GENERATION CAPABILITY
E02.05	= NONFOSSL INCREASED DEMAND FOR NON-FOSSIL FUEL GEN'TG OPTIONS
E02.06	= PHOTOVOL PHOTOVOLTAIC GENERATION
E02.07	= ONSITE ON-SITE GENERATING SYSTEMS
E02.09	= GASAVAIL AVAILABILITY OF NAT GAS TO FPL
E03.01	= UNDRT&CCC UNDERGROUND TRANSMISSION & DISTRIBUTION FACILITIES
E03.03	= TRANSACC TRANSMISSION ACCESS
E03.04	= TRANSPRC TRANSMISSION PRICING SYSTEMS
E04.01	= 3RDPARTY THIRD PARTY COMPETITION FOR DISTRIBUTION SERVICES
E04.02	= OWNRSHP OWNERSHIP STRUCTURE OF NON-UTILITY CONSTRUC. PLANTS
E04.03	= QF'S # OF QUALIFYING FACILITIES
E04.04	= NUG'S NON-UTILITY GENERATORS
E04.06	= NUGMKTS MARKETS SERVED BY NON-UTILITY COMPETITORS
E05.01	= SPLY/DEM ELECTRIC SUPPLY/DEMAND IMBALANCE
E05.02	= ELECDDEM AGGREGATE DEMAND FOR ELECTRIC ENERGY (LOAD)
E05.03	= RESIDDEM RESIDENTIAL ENERGY CONSUMPTION
E05.04	= TRENDS CUSTOMER DEMAND TRENDS
E06.07	= SMARTHS DEMAND FOR "SMART HOUSE" (NEW AND RETROFIT)
E06.08	= ELECCAR ELECTRIC CAR MARKET
E06.09	= MICRO'S MICROPROCESSOR USE AMONG COMM. & RESID. USERS
E07.01	= CUSTOPT CUSTOMER DESIRES FOR CHOICES/OPTIONS
E07.02	= QUALREQT DIFFERENTIATED POWER QUALITY REQUIREMENTS
E07.03	= RISK RISK TAKING/AVERSION AMONG CUSTOMER SEGMENTS
E08.03	= WTETECH WASTE TO ENERGY (WTE) TECHNOLOGY
E10.01	= BATTECH STORAGE BATTERY TECHNOLOGY
E11.02	= INTFCTCH CONSUMER INTERFACE TECHNOLOGY
E11.03	= SMRTTCH ADVANCED "SMART HOUSE" TECHNOLOGY
E11.04	= COOLTECH COOL STORAGE TECHNOLOGY
E12.02	= WHLGTECH WHEELING TECHNOLOGY
E13.01	= SOCNACL SOCIETAL RECEPTIVITY TO NUCLEAR POWER
E13.02	= SOCDMS SOCIETAL PRESSURES FOR DSM
E13.04	= AWARESUP CUSTOMER AWARENESS/CONCERN FOR SECURE ENERGY SUPPLY
E13.05	= EXPCTSRV CONSUMER EXPECTATIONS FOR RELIABLE SERVICE
E14.01	= SOCENV SOCIETAL PRESSURE FOR A CLEAN ENVIRONMENT
E14.02	= SOCHLTH HEALTH RISK FROM ENVIRONMENT
E14.03	= ACTIVISM CONSUMER ACTIVISM
E14.04	= LMTPLANT SOCIETAL PRESSURE TO LIMIT PLANT INVESTMENT
E14.05	= CRIME CONSUMER PREOCCUP WITH HOME SAFETY/SECURITY
E14.06	= DEREG TREND TOWARD DEREGULATION
E16.05	= INVRISK RISK OF HIGH CAPITAL INVESTMENT
E17.02	= WKGFAMS # OF "WORKING FAMILIES"
E17.03	= AGINGPOP AGING OF THE U.S. POPULATION
E18.04	= WASTEDSP CAPACITY TO DISPOSE OF SOLID WASTE
E20.02	= REG/PRICE INCENTIVE REGULATIONS-PRICE CAPS
E20.04	= NONCOST RATE SETTING-NON COST BASED (MARKET PRICE)
E20.06	= PRICEEND PRICING BY END-USE SEGMENT (VS CUSTOMER SEG)
E20.07	= REG/DSM INCENTIVES (REGULATORY INITIATED) FOR MORE DSM
E21.03	= RETACCESS MANDATORY RETAIL ACCESS
E21.04	= REGCMPCT THE REGULATORY "COMPACT" WITH UTILITIES
E22.05	= FEDDEREG UTILITY DEREGULATION
E23.01	= FERCREGS FERC DECISIONS/REGULATIONS
E23.03	= ONESTEP ONE STEP LICENSING (NRC REG'S)
E24.02	= FEDCO2 MANDATORY CO2 REDUCTION
E24.03	= FEDAIR AIR QUALITY STANDARDS
E25.03	= LNGAVAIL LIQUID NATURAL GAS PRICE/AVAILABILITY

\*

# Strategic Decision Issues (C List) of FPL

C LIST	
C01.01	= FPLBUS BUSINESS SEGMENTS APPROPRIATE FOR FPL (TRADITIONAL)
C01.02	= VERTINT DEGREE OF VERTICAL INTEGRATION
C01.03	= GENOWN GENERATION OWNERSHIP MIX
C01.04	= LOB'S LINES OF BUSINESS
C01.05	= JOINT JOINT VENTURES (CONSORTIA)
C02.01	= ONSITGEN ON-SITE GENERATION
C02.02	= RATESCH PRICING/RATE SCHEDULE
C02.03	= PRODMIX PRODUCT MIX
C02.04	= TGTMKTS TARGET MARKETS
C02.05	= DSM DSM
C02.06	= LOCALGEN LOCAL GENERATION
C02.07	= CUSTCLSS END-USE VS. CUSTOMER CLASSES
C02.08	= MKTG/PRM NEW END-USE MARKETING/PROMOTION
C03.01	= FUELMIX FUEL SUPPLY/MIX
C03.02	= OURSRCE OUTSOURCING
C03.03	= ALTGEN ALTERNATE GENERATION TECHNOLOGIES
C03.04	= GENMIX GENERATION MIX
C03.05	= COST COST STRUCTURE
C03.07	= NUC/FOSS NUCLEAR VS FOSSIL
C03.08	= BUY/LSE BUY VS LEASE RE: GENERATION
C03.09	= CAPREQT GENERATION/CAPACITY REQUIREMENTS
C03.11	= NEWFUEL FUEL TYPE FOR NEW GENERATING CAPACITY
C04.01	= CULTURE CORPORATE CULTURE
C04.03	= MIS MIS
C04.04	= WORKMTHD WORK PROCEDURES OR "WORK PRACTICES/METHODS"
C04.05	= RISK RISK PROFILE
C04.06	= FINCAP FINANCING CAPABILITY
C04.07	= INC/REW COMPENSATION/INCENTIVE/REWARD SYSTEM
C04.08	= PRICE PRICING PHILOSOPHY
C05.02	= RESTRUCT RESTRUCTURING (RE: SCOPE)
C05.03	= PRFTCTR COST CENTER/PROFIT CENTER REORGANIZATION
C06.01	= DELSYS UTILITY DELIVERY SYSTEM (E.G., ELECTRIC CARS)
C06.02	= T&D T & D CONFIGURATION
C06.03	= TRANSCAR TRANSMISSION CAPACITY



Examples of Linkage Statements of  
Environmental Dynamics and Strategic Decision Issues

1. Increasing concern about the environment (E 14.01, E 14.02) will lead to stricter air quality standards (E 24.03) which increases R&D expenditures on electric technology applications and a breakthrough in battery technology (E 10.01) for electric vehicles. This impacts corporate decisions relative to systems for delivery of electric power to electric vehicles (C 6.01).

