

STRUCTURE OF SCIENTIFIC REVOLUTIONS:

INTRO: (PREFACE)

v. Philosophical CONTEXT - AVOCATION

NOT a SPECIALIST

vii. FUND. OBJECTIVE: URGE CHANGE IN PERCEP. / EVAL. FAMILIAR DATA.

x. NOTHING SAID RE: TECHNOLOGY - WOULD ADD ANALYTIC DIMENSION.

I. INTRO: ROLE FOR HISTORY:

1. HISTORY OF SCIENCE: MAINLY FROM FINISHED SCIENTIFIC ACHIEVEMENTS.

- INSTANT: RESEARCH ACTIVITY ITSELF

2 - TRADITIONAL: DEVL. BY ACCUMULATION, INCREMENTAL PROCESS

- PRESENTS DIFFICULTIES - MAY NOT = ACCUMULATION.

IE. WRONG QUESTIONS

4 GREATER FOCUS ON COMMUNITY / GROUP / NON-EXPERIMENTAL.

MORE EXPANSIVE

* 5 NORMAL SCIENCE: WORK ASSUMES SCI. COMM. KNOWS WORLD.

- COMMUNITY'S WILLINGNESS TO DEFEND ASSUMPTION, ~ AT CONSID. COST.

- SUPPRESSION OF SUBVERSIVE NOVELTIES

- COMMITMENTS MAY = ARBITRARY :: NOVELTIES

6 - ANOMALIES: LEAD TO NEW COMMITMENTS / REVOLUTIONS.

- SHIFT IN STANDARDS / PROBLEMS -> CONTROVERSIES

- OBVIOUS + NON-OBVIOUS

7 SCIENTIFIC FACT + THEORY: NORMALLY INSEPARABLE, = REVOLUTION

- QUALITATIVE + QUANTITATIVE CHANGE.

II. ROUTE TO NORMAL SCIENCE:

10 NORMAL SCIENCE: BASED ON PAST ACHIEVEMENTS, ACCEPTED.

EFFECTS: 1) ACHIEVEMENT DREW ADHERENTS

2) OPENED NEW PROBLEMS

= paradigms : TRADITIONS

- 11 - STUDY OF PARADIGMS = INITIATION RITE; MAINTAINS TRADITION
- SHARE RULES AND STANDARDS
- ACHIEVEMENT ('% THEORY) = PROFESSIONAL LOCUS

12 REVOLUTION: NON-EXISTENT UNTIL NEWTON (late 17th C.)

prior: THEORETICAL SCHOOLS IN COMPETITION.

: LESS THAN SCIENCE; CONSTANT BUILDING OF FOUNDATIONS

: INTER-COMMUNITY COMPETITION '% DISCOVERING NATURE

13 - COULD SUPPORT SIGNIFICANT DISCOVERY

14 : INCONSISTANT FACT COLLECTION - NO PRE-ESTABLISHED THEORY.

16 NATURAL NK - REQUIRES THEORETICAL + METHODOLOGICAL BELIEF SYSTEM

18 EMERGENCE OF PARADIGM: AFFECTS GROUP STRUCTURE → SYNTHESIS OF NEXT GENERATION.

19 - OLDER THEORISTS: IGNORED - RETREAT TO DEPT. OF Ø.

- MORE RIGID DEFINITION OF SCIENTIFIC GROUP

20 - FROM BOOKS TO SHORT ARTICLES TO PROF. COLLEAGUES.

- FURTHER ISOLATION OF LAYMEN IN UNINTELLIGIBLE LITERATURE.

21 - NOT ALWAYS AS SUDDEN, BUT NOT NORMALLY GRADUAL CHANGES.

III. NATURE OF NORMAL SCIENCE:

23 paradigm: REPRESENTS WORK DONE ONCE + FOR ALL - BUT CREATES QUESTIONS.

STANDARD USAGE: MODEL FOR REPLICATION.

SCIENCE: REPLICATION = UNBIASEDLY

: PARADIGM SUCCESS: SOLVES WIDELY-ACKNOWLEDGED ACUTE PROBLEM.

24 BUT: REQUIRES MAPPING-UP = NORMAL SCIENCE

∴ IN BOX WHICH PARADIGM CREATES

∴ NORMAL SCIENCE ≠ DISCOV. NEW PHENOM.

