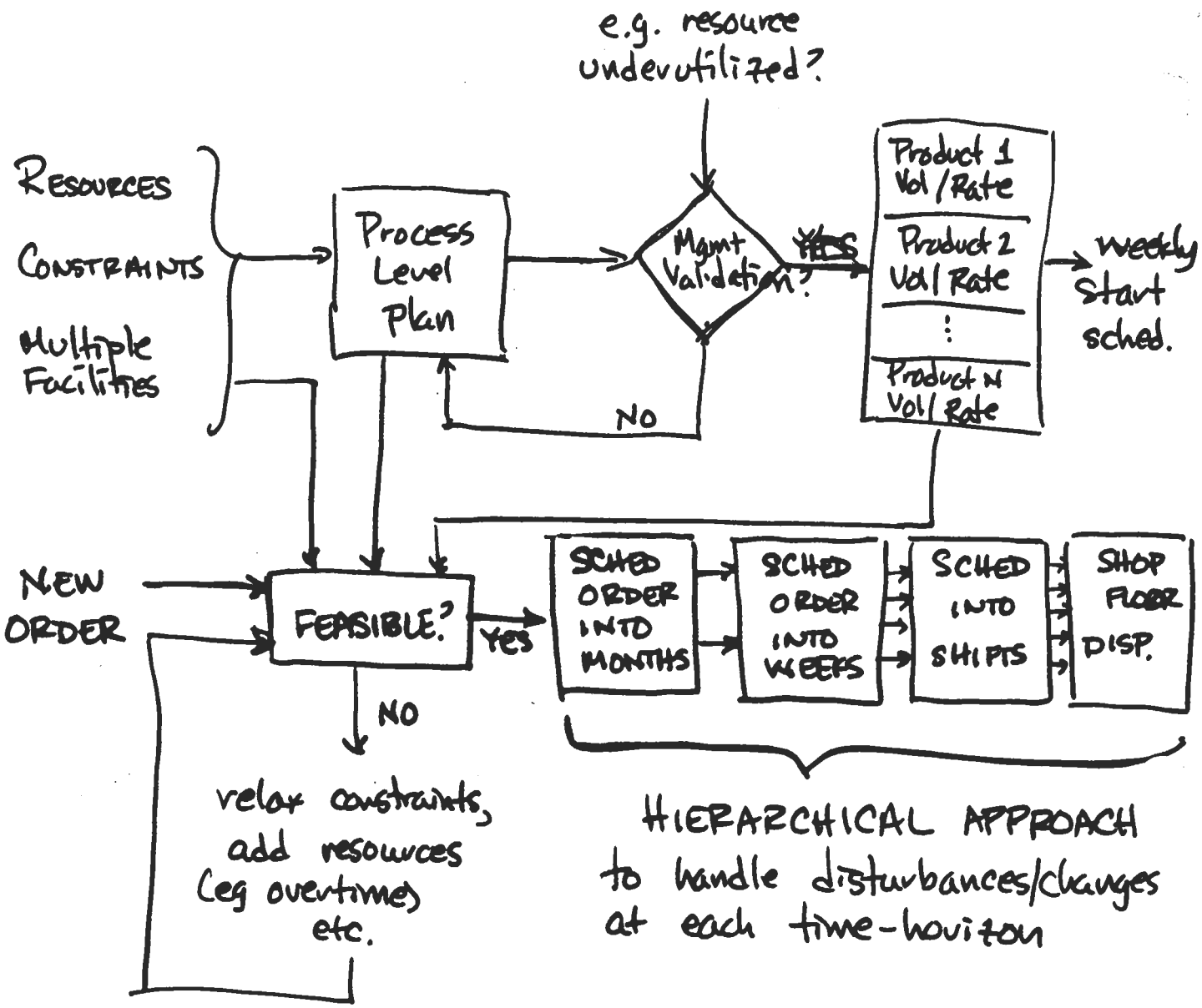
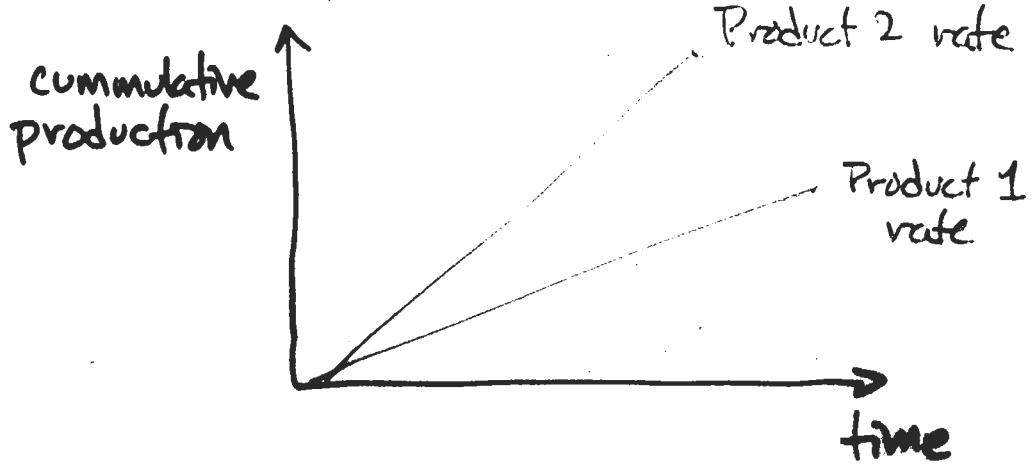
PRODUCTION PLANNING

- Production Planning ISSUES/GOALS
  - capacity planning/estimation
  - check feasibility of aggregate schedules
  - estimate delivery dates
  - translate long term goals into lower level task assignments

    e.g. how much capacity to devote to different product lines?