E 14.01, E 14.02: E 24.03: E 10.01/ C 6.01

2. Consumer awareness of the need for a secure (non fossil fuel) energy supply (E 13.04) leads to a demand for electric vehicles (E 6.08) which, in turn leads to breakthroughs in battery technology (E 10.01). This impacts corporate decisions relative to utility delivery systems for battery charging (C 6.01)

E 13.04: E 6.08: E 10.01/ C 6.01

3. The existence of a market for electric vehicles (E 6.08) impacts corporate decisions relative to target marketing (transportation market) (C 2.04) and marketing and promotion of new end-uses (C 2.08).

E 6.08/ C 2.04, C 2.08

4. Consumers concern for energy security (E 13.04) leads to increased demand for small on-site generating units (E 2.07) and photovoltaic charging systems (E 2.06) which results in an increase in non-central station generated electricity (E 2.01). This impacts corporate decisions relative to generation ownership mix (C 1.03), generating capacity requirements (C 3.09)

E 13.04: E 2.07, E 2.06: E 2.01/ C 1.03, C 3.09

5. Improved storage battery technology (E 10.01) leads to an increase in the number of electric vehicles (E 6.08) and an increased demand for electricity (E 5.02). This impacts corporate decisions relative to generating capacity requirements (C 3.09).

E 10.01: E 6.08: E 5.02/ C 3.09

6. An increased demand for electricity (E 5.02) leads to an increase in on-site generation (E 2.07) and photovoltaic generation (E 2.06) which impacts corporate decisions relative to the mix of products/services to be sold (i.e., bundled electric service versus back-up power and on-site generation repair and maintenance) (C 2.03), target markets for new sales (transportation) (C 2.04), and participation in on-site generation (C 2.01)

E 5.02: E 2.07, E 2.06/ C 2.03, C 2.04, C 2.01

Statements linking  
environmental factors  
(E List) impacting FPL  
strategic decision  
issues (C List) with  
notational representation



## Run the SPIRE heuristic program w/notational statements input

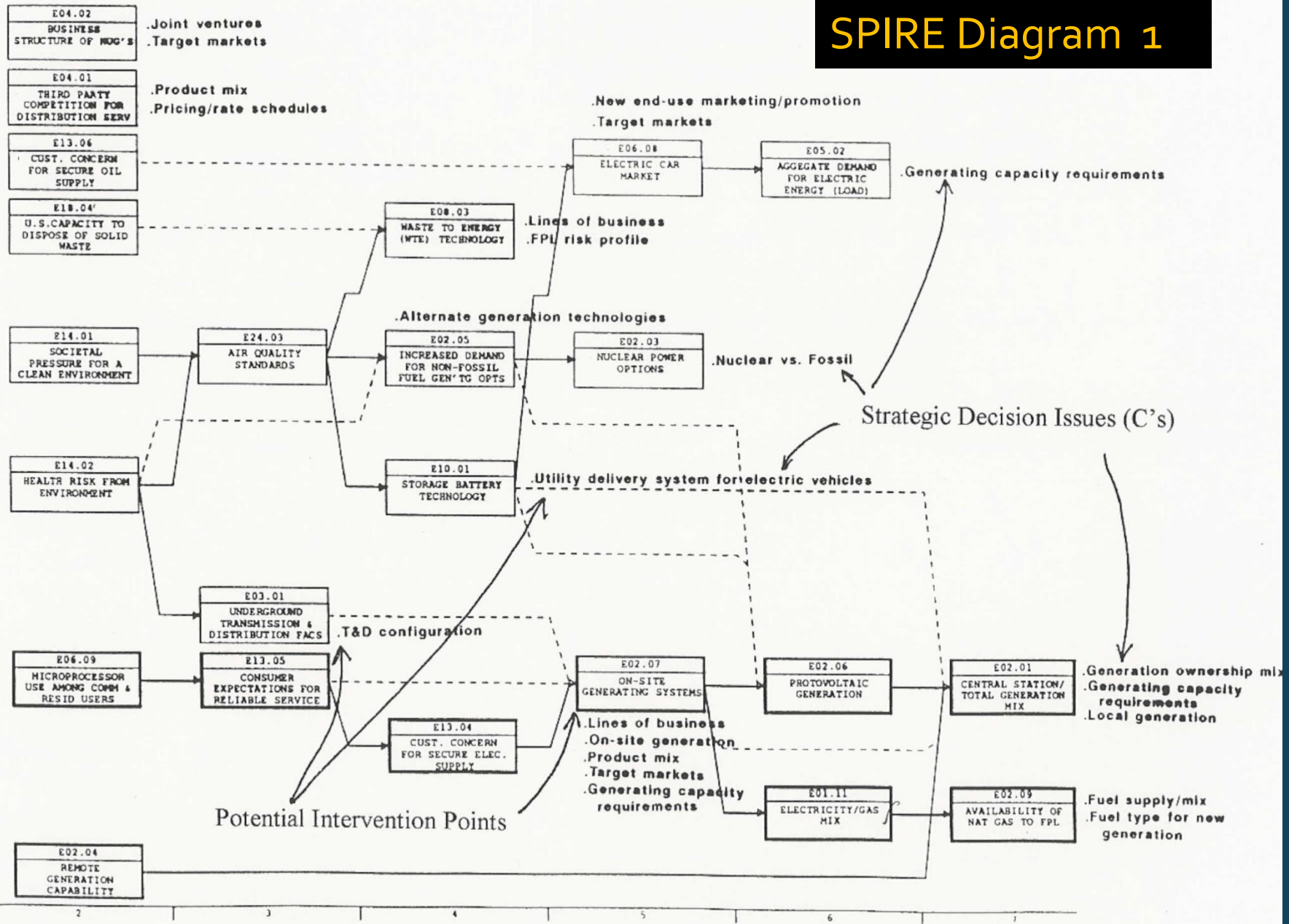
- Identifies and groups closely interacting environmental dynamics
- With relevance for commonly affected SDIs
- Five subsets of environmental dynamics/SDIs emerged (self-organized)
- Each subset provides the specification for a SPIRE diagram

## Five subset SPIRE diagrams emerged:

- Encompassing all environmental factors and their interrelationships and SDIs
- each diagram self-organized about an SDI theme:  
(1) generating capacity & ownership; (2) product/market strategy; (3) economic organization; (4) organization dynamics; and (5) transmission & distribution
- Here following are SPIRE diagrams #1 #2 & #4 (out of a total of five)

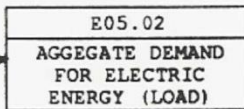
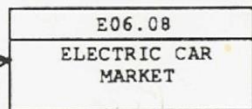


# SPIRE Diagram 1



.New end-use marketing/promotion C02.08

.Target markets C02.04



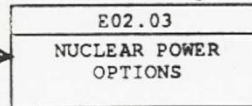
.Generating capacity requirements C03.09



.Lines of business C01.04

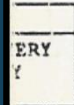
.FPL risk profile C04.05

generation technologies (added to FPL?)



