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SYSTEMS ANALYSIS PROJECT ADVISORY COMMITTEE

and

MAPPS USERS GROUP

SLIDE MATERIAL

October 23-24, 1986

AGENDA

STATUS

PERFORMANCE ATTRIBUTES

MECHANICAL PULPING

UTILITIES

OPTIMIZATION

FUTURE DEVELOPMENTS

STATUS

23 CLIENTS

4 TRAINING COURSES

VERSION 3.0 DUE IN LATE FALL

PERFORMANCE ATTRIBUTE STRUCTURE

MECHANICAL PULPING

NEW UTILITIES

NEW MODULES

MARKETING AND ALLIED EFFORTS

DEMONSTRATION AT TAPPI ANNUAL MEETING

CHAIRED SESSIONS AT TAPPI AND AICHE MEETINGS

PRESENTED SEVERAL MAPPS SEMINARS

PREPARED TWO PAPERS FOR PUBLICATION/PRESENTATION

PERFORMANCE ATTRIBUTE MODELING

PURPOSE IS TO DEFINE STRUCTURE

CARRY NONCONSERVED INFORMATION

TESTED WITH MECHANICAL PULPING MODULES

SIMILAR TO EXISTING STREAM STRUCTURE

SYSTEMS ANALYSIS
PROJECT ADVISORY COMMITTEE MEETING

OCTOBER 1986

GARY L. JONES
PROCESS MODELING GROUP
MAPPS DEVELOPMENT

TOPICS

- MECHANICAL PULPING MODELING SIMULATION
- PERFORMANCE ATTRIBUTES
- OPTIMIZATION

MECHANICAL PULPING

OBJECTIVE

BY FALL MEETING:

1. DEVELOP MAPPS MODULES AND FLOW SHEET TO SIMULATE MAIN FEATURES OF MECHANICAL PULPING PROCESSES

2. INCORPORATE AND TEST FEASIBILITY OF SIMULATION OF PERFORMANCE ATTRIBUTES

MECHANICAL PULPING

BACKGROUND

- FAMILY OF HIGH-YIELD PULPING PROCESSES
  - TMP, CMP, TCMP
  - SGW, RMP, PGW

- MAJOR STEPS
  - PRETREATMENT
  - CHIP REFINING OR GRINDING
  - SECONDARY REFINING
  - SCREENING
  - CLEANING
  - REJECT
    - REFINING
    - SCREENING
    - CLEANING
  - CONSISTENCY CONTROL
    - STOCK MIXING
    - DILUTION
    - THICKENING

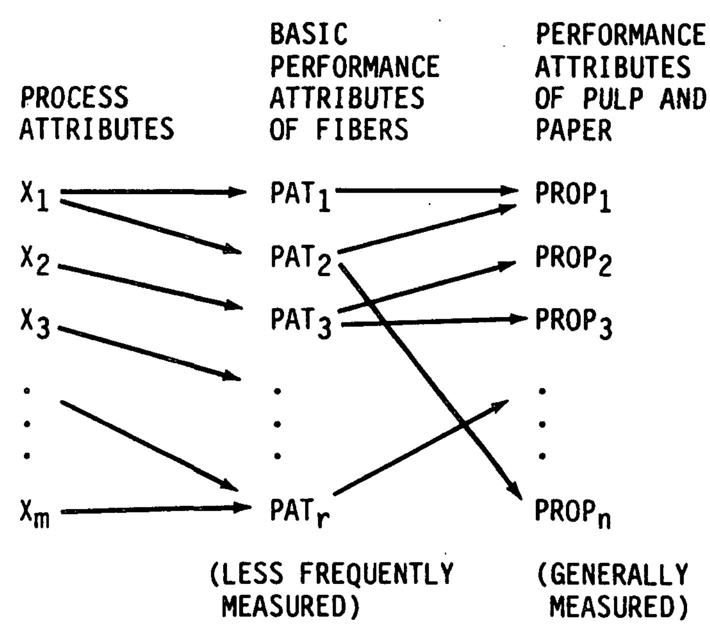
  - PROPERTY DEVELOPMENT
    - FIBERS SIZE REDUCTION
    - SHIVE REMOVAL
    - CURL SETTING OR REMOVAL
    - SURFACE AREA DEVELOPMENT
    - BRIGHTENING

MECHANICAL PULPING

BACKGROUND

- LITERATURE ABOUNDS WITH PROPERTY, QUALITY AND PERFORMANCE MODELS, AND DATA
- DIFFICULT TO INCORPORATE ALL FEATURES

- CONSENSUS POINTS TO FOLLOWING STRUCTURE



BACKGROUND

- PROP's CORRELATE WITH EACH OTHER
- PAT's MAY BE INDEPENDENT OR DEPENDENT
- NOT ALL X's ARE CONTROLLABLE

EXAMPLES

- X's PULP SPECIES, REFINING CONDITIONS, SCREENING, CLEANING DESIGN, PRE-TREATMENT AND BLEACHING CONDITIONS
- PAT's SIZE DISTRIBUTION, SHAPES, SPECIFIC SURFACE DEVELOPMENT, TENSILE PROPERTIES, CHEMICAL PROPERTIES
- PROP's HANDSHEET PROPERTIES:
  BULK, TEAR, BURST, TENSILE, ROUGHNESS, BRIGHTNESS, BREAKING LENGTH
  PULP PROPERTIES:
  VISCOSITY, YIELD, WET-WEB STRENGTH, FREENESS