NORMAL SCIENCE: RELAXES BOUNDARIES WHEN PARADIGM CEASES TO HOLD.

25 3 NORMAL FOCI: FACTUAL SCIEN. INVES: [NOT always distinct]

1. CLASS OF THINGS WHICH PARADIGM SHOWS = REVEALS
2. SMALLER CLASS WHICH CAN = COMPARED TO PARADIGM PREDICTIONS.
3. EMPIRICAL WORK TO ARTICULATE PARADIGM THEORY. ie. Residual Ambig.

28 - NOT RESTRICTED TO UNIVERSAL CONSTANTS.

- ALSO = QUALITATIVE LAWS.

- APPLYING PARADIGM TO NEW AREAS OF INTEREST.

30 - PARADIGM-DEPENDENT: PREDICT FACTUAL INFO. (TECH.)

- INCREASES PARADIGM APPLICATION.

34 ALSO = SOME EXTRAORDINARY PROBLEMS.

IV. NORMAL SCIENCE AS PUZZLE-SOLVING:

NORMAL SCIENCE: STRIKINGLY ≠ AIM TO PRODUCE MAJOR NOVELTIES.

37 PUZZLES: INTRINSIC VALUE ≠ CRITERION; = EXISTENCE OF SOLUTION.

PARADIGM - WHILE ACCEPTED, ASSUMES SOLUTIONS TO PROBLEMS.

*→ - MAY INSULATE COMMUNITY FROM SOCIALLY IMPORTANT PROBLEMS.

LAW - SCIENCE

*→ - SEEMINGLY RAPID PROGRESS = DUE TO ONLY WORKING PARADIGM.

IE. ILLUSION

*→ 38 - ATTRACTION IN PUZZLE 'LO OPENING UP HORIZONS.

- ADDICTIVE

RULES WHICH LIMIT NATURE OF ACCEPTIBLE SOLUTIONS, STEPS TO ACHIEVE.

41 QUASI-METAPHYSICAL COMMITMENTS: eg. CARTESIAN UNIVERSE

42 STRONG NETWORK OF COMMITMENTS - DEFINE PROBLEMS.

- MAY = SIGNIFICANTLY MISLEADING.

- RULES DERIVED FROM PARADIGMS

V. THE PRIORITY OF PARADIGMS :

- 43 SEARCH FOR RULES = MORE DIFFICULT THAN PARADIGMS.
- 44 - LACK STANDARD INTERP. / AGREEMENT ≠ PREVENT PARADIGM
- 45 WITTGENSTEIN : LANGUAGE ≠ UNIVERSAL, AGREED CHARACTERISTICS.
= CLOSE RESEMBLANCES ONLY : NETWORK
= SAME IN RESEARCH w/in SINGLE TRADITION.
- 46 problem w/ rules: 1) DIFFICULTY DISCOVERING;
2) CONCEPTS NOT LEARNED IN ISOLATION.
- RELATED TO NATURAL PHENOM: APPLICATION.
- 47 SCIENTISTS : LITTLE BETTER THAN LAYMEN AT CHARACTERIZING FIELD BASIS.
- 48 RULE DEBATE - OCCURS BEFORE + DURING REVOLUTIONS.
- 49 MAY = SUB-SPECIALTY REVOLUTION : RELATED TO LITTLE REAL COHERENCE.

VI. ANOMALY + EMERGENCE OF SCIENTIFIC DISCOVERIES :

- WHEN SUCCESSFUL, NORMAL SCIENCE ≠ FIND NOVELTIES.
- 52 DISCOVERY : REGULARLY RECURRENT EVENT.
- BEGINS w/ AWARENESS OF ANOMALY - VIOLATION OF PARADIGM.
- PARADIGM THEORY ADJUSTS TO EXPECT.
- 55 "DISCOVERY" - SUGGESTS SIMPLE ACT, BUT = COMPLEX EVENT
IE. OBSERVATION + CONCEPTUALIZATION. = PROCESS.
- 56 MAY / NOT = CHANGE IN PARADIGM.
CAN BEGIN w/ PERCEPTION OF "PROBLEM."
- 59 [X-RAYS] VIEWED w/ SHOCK - VIOLATED EXPECTATIONS. [RESISTANCE]
DECISION TO EMPLOY INSTRUMENTS - ASSUMPTIONS AS TO RESULTS.
- PARADIGM PROCEDURES = NECESSARY BUT RESTRICTIVE.
- 60 ALSO = SPECULATIVE, UNARTIC. THEORIES - LEAD TO DISCOVERY.
- 64 NOVELTY EMERGES w/ DIFFICULTY AGAINST BACKGROUND OF EXPECTATIONS.
- IE. PROFESSIONAL RIGIDITY. v. LESS DISTRACTIONAL COMPLETENESS