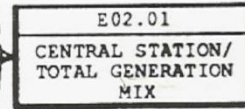
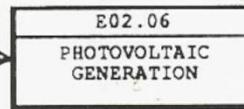
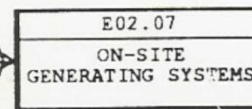
.Nuclear vs. Fossil C03.07

Detail from SPIRE diagram 1 showing SDI notations, e.g., C03.07, C01.04, C04.05

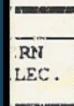


C06.01

.Utility delivery system for electric vehicles



C01.03  
.Generation ownership mix  
.Generating capacity requirements C03.09  
.Local generation C02.06



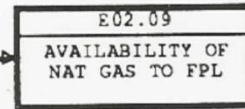
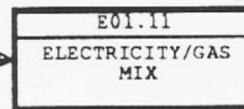
.Lines of business C01.04

.On-site generation C02.01

.Product mix C02.03

.Target markets C02.04

.Generating capacity requirements C03.09



.Fuel supply/mix C03.01  
.Fuel type for new generation C03.11

# SPIRE Diagram 2

JRV2	Approved	
	Checked	
	Revision	
	Date	

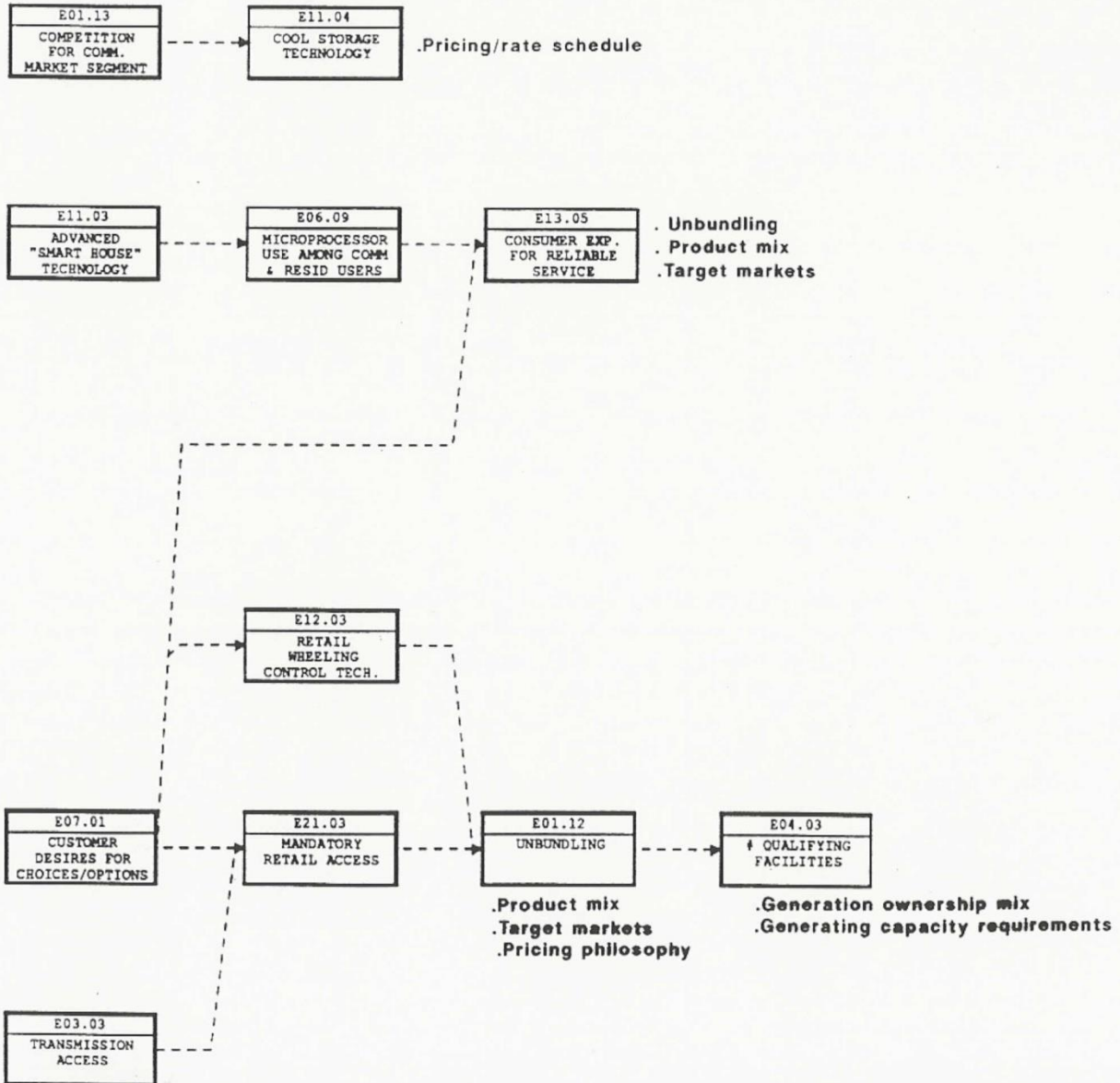
Primavera Systems, Inc. 1987-1990

FPL  
JRV2  
JRV2

Project start : 18OCT90  
Project Finish: .....

Date Date: 18OCT90  
Plot Date: 6JUL90

ACT ID
Description
<input checked="" type="checkbox"/> In progress
<input checked="" type="checkbox"/> Complete