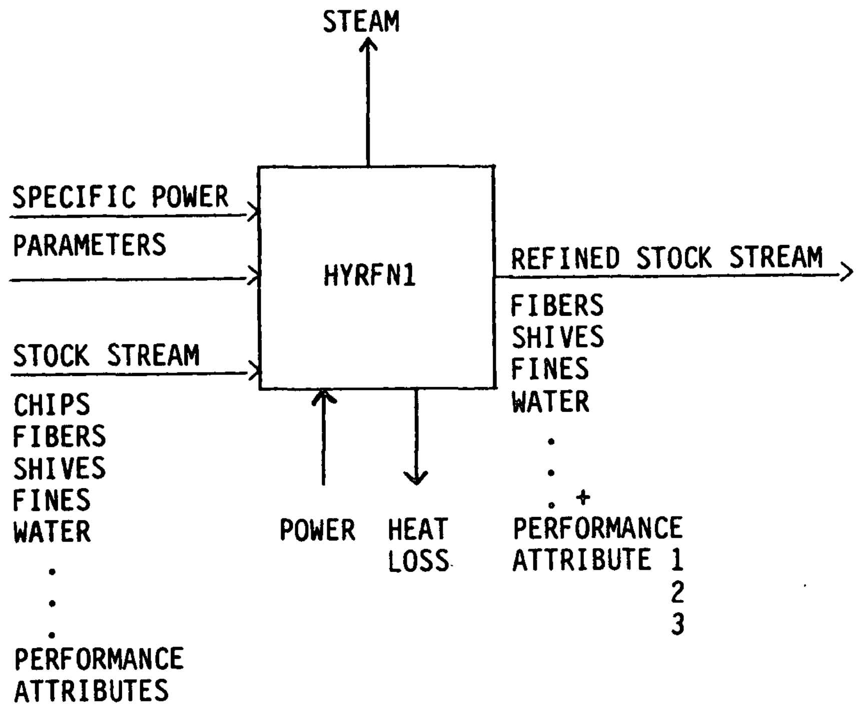
MECHANICAL PULPING

STATUS

- FOUR MECHANICAL PULPING MODULES DEVELOPED AND TESTED
- FLOW SHEET DEVELOPED AND TESTED
- PERFORMANCE ATTRIBUTES INCORPORATED AS INTEGRAL FEATURE OF MP SIMULATION
- FLOW SHEET OPTIMIZATION PERFORMED
- SEVERAL PRELIMINARY PULP AND PAPER PROPERTY MODELS INTRODUCED

MECHANICAL PULPING

REFINER MODULE SCHEMATIC



MECHANICAL PULPING

REFINER MODULE

INPUT PARAMETERS ACCOUNT FOR

- WOOD SPECIES
- FIBER PROPERTIES
- REFINER DESIGN
- PLATE OR STONE PATTERN
- PRETREATMENT CONDITIONS

MECHANICAL PULPING

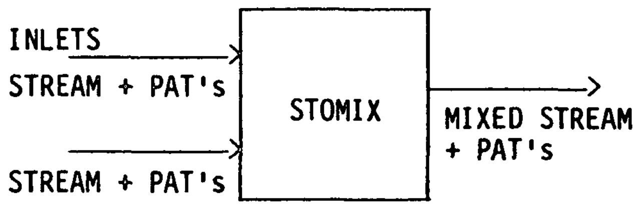
REFINERS CALCULATE

- CHANGE IN FIBER DISTRIBUTIONS
- FIBER FLOWS
- OUTLET CONSISTENCY AND TEMPERATURE
- PERFORMANCE ATTRIBUTES
  - LENGTH
    WEIGHT AVERAGE
    STANDARD DEVIATION
  - WIDTH
    NUMBER AND WEIGHT AVERAGE
    STANDARD DEVIATIONS
  - SURFACE AREA PARAMETER
    (STRAND-EDWARDS K-FACTOR
  - CANADIAN STANDARD FREENESS
- DISTRIBUTION 10 VALUES

- PULP AND PAPER PROPERTIES
  - BULK
  - TEAR FACTOR
  - BREAKING LENGTH
  - BURST INDEX
  - WET-WEB STRENGTH

MECHANICAL PULPING SIMULATION

STOCK MIXER MIXES STREAMS AND PERFORMANCE ATTRIBUTES (PAT's)



PERFORMANCE ATTRIBUTE MIXING

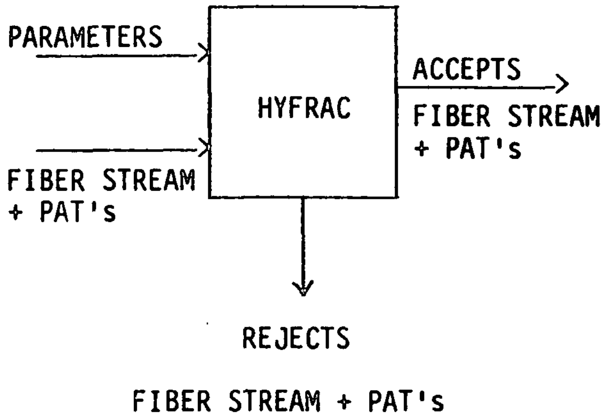
FIBER DIMENSIONS AND SPECIFIC SURFACES ASSUMED CONSERVED DURING MIXING

- $\overline{L}$, σ_{ℓ}, $\overline{W}$, σ_{W}, K-FACTOR, SPECIFIC GRAVITY MIXED BASED ON CONSERVATION
- CSF MODELED ON K-FACTOR (SPECIFIC SURFACE AREA)
- ABSORPTION COEFFICIENT C_k WT-AVERAGED
- KAPPA NO., FIBER TENSILE PROPERTIES NOT YET COMPUTED
- CURL INDEX (LATENCY) UNDER DEVELOPMENT

MECHANICAL PULPING

FIBER SEPARATION AND CONSISTENCY CONTROL

- PRESSURE SCREEN
- CENTRICLEANER
- THICKENER



THICKENER:

REJECTS = WATER + DISSOLVED COMPONENTS

ACCEPTS = SPECIFIED CONSISTENCY

SCREEN AND CENTRICLEANER:

REJECT PROBABILITY, P_{ij}

P_{ij} = f(FLOW SPLIT, L_i, W_j, 2 PARAMETERS)

CENTRICLEANER:

DIRT GOES TO REJECTS

HYDROGEN PEROXIDE BLEACHING

BACKGROUND

- LIGNIN PRESERVING (2-3% LOSS) REACTIONS
- OXIDATIVE ACTION OF PEROXIDE ANION, HO_2^-
- VARIOUS CHROMOPHORES CONTRIBUTE TO COLOR
- CARBOXYLIC ACIDS FORMED DECREASE pH
- CHROMOPHORES FORMED AT HIGH pH

- STABILIZED BY CHELATING AGENTS
- IONIC STRENGTH HAS LITTLE EFFECT
- BRIGHTNESS INCLUDES ABSORPTION (k) AND SCATTERING (S)
- ABSORPTION COEFFICIENT MORE FUNDAMENTAL
  - VARIES WITH WAVELENGTH
  - KINETICS BASED ON R_{457}