VII. CRISIS AND EMERGENCE OF SCIENTIFIC THEORIES:

66 GAIN ACHIEVED ONLY THRU DISCARD AND REPLACEMENT: DISCOV. / NEW THEORIES

- CHANGE THRU = DISCOVERY - THOUGH NOT ONLY ONE

: NEW THEORIES =

- NORMALLY PRECEDED BY PROF. INSECURITY / RULE FAILURE

Eg. Ptolemaic system: [ADVANCES SLOWED BY NON-PRINTING].

- SOCIAL PRESSURE - CALENDAR REFORM

- KNOWN INADEQUACIES

- TECHNICAL BREAKDOWN (CRISIS)

71 PROLIFERATION OF VERSIONS OF THEORY ~ SYMPTOM OF CRISIS.

Eg. phlogiston

73 ABSENCE OF CONFLICT UNTIL = RELEVANT EXPERIMENTAL TECHNIQUES.

eg. relativity IN Leibniz v. NEWTONIAN IDEA OF SPACE & CRISIS.

VIII. RESPONSE TO CRISIS:

77 PARADIGMATIC THEORY - NOT INVALID UNLESS = REPLACEMENT

- NO RESEMBLANCE TO FALSIFICATION BY COMPARISON: (IN PARADIGMS).

80 CRISIS - LOOSENS RULES OF NORMAL PUZZLE-SOLVING.

82 ANOMALY - MUST = MORE THAN ANOMALY TO PROVOKE CRISIS.

- QUESTION FUNDAMENTAL GENERALIZATIONS

- INHIBITS PRACTICAL APPLICATIONS.

- CAUSE RE-ADJUSTMENT OF PARADIGM - MULTIPLE TIMES = BLURS

84 TRANSITION TO NEW TRADITION PARADIGM ≠ CUMULATIVE.

- RECONSTRUCTION - NEW FUNDAMENTALS

- DECISIVE DIFFERENCE IN MODES OF SOLUTIONS.

EXTRAORDINARY SCIENCE: PUSH NORMAL SCIENCE RULES HARDER

: SPECULATIVE THEORIES

88

: TURN TO Ø

IX. NATURE AND NECESSITY OF SCIENTIFIC REVOLUTIONS:

92 COMPARISON w/ POLITICAL DEFINITION.

- CESSATION OF INSTITUTIONS MEETING NEEDS.
- AIM TO CHANGE IN WAYS PROHIBITED BY INSTITUTIONS.
- TECHNIQUES OF MASS PERSUASION.
- EXTRA-POLITICAL / EXTRA-INSTITUTIONAL EVENTS.

95 - CHOICE BETWEEN INCOMPATIBLE MODES OF COMMUNITY LIFE.

- NO STANDARD HIGHER THAN COMMUNITY ASSENT

∴ LOGIC AND PERSUASION.

96 CUMULATIVE IMAGE OF SCIENCE - NOT HISTORICALLY SHOWN TO EXIST.

THEORETICALLY IMPROBABLE - NORMAL SCIENCE = CUMULATIVE BUT ROUTINE

98 LOGICAL INTER-THEORY = HISTORICALLY IMPLAUSIBLE. - CONTRADICTORY

100 - MUST = COMMITMENT TO PARADIGM + ITS KNOWN/UNKNOWN EXTENSIONS.

102 - CHANGE MEANING OF FAMILIAR CONCEPTS / VIEW.