6  
5  
4  
3  
2  
1



# SPIRE Diagram 4

EPRJ/FPL JOINT PROJECT		Approved
Revision		Checked
Date		

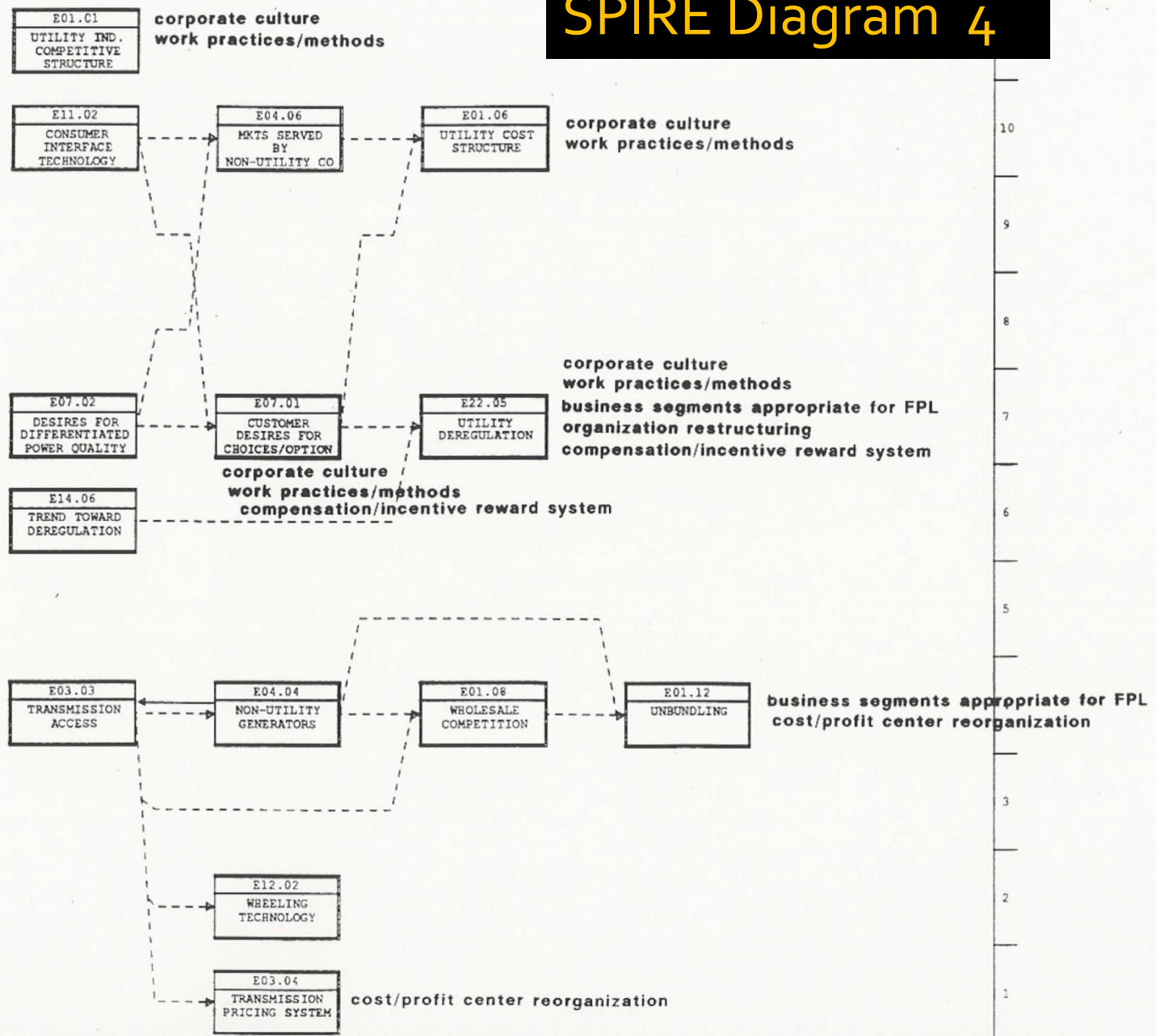
Primavera Systems, Inc. 1987-1990

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FPL/JOHN VETTER  
EPRJ/FPL COLLABORATION  
JR VH