PEROXIDE BLEACHING

EQUILIBRIA

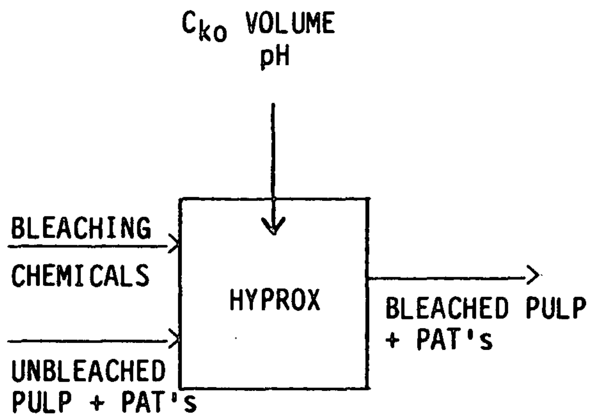
$$OH^- + H_2O_2 \rightleftharpoons HO_2^- + H_2O \qquad \text{PEROXIDE}$$

$$H_2O \rightleftharpoons H^+ + OH^- \qquad \text{WATER}$$

$$SiO_2 + H_2O \rightleftharpoons Si(OH)_2^{+2} + 2OH^- \qquad \text{BUFFER}$$

HYDROGEN PEROXIDE BLEACHING

MODULE SCHEMATIC



MODEL BASED ON S. MOLDENIUS, ROYAL INSTITUTE

MODULE CALCULATES

- CHANGE IN ABSORPTION COEFFICIENT, C_k
- PEROXIDE CONSUMPTION
- pH CHANGE - NEUTRALIZATION
- YIELD LOSS
- SHIVE REDUCTION
- REACTION TIME
- BLEACHED PULP PROPERTIES
  - TENSILE STRENGTH
  - DENSITY
  - SCOTT BOND
  - TEAR INDEX
  - ROUGHNESS

PEROXIDE BLEACHING

KINETICS (MOLDENIUS)

$$\frac{-dC_k}{dt} = k\ [C_k]^a\ [OH^-]^b\ [H_2O_2]_t{}^c$$

$C_k = C_{ko}\ t = 0$

$a = 2.2 \quad b = 0.23 \quad c = 0.69$

MAY BE CHANGED BY USER

$k = f_1\ (pOH_i)\ A(\text{CONSISTENCY})\ EXP(-E/RT)$

OPTIMAL CONSISTENCY: 10-11%

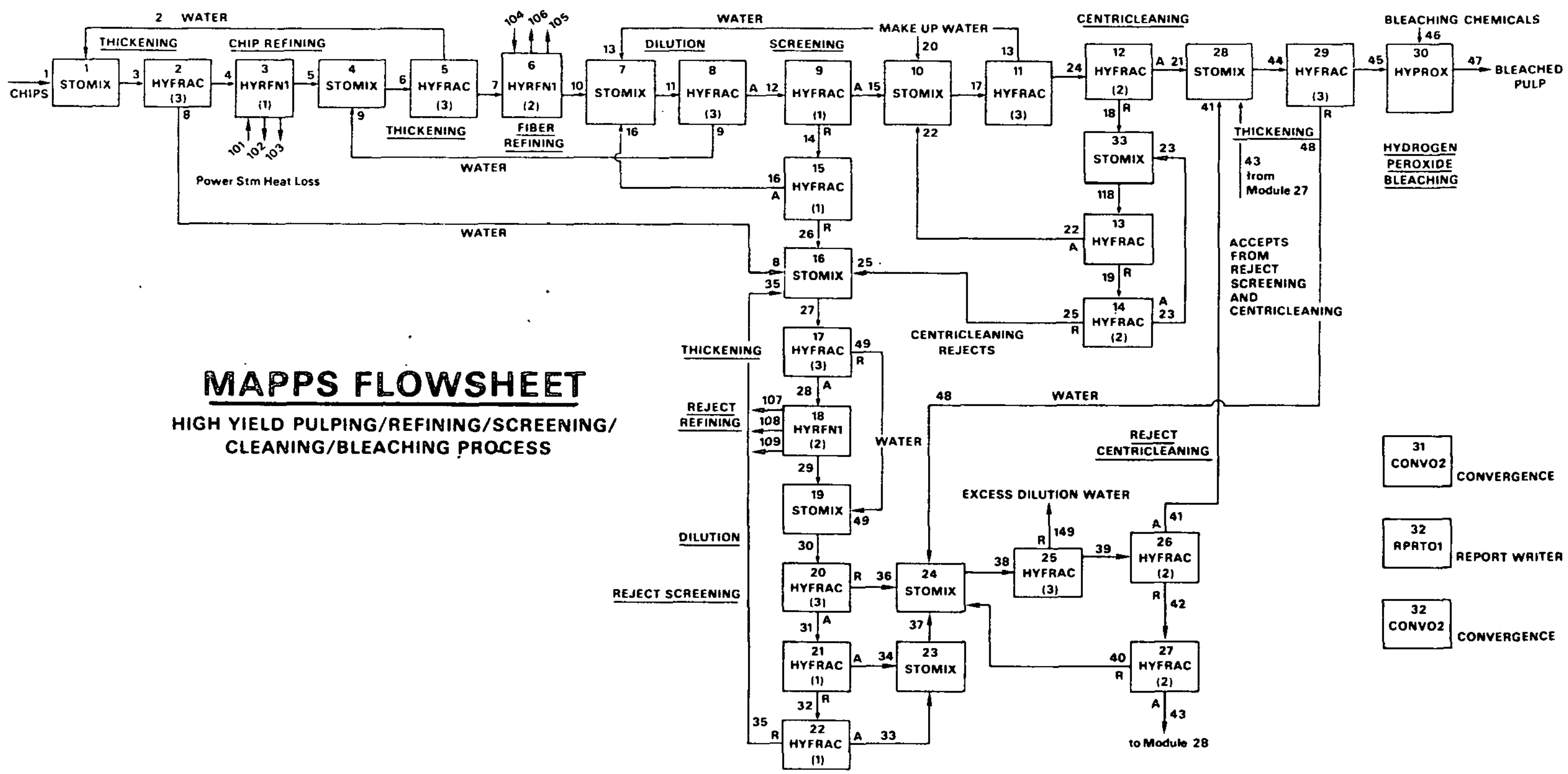
OPTIMAL pOH_i: ~11

C_{ko} = f(SPECIES, QUALITY)