103 DIFFERENCES IN SUCCESSIVE PARADIGMS = BOTH NECESSARY + IRRECONCILABLE

- DIFFER IN MORE THAN SUBSTANCE = METHODS, STANDARD OF SOLUTION

∴ ~ REDEFINITION OF CORRESPONDING SCIENCE.

OLD PROBLEMS - RELEGATED TO ANOTHER SCIENCE OR DECLARED UNSCIENTIFIC

- NEW NORMAL SCIENCE TRADITION = INCOMMENSURABLE w/ PRIOR

108 - CUMULATIVE IMPROVEMENT OF STANDARDS = MYTH. [IN THEORY CHANGE]

109 SIGNIFICANT SHIFTS IN CRITERIA FOR PROBLEMS + SOLUTIONS

*-> 110 QUESTION OF VALUES = CRITERIA OUTSIDE NORMAL SCIENCE

X. REVOLUTIONS AS CHANGES OF WORLD VIEW:

114 CHANGE IN <VISUAL> GESTALT / GESTALT SWITCH

116 MINOR PARADIGM CHANGE - PREPARES FOR MORE DISCOVERY.

119 CHANGE WAY NATURAL PHENOM. SEEN. - SHIFT OF VISION

- 122 VIEW CHANGE ≠ INTERPRETATION. No raw data.
= SUDDEN, UNSTRUCTURED EVENT - LIKE Gestalt switch
- 123 FLASHES OF INTUITION - EXPERIENCES, BUT NOT LOGICALLY CONNECTED
NEW LINK TO NEW PARADIGM.
- 126 SENSORY EXPERIENCE: WESTERN EPISTEMOL. = FIXED AND NEUTRAL.
- SCIENTIST SEES ACCORDING TO PARADIGM
 - SELECTS ACCORDING TO PARADIGM
- 127 - LANGUAGE ≠ PROVIDE NEUTRAL / OBJECTIVE REPORTS
- 128 - CHANGING OF MEANING TO ADAPT [IE. RE-EMPLOYING INSTRUMENTS]
- 132 PRIOR TO ANY PARTICULAR LAB EXPERIMENT.
- 135 MAKING NATURE FIT PARADIGM - CHANGES OF PUZZLES.

POST-MODERNISM

XI. INVISIBILITY OF REVOLUTIONS:

- 136 AUTHORITATIVE SOURCE - SCIENTISTS / LAYMEN - SYSTEMATICALLY DISGUISES.
- 137 - UNPRECEDENTED EXTENT: KNOWLEDGE BASED ON TEXTBOOKS.
- CONTAIN LITTLE HISTORY: ILLUSION OF HX. TRADITION.
 - ILLUSION THAT SCIENCE = CUMULATIVE.
- 139 - REVISIONIST HISTORY
- 140 RENDER REVOLUTIONS INVISIBLE
- IMPLIES STRIVEN FOR PARTICULAR OBJECT.
 - IGNORES THAT MANY PUZZLES ≠ EXIST PRIOR TO PARADIGM.

XII. RESOLUTION OF REVOLUTIONS:

- 145 PARADIGM TESTING: ONLY AFTER PERSISTENT PUZZLE FAILURE → CRISIS
- RIVAL PARADIGMS IN COMPETITION.

146 VERIFICATION - LIKE NATURAL SELECTION : PROBABILISTIC

FALSIFICATION - POPPER : NEGATIVE OUTCOME = REJECT THEORY.

- DOUBTS THAT EXISTS: THEORIES ≠ PERFECT.

147 - MORE LIKE POST-PARADIGM TRIUMPH, CLOSE TO VERIFICATION.

149 ONLY PARTIAL COMMUNICATION BETWEEN NEW/OLD PARADIGMS UNTIL CONVERSION.

151 TRANSFER TO PARADIGM = CONVERSION PROCESS : CAN = GENERATIONAL.

155 COMPETITOR'S ABILITY TO SOLVE PROBLEMS

ALSO: AESTHETIC SUPERIORITY: SUBJECTIVE CONSID.

157 ONLY = COUCHED IN PROBLEM-SOLVING ABILITIES = GUIDE FUTURE RESEARCH.

158 CRISIS ≠ ENOUGH. MUST = OTHER BASIS : NEED NOT = RATIONAL.

XIII. Progress through Revolutions :

160 CONTINUING EVOLUTION

SCIENCE ASSOCIATED W/ PROGRESS : FUNDAMENTAL QUESTION.