Project Start: 24JUN90  
Project Finish: \*\*\*\*\*

Data Date: 24JUN90  
Plot Date: 4JUL90



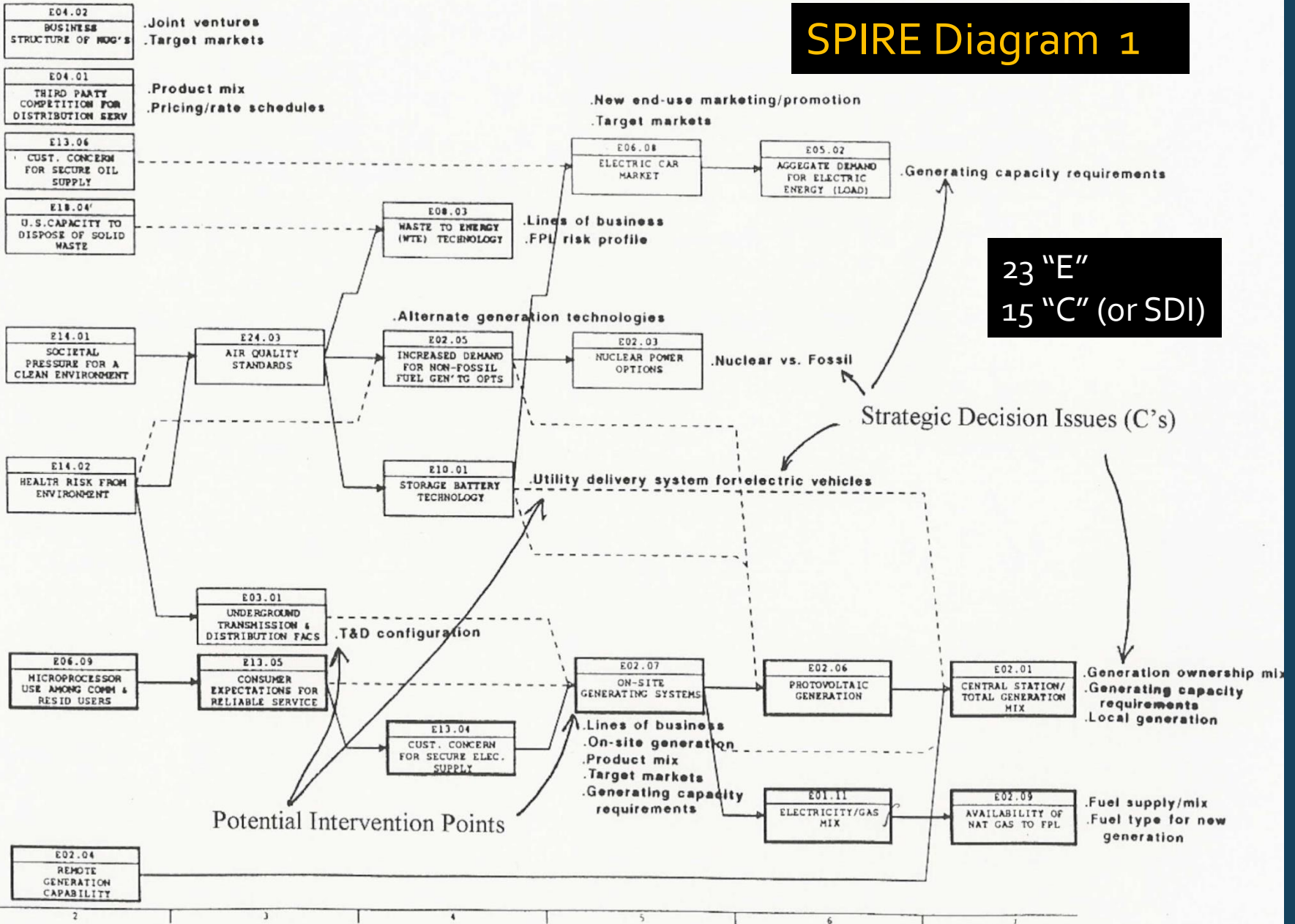
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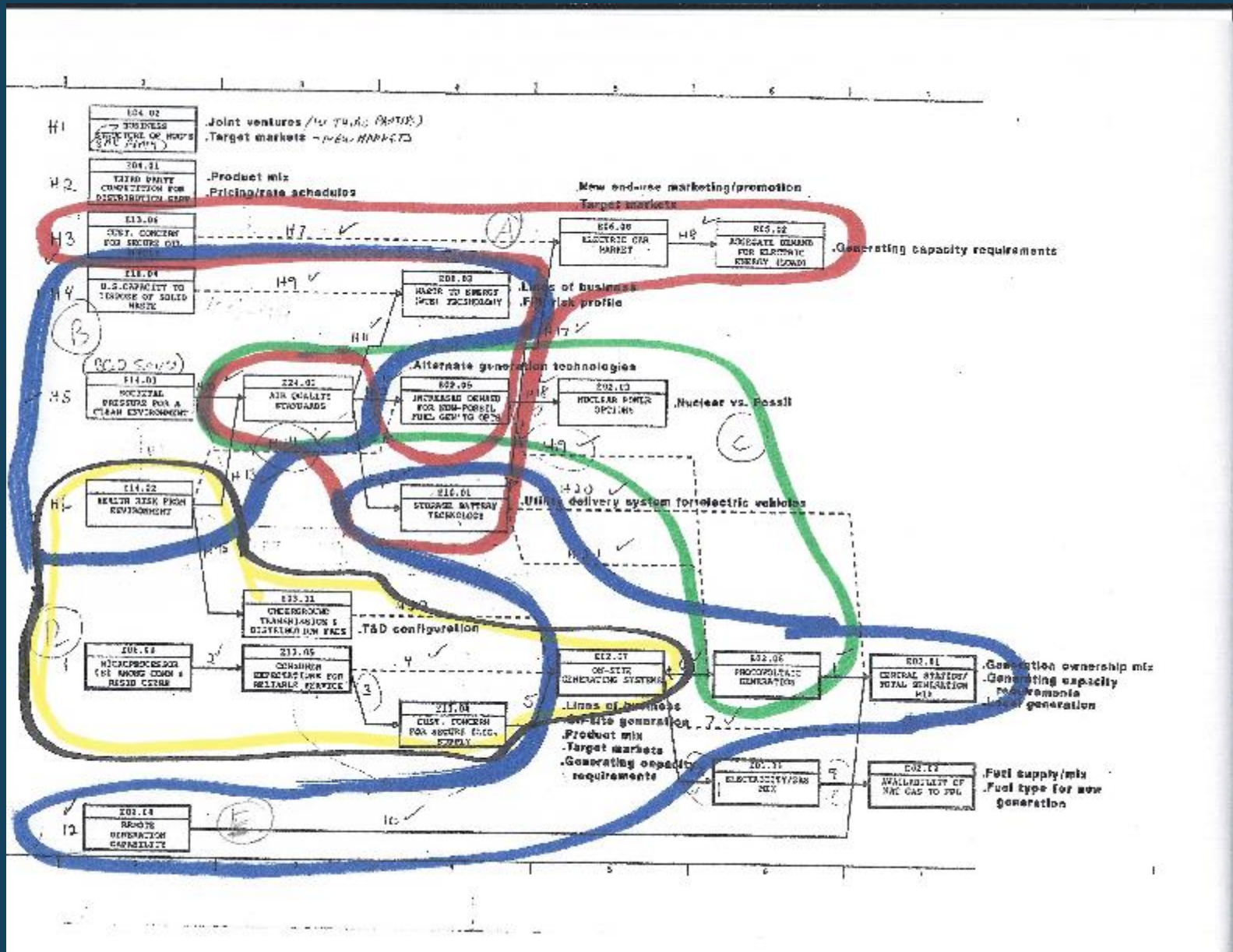
## NOW LET'S SEE HOW SPIRE DIAGRAMS ARE USED TO CREATE SCENARIOS THAT ARE:

- MOST LIKELY (IOW, "APPROXIMATE FORECASTS")
- SPECIFIC DECISION(S)-FOCUSED
- LIMITED TO RELEVANT ENVIRONMENT
- IMMEDIATELY RESPONSIVE TO CHANGE
- EASILY COMPREHENDED AND
- RESPONSIVE TO THE CROWN JEWELS QUESTIONS!

# SPIRE Diagram 1

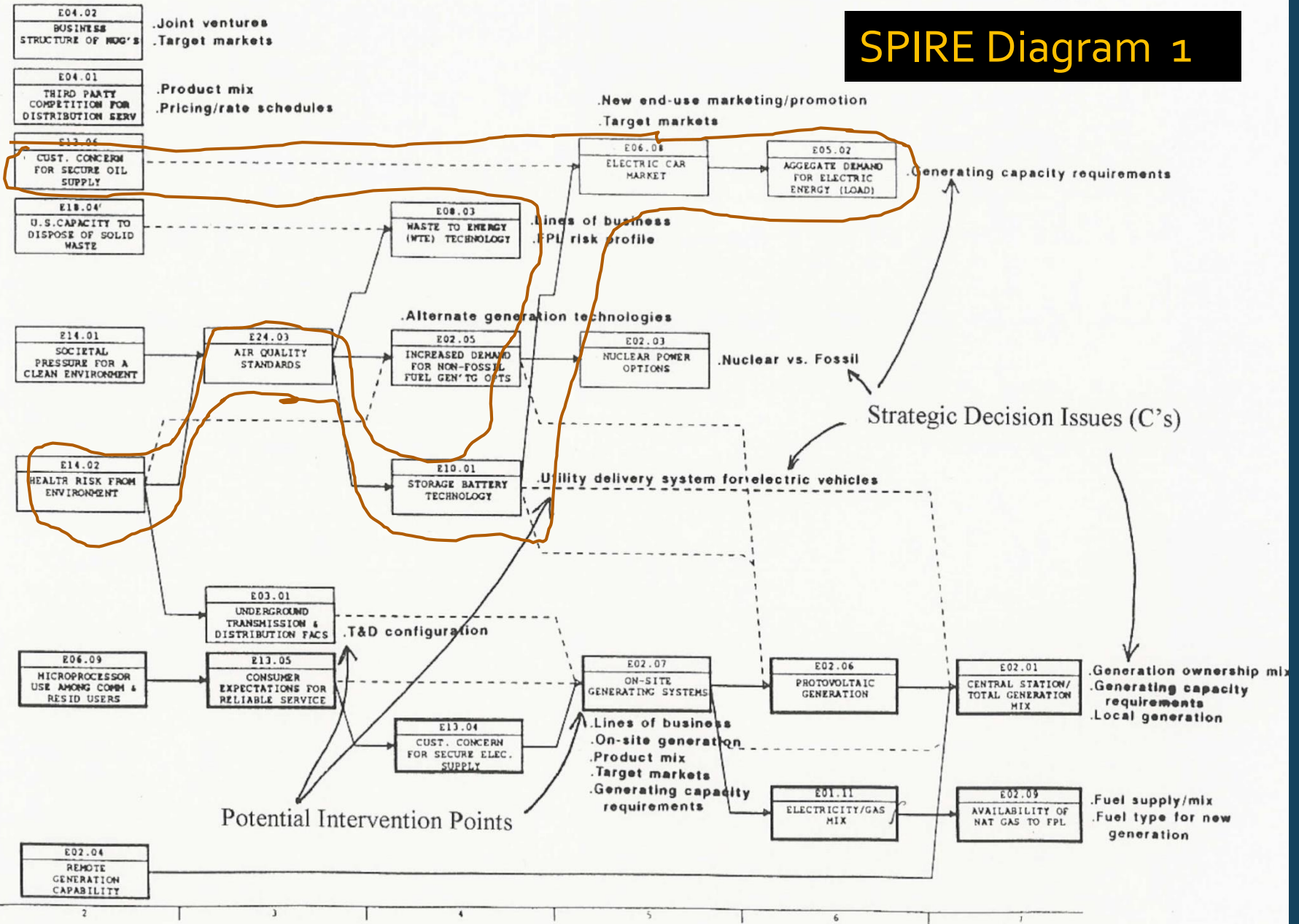


# Subset #1 with scenario roadmaps A-E



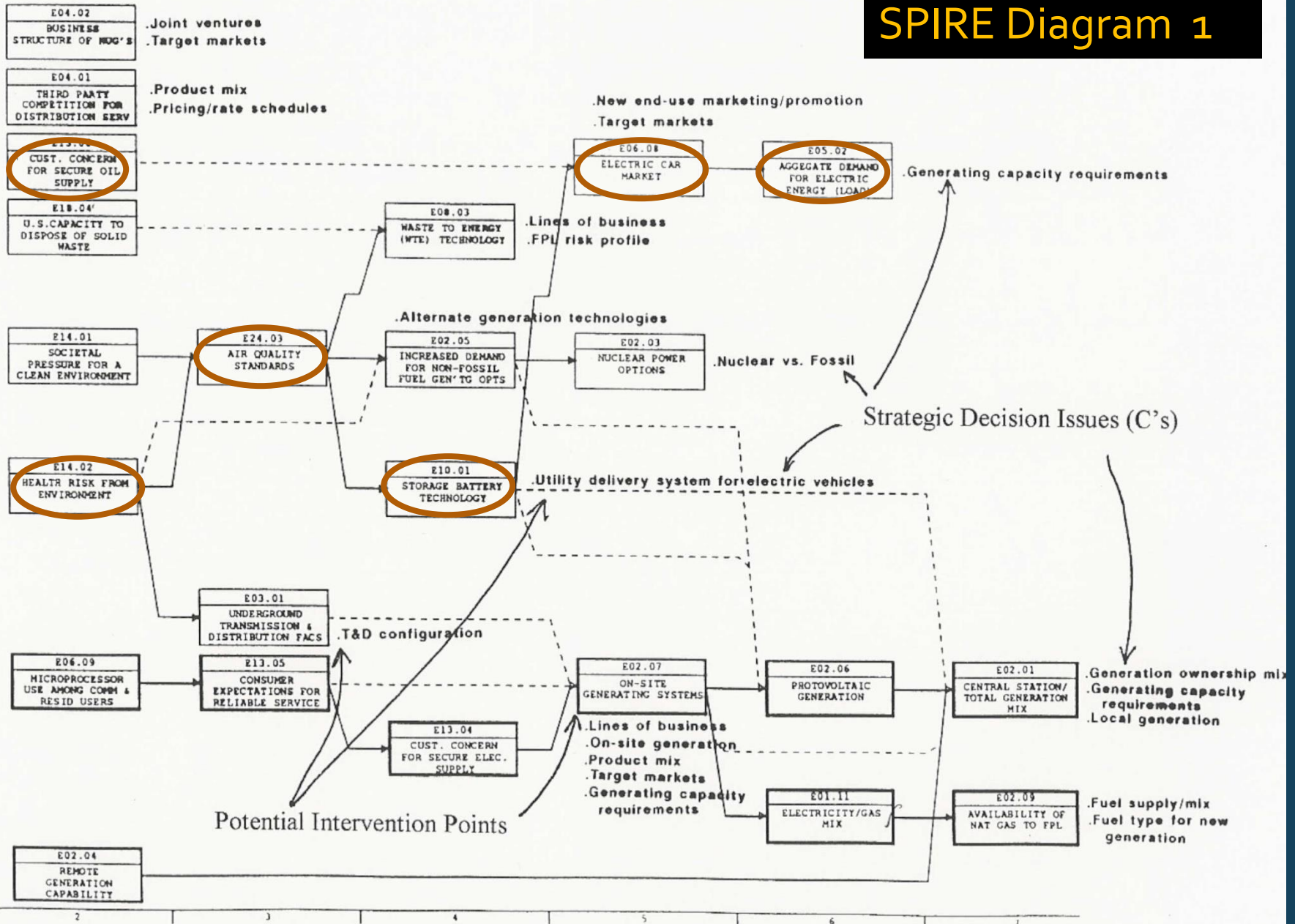


# SPIRE Diagram 1





# SPIRE Diagram 1



## SCENARIO A - ELECTRIC VEHICLES

Projections of adequate crude oil supplies argue that the introduction of electric cars (1)\* will be based on air quality considerations versus fuel costs. In order to comply with California's air quality standards, major breakthroughs in battery technologies are occurring now that will allow for electric vehicles to achieve significant market penetration in Dade, Palm Beach and Broward Counties, Florida by the year 2000 (10% of commuter traffic and 20% of fleet traffic or 250,000 vehicles).(2) As a result of this expansion of the electric vehicle market, night-time load will be increased by 1000 mw by the Year 2000 and by 4000 mw by Year 2010 (3). This scenario has implications for:

- 1) FPL's marketing and promotion efforts to encourage electric vehicle ownership/operation and appropriate markets to target.
- 2) The battery charging delivery system required, and
- 3) Additional generating capacity, if any, required. (It should be noted that if little new capacity is required to support the incremental night-time load generated by electric vehicles, the result should have a favorable impact on FPL's cost/kwh of generation.)

\*The numbers in parentheses indicate environmental states that would appear to have relevance for areas of FPL strategic decisions. These are identified directly below the scenario itself. Such strategic decision issues also may be found in the specified scenario branch in Subset Diagram One.

Scenario A  
derived from  
Subset #1  
roadmap  
relevant for  
shown SDIs




# WHAT SPIRE PROVIDES

- Strategic decisions that need to be coordinated; how to organize to do so
- The sequence or order in which decisions need to be addressed
- The intervention points wherein the prospective environment can be “shaped”
- A comprehensive tool for monitoring environmental change

## WHAT SPIRE PROVIDES (cont.)

- Sequence of event (or “path”) forecast scenario road maps with direct relevance for SDIs
- A strategic Knowledge Management architecture for monitoring “change.”
- The design specifications for an adaptive network organization, and
- **Most importantly, provides almost instantaneous revision of all of the above with input of additional linkage statements.**