EQUATIONS INTEGRATED OVER PLUG FLOW REACTOR

MECHANICAL PULPING FLOW SHEET

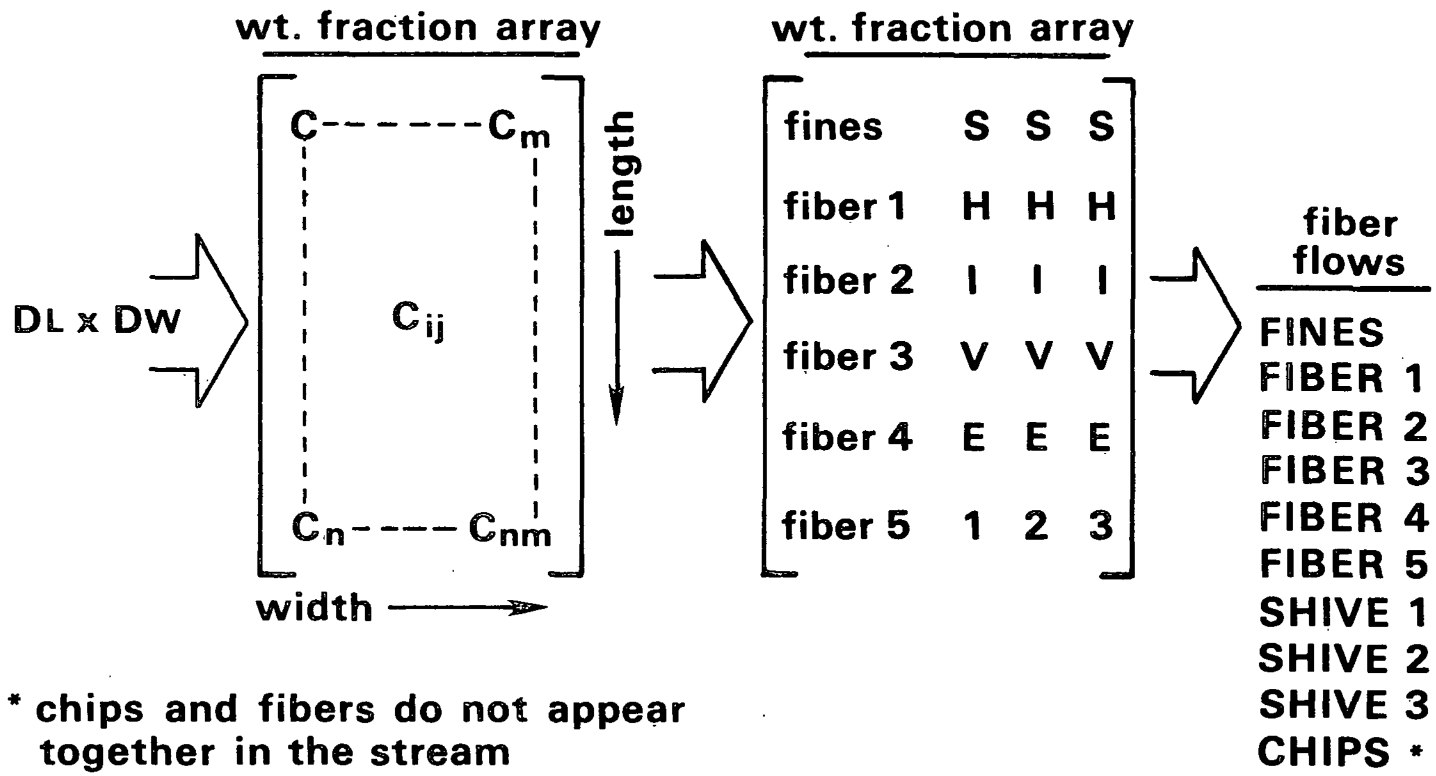
- PRIMARY REFINER
- SECONDARY REFINER
- REJECT REFINER
- PRIMARY SCREENS
- PRIMARY CENTRICLEANERS
- REJECT SCREENING
- REJECT CENTRICLEANING
- CONSISTENCY CONTROL
- PEROXIDE BLEACHING - SINGLE STAGE



MAPPS FLOWSHEET

HIGH YIELD PULPING/REFINING/SCREENING/ CLEANING/BLEACHING PROCESS

Mapping of 100 Internal Fiber Types to 9 Fiber Stream Components



* chips and fibers do not appear together in the stream

PERFORMANCE ATTRIBUTES

SURFACE AREA DEVELOPMENT PARAMETER
- RELATED TO FORMATION, BONDING, TENSILE PROPERTIES
- MODELED BY STRAND-EDWARDS K-FACTOR

CHIP REFINER
K = f(CONSISTENCY, SPECIFIC POWER)

SECONDARY REFINER
$K = f(K_o,$ CONSISTENCY, SPECIFIC POWER)

MIXING SPLITTING
K BASED ON CONSERVATION OF SPECIFIC SURFACE

$$\text{SPECIFIC SURFACE} = 1 - \frac{\sum X_i \, \ell n(L_i/2.4)}{K}$$

FREENESS MODEL

$$\text{CSF} = \text{EXP}\left(\frac{\text{ATOT} - 21.263}{3.032}\right)(\text{mL})$$

ATOT = SPECIFIC SURFACE (m^2/g)