161 - RENAISSANCE - NO DISTINCTION: ARTS + SCIENCES

163 PROGRESS = EYE OF THE BEHOLDER; NON-COMPETITION - MAKES EASIER TO SEE.

164 UNPARALLELED ISOLATION FROM LAITY + EVERYDAY LIFE.

166 REVOLUTIONS - CLOSE W/ TOTAL VICTORY: IE. "PROGRESS"

167 CHOICE : PARADIGMS - TO COMMUNITY (SCIENTISTS)

*> - TENUOUS HOLD OF SOCIETY ON SCIENCE.

168 BULK OF SCIENCE EXP. = EUROPE, LAST 4 CENTURIES.

- PROBLEM-SOLVING : DETAIL PROBLEMS

- NON-APPEAL TO GOV'T

169 - NATURE 'O SOCIETY UNDERMINES

170 NO ATTEMPT TO SHOW PROGRESS TOWARD ANYTHING. IE. TRUTH.

172 EQ. EVOLUTION : NOT TELEOLOGICAL, = INCREASED COMPLEXITY.

POSTSCRIPT - 1969: (+7 yrs)

175 paradigm in book: 2 SENSES :

1 - ENTIRE CONSTELLATION OF SHARED VALUES, TECHNIQUES w/in Community.

2 - ELEMENT: CONCRETE PUZZLE SOLUTIONS, REPLACE EXPLICIT RULES

176 1. Paradigms + Community Structure:

paradigm: ENTERS circularly, shared by all w/in community

- INTUITIVE ASPECT OF COMMUNITY: PRACTITIONERS, SPECIALTY, EDUCATION

- INCOMPAT. VIEW = RARE

- FULL COMMUNICATION, RELATIVELY UNANIMOUS: global + SPECIFIC (+micro)

177 - SAME SOCIETIES + JOURNALS

178 - PRE-TRANSITION = COMPETITION; post = reduced schools, > EFFICIENCY.

180 2. paradigm ≠ govern SUBJECT MATTER. GOVERNS COMMUNITY:

181 CRISIS AS PREREQUISITE: NOT NECESSARY but seldom WITHOUT.

182 DISCIPLINARY MATRIX 'lo paradigm for specialist theories:

- MORE GENERAL THAN "theories"

1. Symbolic generalizations = SERVE AS LAWS + def. of symbols, IE. legislative

2. metaphysical paradigms : / PARTS OF PARADIGMS: BELIEFS IN MODELS

184 3. VALUES: PREDICTIONS; JUDGING WHOLE THEORIES; VARY RE: APPLICATION

185 - INDIV. VARIATION (SUBJECTIVITY)

186 Role of Subjectivity:

1. Shared values - IMPORTANT determinants of group behavior.

- ROLE OF RISK TAKING RE: ANOMALIES

- RISK DISTRIBUTION

Role of Soc. Science

4. EXEMPLARS : model problem-solutions

3. PARADIGMS AS SHARED EXAMPLES:

187 MOST NOVEL, LEAST UNDERSTOOD

LOCALIZATION OF COGNITIVE CONTENT TO THEORY ONLY = WRONG.

IE. PROBLEMS = ROLE; SEE problem like old problem.

189

- SOLVE PUZZLES THROUGH MODELING ON PRIOR PUZZLE-SOLUTIONS.

4. TACIT KNOWLEDGE AND INTUITION:

191 INTUITION: USED AS COMMUNITY % INDIV. CONCEPT; ACQUIRED THRU TRAINING.

≠ UNANALYZABLE :

5. EXEMPLARS, INCOMMEN., REVOLUTIONS:

204 GESTALT SWITCH - HEART AT REVOLUTIONARY PROCESS.

6. REVOLUTIONS + RELATIVISM:

206 NO THEORY INDEPENDENT WAY TO DEAL W/ REALITY.

7. NATURE OF SCIENCE:

209 NEED FOR CROSS-COMMUNITY COMPARATIVE STUDY.

210 SCIENTIFIC KNOWLEDGE, LIKE LANGUAGE = PROPERTY OF COMMUNITY.