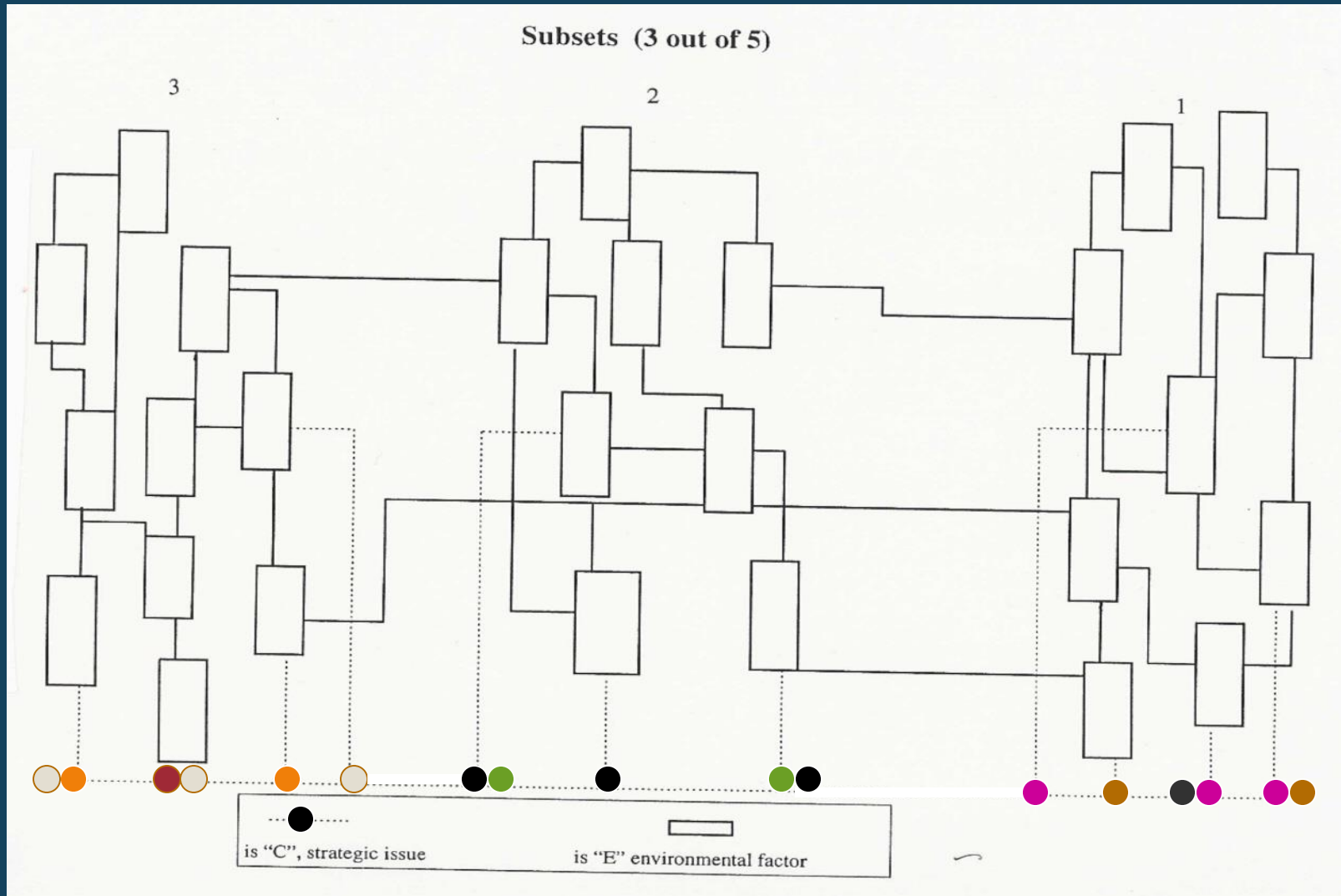
- 
- THESE ARE THE “CROWN JEWELS”  
-- WHEN THERE’S NO “DESIRED  
OUTCOME” PROVIDED OR  
EVEN APPROXIMATELY KNOWN

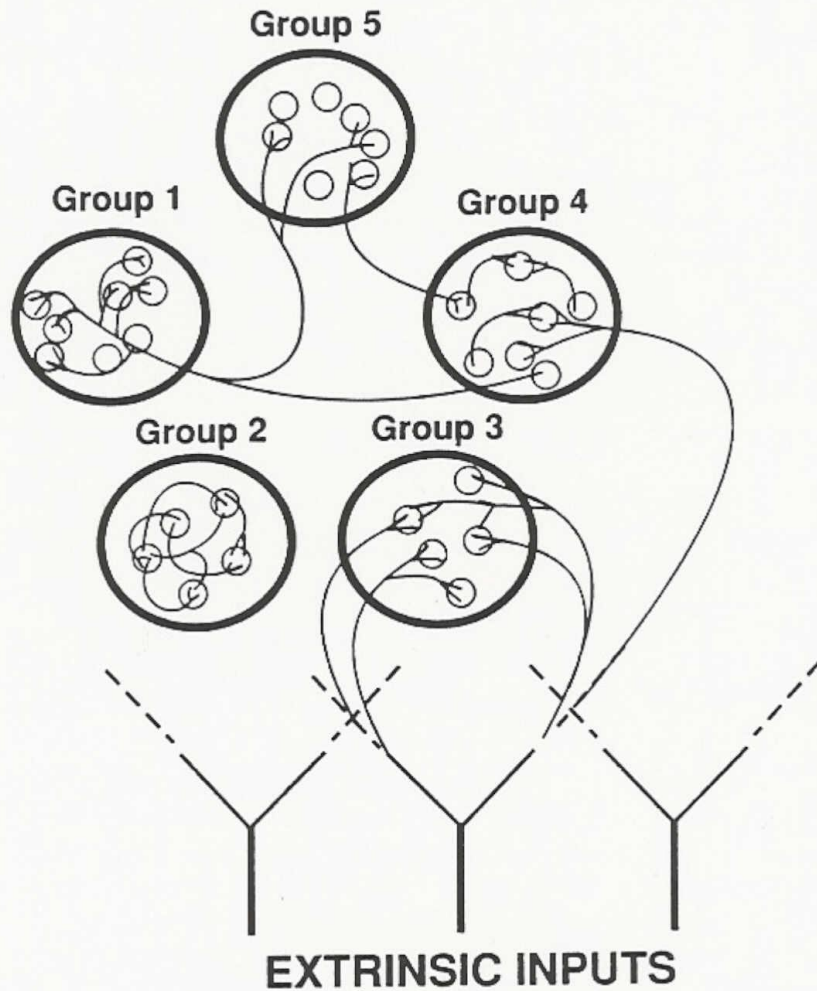
- THESE ARE THE "CROWN JEWELS"  
-- WHEN THERE'S NO "DESIRED  
OUTCOME" PROVIDED OR  
EVEN APPROXIMATELY KNOWN

BUT DOES THE SPIRE ARCHITECTURE  
HAVE ANY CONCEPTUAL FOUNDATION?

# Schematic of SPIRE Architecture

(Note SWN and neural network architecture)