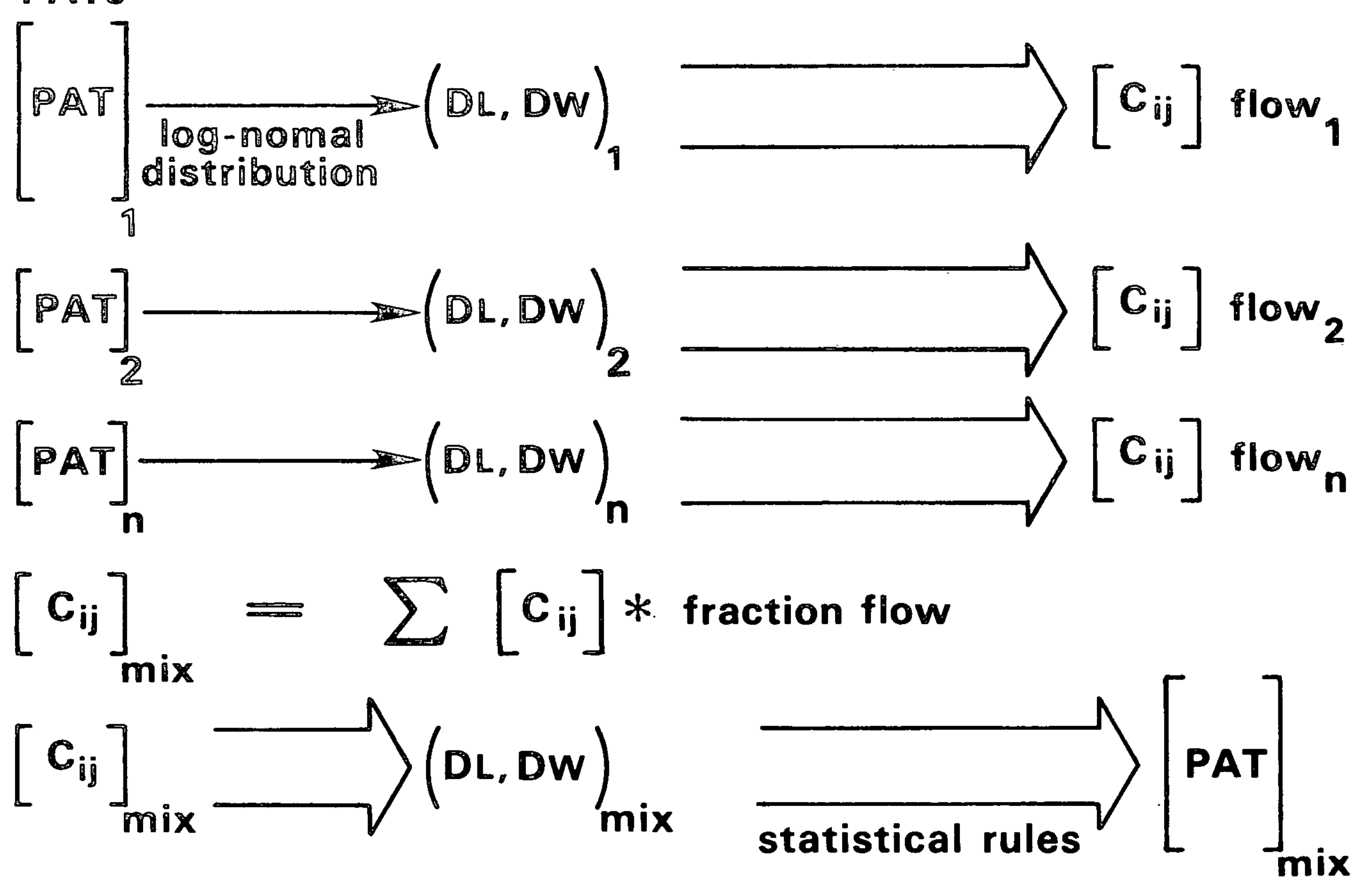
- RELATIONSHIP DUE TO STRAND AND EDWARDS BASED ON DATA BY STATIONWALA AND ATACK
- APPLIES TO REFINER, SPLITTING AND MIXING

PERFORMANCE ATTRIBUTE SUBSTREAM

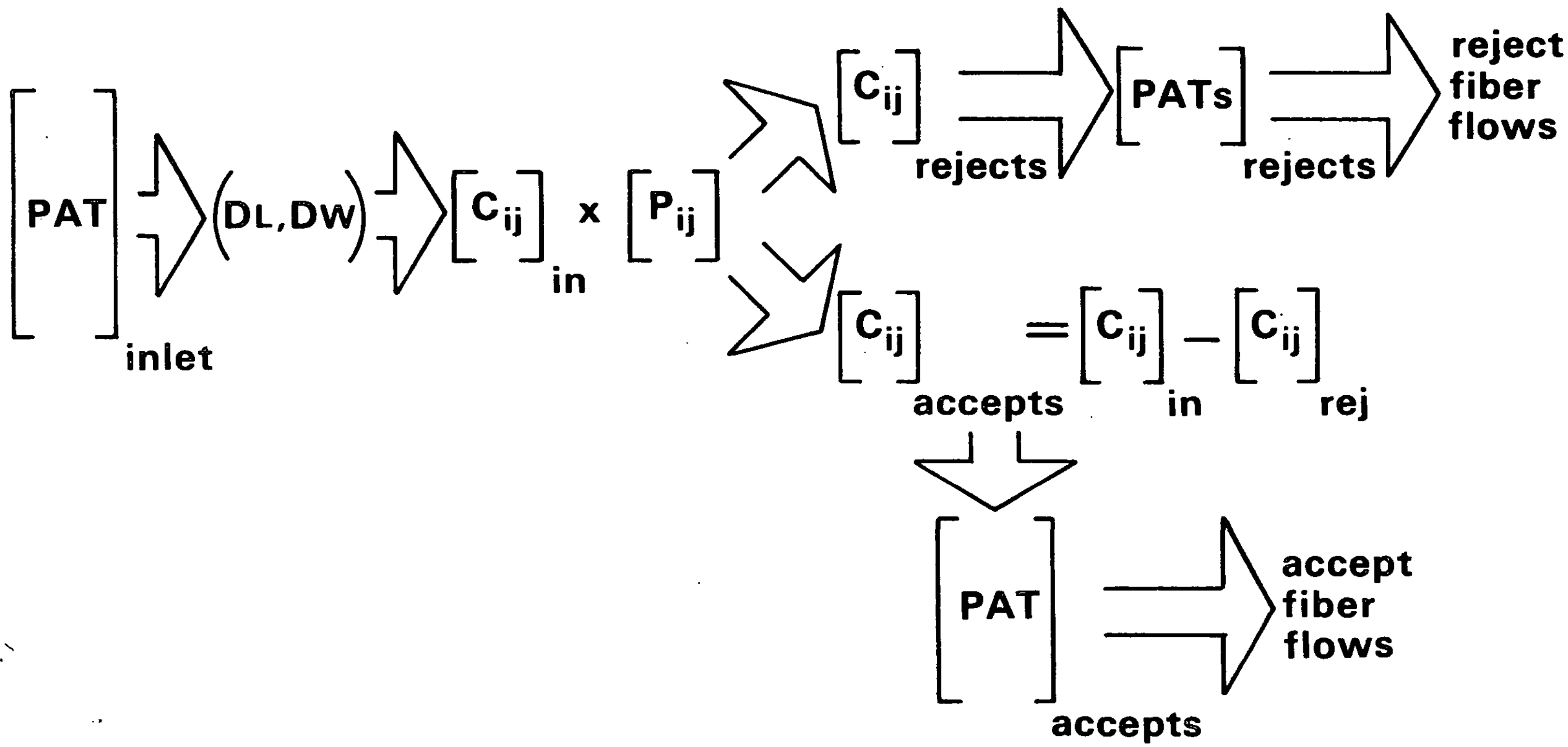
PATs ⟶

1	STREAM NO.	
2	TYPE	
3	KAPPA NO.	YIELD
4	$\bar{L}$	FIBER LENGTH DISTRIBUTION
5	σ_ℓ	
6	$\bar{W}$	FIBER WIDTH DISTRIBUTION
7	σ_W	
8	K-FACTOR	SURFACE AREA DEVELOPMENT
9	CSF	SURFACE AREA
10	C_k	ABSORPTION COEFFICIENT
11	CURL	LATENCY
12	SP. GR.	FIBER PHYSICAL PROPERTIES
13	TENSILE STRENGTH	
14	MODULUS	
15	CELL WALL THICKNESS	