- Information Required
  - capacities @ all facilities
  - recipes for all products
  - yields
  - downgrading/binning data
  - inventories
  - sales projections (min & max)
  - price and cost data


e.g. resource underutilized?
RESOURCES
CONSTRAINTS
Multiple Facilities
Process Level Plan
Mgmt Validation?
YES
NO
Product 1 Vol/Rate
Product 2 Vol/Rate
Product N Vol/Rate
Weekly Start sched.
NEW ORDER
FEASIBLE?
YES
NO
SCHED ORDER INTO MONTHS
SCHED ORDER INTO WEEKS
SCHED INTO SHIFTS
SHOP FLOOR DISP.
relax constraints, add resources (eg overtime) etc.
HIERARCHICAL APPROACH to handle disturbances/changes at each time-horizon


cummulative production
Product 2 rate
Product 1 rate
time

ASSUMPTIONS - LP & Front End Planning

① ACTIVITIES are activity levels on each route, measured as
- # wafers released
- quantity output (good die)

...can be alternative routes for each product type

② PLANNING HORIZON - multiple periods where DEMANDS, CAPACITIES, PROD. RATES ⇒ assumed held const.

③ PRODUCTION VARIABLE - quantity of product type to be released to a particular route

INVENTORY VARIABLE - inventory of product type at end of planning period

BACKORDER VARIABLE - die demand that cannot be satisfied on time at end of plan peri.

④ DEMAND - time-based die output requirements
- may be in PRIORITIZED CLASSES

⑤ Assume production is RATE-BASED ... i.e. release quantity is distributed uniformly over period.

⑥ CAPACITY CONSTRAINTS limit total workload on a machine type.

⑦ STEADY STATE → constant rate production releases

CAPACITY MODELING w/. ALTERNATIVE MACHINE TYPES

Leachman & Carmon, IIE, 24(4) 1992

- GOAL: Understand capacity limitations for various products in facilities with hundreds of machines

- CONVENTIONAL ASSUMPTION
  - multiple identical machines
  - process steps assigned to UNIQUE machine type

VS.

- ALTERNATIVE CONSIDERATION
  - may have different machine types that are all suitable for performing some operation

Examples:

- "MIX & MATCH" Lithography
  - expensive steppers may be able to handle the finest feature steps AND any others
  - less expensive steppers can only handle related feature steps

- Mixture of equipment technology generations
  - older tools for non-critical steps
  - newer tools for either

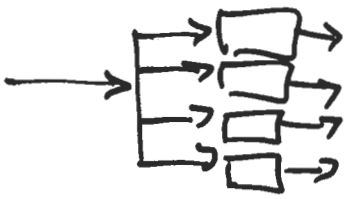
- BENEFITS of ALTERNATIVE MACHINES — higher THROUGHPUT and CAPACITY UTILIZATION by balancing workload among alternative machine types

- So WHAT's THE BIG DEAL?

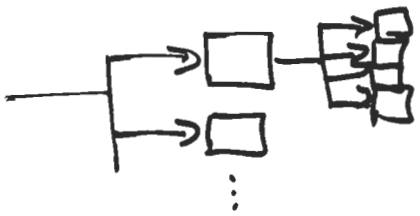
(A) Conventional LP Formulation
- define multiple possible routes/products
- allocate capacity across these alternatives

(B) Now add in alternative equipment types

- 1 step product
  4 alt. eq. types



- 2 step product using step twice



∴ With RE-ENTRANT Flows
⇒ combinatorial explosion

E.g. litho – 20 reentries

- RETURN TO GOAL:

SET COMPANY-WIDE DEMANDS TO ACHIEVE CAPACITY FEASIBILITY

⇒ don't actually care about detailed routes!

… use this to <u>SIMPLIFY</u> the LP problem form.

- BASIC IDEAS / FORMULATIONS

① "STEP-SEPARATED FORMULATION"

- replace variables for ROUTES with variables for ACTIVITY at operations
- ∀ product, oper → allocation vars ← alternative machines ⋮

② "WORKLOAD ALLOCATION FORMULATION"

- Assume process times identical across all alternative types, OR proportional across all operations

  e.g. type 2 machines are 3x slower than type 1 machines for any & all ops that both can perform

- THEN

  ∀ product → total workload

  ... ignore workload for individual steps

③ "DIRECT PRODUCT MIX FORMULATION"

- No allocation vars. Just vars for the production of each product

⇝ ≈ same size as LP conventional planning formulation w/out alternative resources