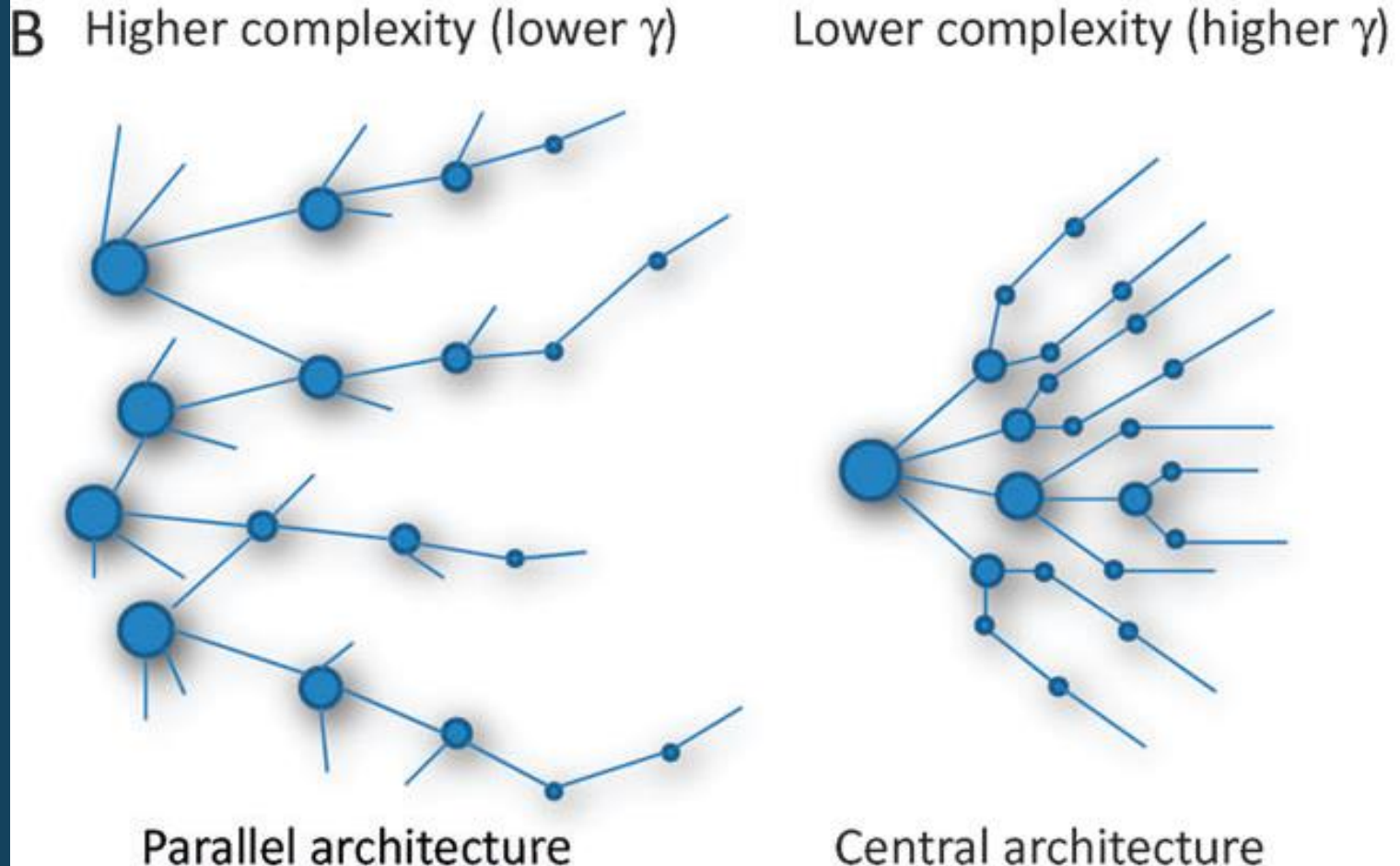


## Edelman's proposed neuronal group architecture (1992):

- group structure triggered by common set of ext. inputs
- all neuronal groups not connected to all inputs
- No two groups internally structured the same way
- More interconnectedness within groups than among groups



# Note similarity to Edelman architecture



Tomasi & Volkow, 2011

Hypothetical neural networks representing resting state (left) and focused single goal-oriented mental activity (right). Hub (circle) size related to functional connectivity density between hubs.

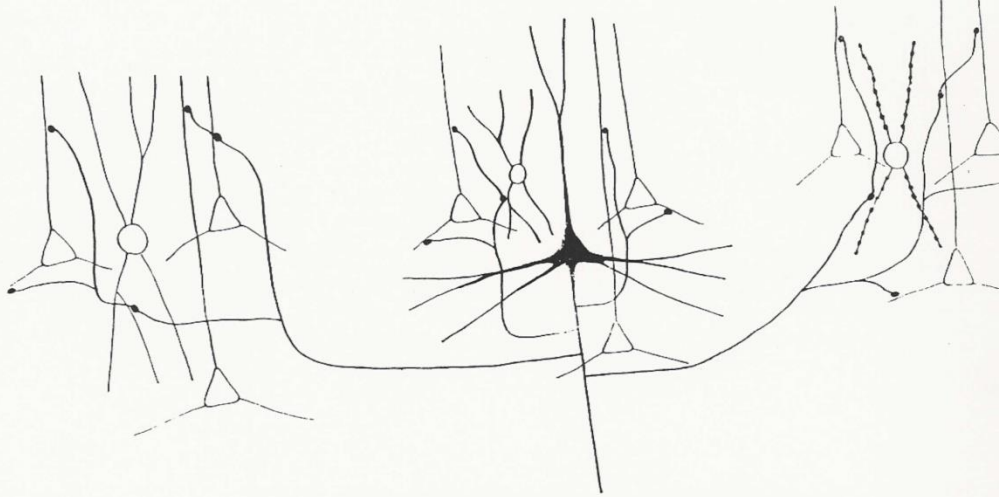
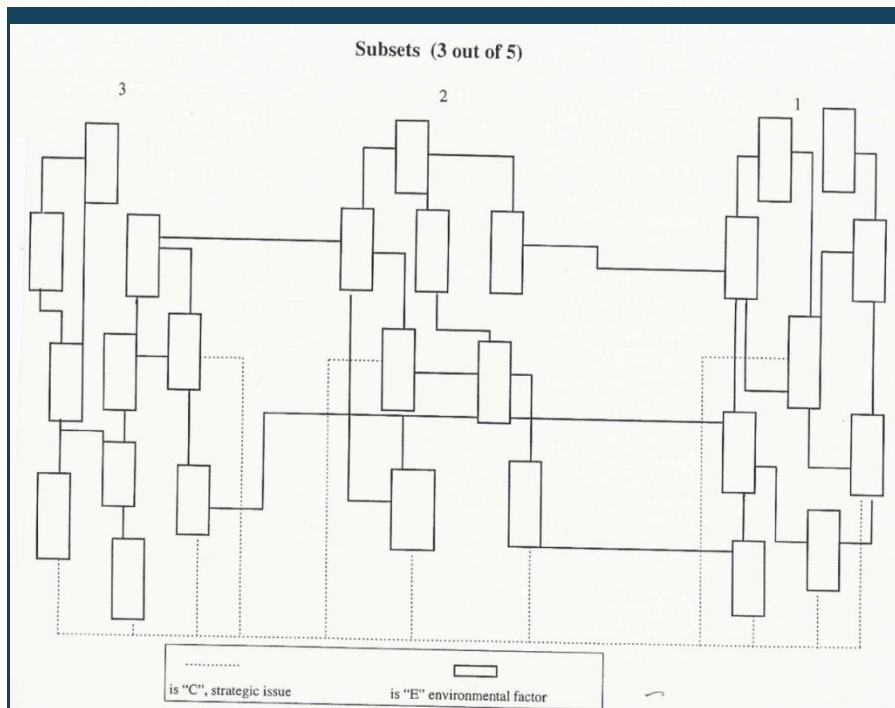


Fig. 17. Schematic diagram of intrinsic horizontal connections described in this paper. Superficial layer pyramidal cell (in black) has discrete clusters of axon terminals. Within each cluster, the axon terminals contact other pyramidal cells (usually on spines, not shown), and some smooth stellate cells. There are several morphological types of smooth stellates contacted, suggested by different shapes here. Actual terminal positions of pyramidal cells is not known.

SCHMATIC OF NEURON NETWORK STRUCTURE  
(INDICATING CONNECTIVITY)  
FROM MCGUIRE (1991)



SPIRE diagram  
architecture resembles  
biological neural  
networks, exhibiting

- connectivity
- plasticity/adaptation
- emergence
- self-organization
- CAS & SWN properties



A case can be made that –

SPIRE architecture is just about as good as you can get from a neurocognitive perspective.



THAT'S ALL, FOLKS!