Mechanical Pulping Stock Mixing



Screening and Centricleaning Performance Attribute Calculation



PHYSICAL PROPERTY MODELS

PROPERTY = $f(L_1, L_2, L_3)$

$L_1 > 28$ MESH

$100 < L_2 < 28$ MESH

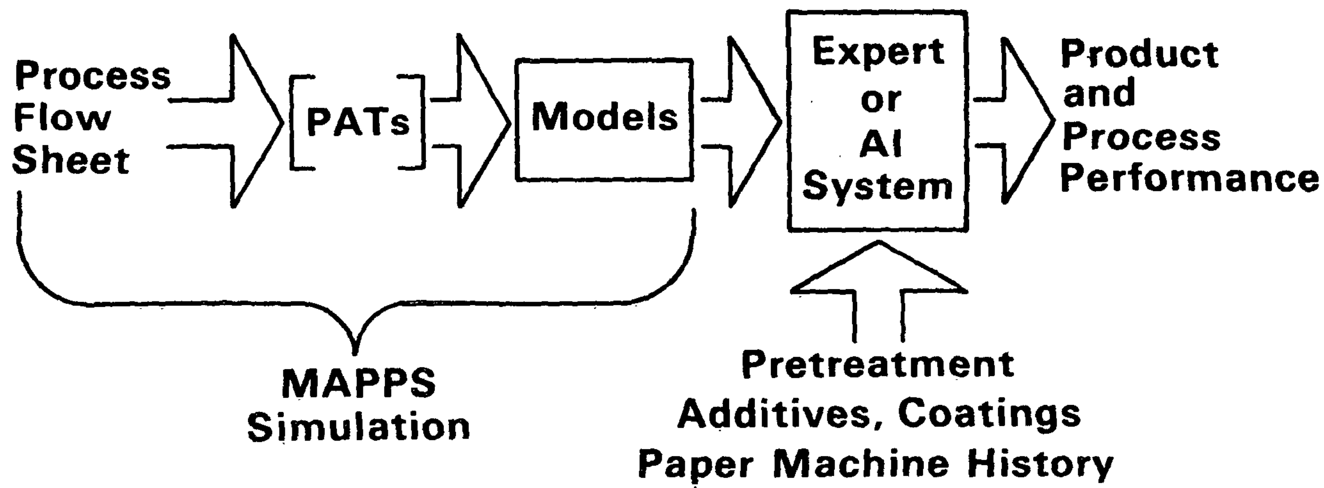
$L_3 < 100$ MESH

BASED ON WORK OF GAREAU AND LAW

REQUIREMENTS FOR EXPANDED USE OF PERFORMANCE ATTRIBUTES IN MAPPS

- DATABASE
- "STRUCTURE"
- MODELS, RULES
  - TRANSFORMING
  - MIXING
  - SPLITTING
- USER INTERFACE

Simulating Performance Attributes With MAPPS



EFFECT OF SEPARATION PROCESSES ON PULP AND PAPER PROPERTIES

PRIMARY SCREEN - TOTAL FLOW SPLIT 0.35

PROPERTIES	ENTERING FIBER STREAM	ACCEPT STREAM	REJECT STREAM
CONSISTENCY, %	1.0	0.9	1.05
CSF, mL	620	280	734
SPECIFIC SURFACE, m^2/g	2.5	4.2	1.3
BULK, cm^3/g	3.5	3.3	3.7
WET-WEB STRENGTH, g	123	120	125
TEAR INDEX	44	37	49
BURST INDEX	10.4	10.6	10.6
BREAKING LENGTH, km	1.7	1.9	1.4

EFFECT OF SEPARATION PROCESSES ON FIBER SIZE DISTRIBUTIONS

PRIMARY SCREEN - TOTAL FLOW SPLIT 0.35 FIBER SPLIT 0.44

		ENTERING FIBER STREAM (FLOWS IN LB/HR)	ACCEPT FIBER STREAM	REJECT FIBER STREAM
FINES		24	24	0
FIBER	1	47	29	18
	2	231	98	133
	3	155	39	116
	4	65	12	53
	5	163	28	134
SHIVES	1	65	7	58
	2	0	0	0
	3	0	0	0
PERFORMANCE ATTRIBUTES				
$\bar{L}$, mm		3.4	2.4	4.4
σ_L		3.1	3.4	3.3
$\bar{W}$, mm		0.08	0.08	0.08
σ_W		2.0	2.3	2.4
K-factor		0.214	0.214	0.214
CSF, mL		620	280	734

EFFECT OF SEPARATION PROCESSES ON FIBER SIZE DISTRIBUTIONS

PRIMARY CENTRICLEANER - TOTAL FLOW SPLIT 0.35
FIBER SPLIT 0.52

		ENTERING FIBER STREAM (LB/HR)	ACCEPT FIBERS	REJECT FIBERS
FINES		24	24	0
FIBER	1	34	11	23
	2	107	26	81
	3	43	12	31
	4	13	4	9
	5	33	13	20
SHIVES	1	8	1	7
	2	0	0	0
	3	0	0	0
PERFORMANCE ATTRIBUTES				
$\overline{L}$, mm		2.4	2.8	2.0
σ_L		4.2	4.8	4.5
$\overline{W}$, mm		0.077	0.066	0.091
σ_W		2.5	2.5	2.7
K-factor		0.214	0.214	0.214
CSF, mL		232	222	137

EFFECT OF SEPARATION PROCESSES
ON PULP AND PAPER PROPERTIES

PRIMARY CENTRICLEANER - TOTAL FLOW SPLIT 0.35
PULP SPLIT 0.52

PROPERTIES	ENTERING FIBER STREAM	ACCEPT STREAM	REJECT STREAM
CONSISTENCY, %	0.400	0.397	0.402
CSF, mL	232	222	137
SPECIFIC SURFACE AREA, m^2/g	5.6	4.9	6.3
BULK, cm^3/g	3.2	3.3	3.1
WET-WEB STRENGTH, g	128	129	126
TEAR INDEX	37	38	36
BURST	11.5	11.4	11.6
BREAKING LENGTH, km	2.11	2.09	2.10

EFFECT OF FIBER MIXING ON PULP AND
PAPER PROPERTIES MIXING THREE ACCEPT STREAMS

	PRIMARY CENTRICLEANING	REJECTS CENTRICLEANERS NO. 1	NO. 2	MIXTURE TO BLEACHING
PERFORMANCE ATTRIBUTES				
$\overline{L}$, mm	2.8	2.5	2.5	2.5
σ_L	4.8	5.9	6.0	6.3
$\overline{W}$, mm	0.066	0.029	0.029	0.029
σ_W	2.5	1.17	1.17	1.24
K-factor	0.214	0.176	0.176	0.180
CSF, mL	222	80	77	86
PROPERTIES				
SPECIFIC SURFACE, m^2/g	4.9	8.0	8.1	--
BULK, cm^3/g	3.3	3.1	3.1	3.1
WET-WEB STRENGTH, g	129	128	127	128
TEAR INDEX	38	37	37	38
BURST FACTOR	11.4	12.0	12.0	11.9
BREAKING LENGTH, km	2.09	2.1	2.1	2.1

CONCLUSIONS

MECHANICAL PULPING

- MODULES ARE FLEXIBLE AND ROBUST
- PROCESSING DIFFERENCES ACCOUNTED FOR BY MODULE PARAMETERS
- STRUCTURE IN PLACE FOR DETAILED SIMULATION

PERFORMANCE ATTRIBUTES MODELING

- PAT MODELING SHOWS PROMISE
- NEED MORE STRUCTURAL CHANGES TO MAPPS OR ADDITIONAL TOOLS DOWN THE ROAD
- ADDITIONAL PROPERTY MODELING SHOULD BE LEFT TO THE USER

MAPPS

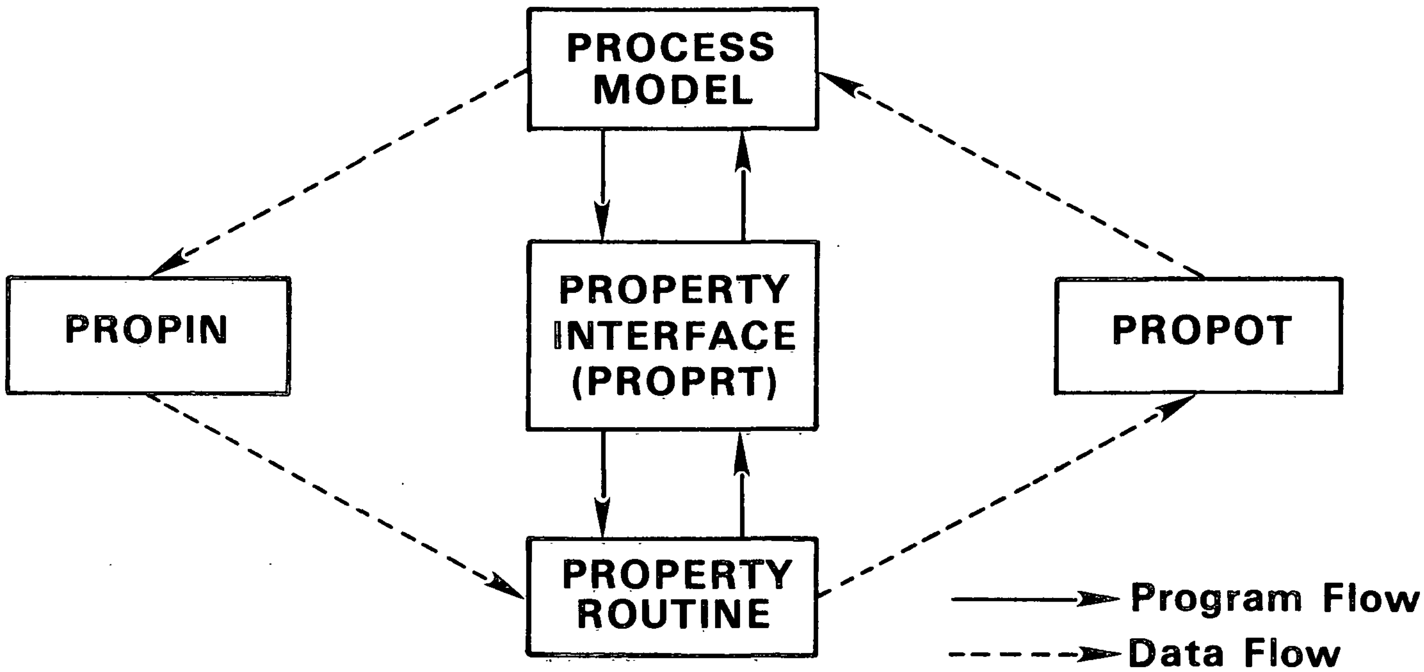
EXPANDED CAPABILITIES IN PHYSICAL PROPERTIES CALCULATIONS

- USE OF A PROPERTY INTERFACE
- LIBRARY OF PROPERTY ROUTINES
- USE OF UTILITY ROUTINES ("TOOLS")

BENEFITS ARE

- EXPANDED CAPABILITIES
- SIMPLIFY MODULE PROGRAMMING
- SIMPLIFY TROUBLESHOOTING

THE PROPERTY INTERFACE



PROPERTY ROUTINES

THERM1
STEAM
MASSFR
MOLEFR
PMOLWT
DENGAS
DENLIQ
VISLIQ

THERM1

- STREAM THERMODYNAMIC PROPERTIES

  ALL STREAMS
  - TOTAL FLOW
  - HEAT CAPACITY
  - ENTHALPY
  - EXERGY
  - TEMPERATURE

  WATER (STEAM) STREAMS
  - SPECIFIC ENTHALPY
  - QUALITY
  - PRESSURE

STEAM

- PROPERTIES OF WATER/STEAM
  - PRESSURE
  - QUALITY
  - TEMPERATURE
  - SPECIFIC VOLUME
  - SPECIFIC ENTHALPY
  - SPECIFIC ENTROPY
  - HEAT CAPACITY

DENGAS

- COMPUTE DENSITY OF A GASEOUS STREAM
  - IDEAL GAS LAWS

DENLIQ

- COMPUTE DENSITY OF A LIQUID STREAM

VISLIQ

- COMPUTE VISCOSITY OF A LIQUID STREAM

MASSFR

- CONVERT STREAM COMPONENT FLOWS TO MASS FRACTIONS OF TOTAL FLOW

MOLEFR

- CONVERT STREAM COMPONENT FLOWS TO MOLE FRACTIONS

PMOLWT

- RETURN MOLECULAR WEIGHT OF A STREAM COMPONENT

UTILITY ROUTINES
(TOOLS)

PROPRT
PHASE
UCONSY
STRMAN
UCOPYI
UCOPYO

PHASE

- CLASSIFY EVERY COMPONENT OF A GIVEN STREAM TYPE AS:
  - DISSOLVED/SUSPENDED
  - NONVOLATILE/VOLATILE
  - NONFIBROUS/FIBROUS
  - INORGANIC/ORGANIC

UCONSY

- COMPUTE PERCENT DISSOLVED SOLIDS AND PERCENT CONSISTENCY FOR A GIVEN STREAM

STRMAN

- COMPUTE ELEMENTAL ANALYSIS OF GIVEN STREAM BASED ON 15 ELEMENTS

UCOPYI

SN
SI ——> PROPIN
SO

UCOPYO

PROPOT ——> SN
SO

OPTIMIZATION

OBJECTIVE

DETERMINE FEASIBILITY OF PERFORMING OPTIMIZATION WITH MAPPS

- USE A "DIFFICULT" PROBLEM
- COMPARE RESULTS TO SIMULTANEOUS APPROACH (SACDA-MASSBAL)

OPTIMIZATION

BACKGROUND

OPTIMIZATION: "IMPROVEMENT" FINDING A LOCAL OR GLOBAL "BEST" SOLUTION

- APPLICATIONS
  - DATA RECONCILIATION (TYPE 1)
  - OPTIMIZING PROCESS CONDITIONS (TYPE 2)
  - PROCESS DESIGN (TYPE 3)

- METHOD

DETERMINE PROCESS VARIABLES SUCH THAT

MINIMIZE Y OR [MAX (-Y)]

Y = OBJECTIVE FUNCTION

G(VARIABLES) $\geq$ 0 INEQUALITY CONSTRAINTS

H(VARIABLES) = 0 EQUALITY CONSTRAINTS

LOWER BOUND < VARIABLES < UPPER BOUND

OPTIMIZATION

BACKGROUND

- OPTIM PACKAGE
  - DEVELOPED BY KEN SAFFRAN AT IPC, 1983
  - TESTED OPTIM WITH EARLY VERSION OF MAPPS

    BLACK LIQUOR OXIDATION
    AQ AND KRAFT PULPING AND RECOVERY
    COUNTER-CURRENT BROWN STOCK WASHING

    OBJECTIVE FUNCTION = OPERATING PROFIT

OPTIMIZATION

BACKGROUND

- SHOWED MAPPS + OPTIM WOULD WORK
- DEVELOPED AND EVALUATED SEVERAL INTERFACES
  - DIRECT INTERFACE CHOSEN AS "BEST"
- DETERMINED "BEST" OPTIMIZATION ALGORITHMS OF MANY
  - GRIFFITH-STEWART - SEQUENTIAL LINEAR PROGRAMMING (SLP)
  - OPT - REDUCED GRADIENT SEARCH

STATUS

- SELECTED TEST PROBLEM (TYPE 1)
  - MULTIPLE EFFECT EVAPORATOR SYSTEM INCLUDING SPLIT EFFECTS
  - DATA RECONCILED WITH MASSBAL
  - MEASUREMENTS AND FLOW SHEET
- DEVELOPED CONVERGED MAPPS FLOW SHEET
  - SINGLE EFFECT EVAPORATOR MODULE EVAPO2
  - HEATER, HEAT EXCHANGERS, FLASHES, SPLITTERS, AND MIXERS
- RAN SENSITIVITY STUDIES
- SET UP OPTIMIZATION PACKAGE

- SPECIFY OBJECTIVE FUNCTION OF REGRESSION FROM

$$Y = \sum_{i=1}^{n} W_i \left(\frac{X_i - XM_i}{XM_i} \right)^2$$

XM_i = MEASUREMENTS

X_i = MAPPS VALUES

W_i = WEIGHTING FACTORS

- DETERMINE X_i TO MIN Y
- SATISFY ALL CONSTRAINTS BY MAPPS
  - HEAT AND MATERIAL BALANCE
  - PHYSICAL CONSTRAINTS

OPTIMIZATION

METHODOLOGY

- START WITH CONVERGED FLOW SHEET DATA OF 1/19/84 (RELATIVELY CLEAN TUBES)
- OPTIMIZE AGAINST DATA OF 11/13/84 (PRIOR TO BOIL OUT)
- POOR STARTING POINT ALSO CHOSEN
- ADJUST WEIGHTING FACTORS

OPTIMIZATION

RESULTS

- OPTIMIZATION MADE SUCCESSFULLY
- RESULTS IN GOOD AGREEMENT WITH SACDA
- MINOR DIFFERENCES DUE TO FOLLOWING

	MAPPS	MASSBAL
BPR CORRELATION	IPC DATA	--
STEAM SUPERHEAT LOSS	AT MODULE INLET	AT MODULE OUTLET
BL COMPOSITION	HEAT CAPACITY	
HORTON CONCENTRATORS	EVAPO2 + HEATER	SINGLE EFFECT
WEIGHTING FACTORS	ASSUMED	NOT KNOWN
VARIABLES (INDEPENDENT AND DEPENDENT)	36	50
VARY	COMPONENT FLOWS	TOTAL FLOW + CONCENTRATION

RUN TIMES - EVAPORATOR CASE

161 SIMULATIONS
23 MINUTES PROCESSOR TIME

OPTIMIZATION

APPLICATION TO DESIGN OF
MECHANICAL PULPING PROCESSES

- OBJECTIVE FUNCTION
  - DETERMINE SPECIFIC POWER IN THREE REFINERS TO
  - MINIMIZE TOTAL SHIVES IN BLEACHED PULP
- SHIVES REDUCED FROM 22.9% TO 0.76% BY ADJUSTING SPECIFIC POWER FOR THREE REFINERS
  - LONG FIBER SPECIES CASE

OPTIMIZATION

CONCLUSIONS

- OPTIMIZATION IS FEASIBLE WITH MAPPS
- CODING IS SIMPLE
- RUN TIMES NOT EXCESSIVE
- PROVIDES POWERFUL NEW FEATURE FOR MAPPS PACKAGE
- NEED TO DEVELOP OPTIMIZATION ALGORITHMS IN-HOUSE

FUTURE DEVELOPMENTS

PHYSICAL PROPERTY MODELS

DEVELOP OPTIMIZATION CODE

CONTINUE MODULE DEVELOPMENT

FUTURE DEVELOPMENTS (μMAPPS)

USER FRIENDLY INTERFACE

640 K BARRIER

USER GROUP DEFINED MODULES

FUTURE DEVELOPMENTS (STUDENTS)

EVAPORATOR MODULES

CONVERGENCE ACCELERATION

CALCULATION ORDERING

PHYSICAL PROPERTIES

BOILING POINT RISE CALCULATION

NONIDEAL GAS PROPERTIES

ELECTROLYTE SOLUTION BEHAVIOR