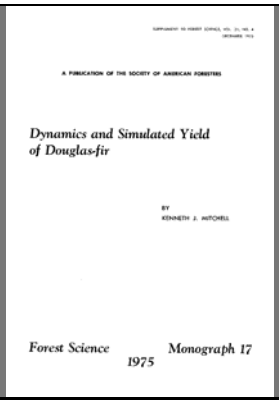
TASS



A PUBLICATION OF THE SOCIETY OF AMERICAN FORESTERS

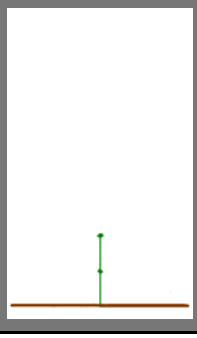
Dynamics and Simulated Yield of Douglas-fir

BY
KENNETH J. MITCHELL

Forest Science *Monograph 17*
1975

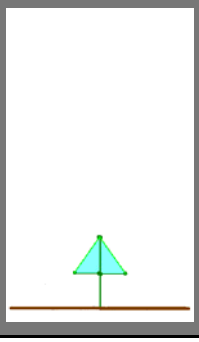
Distance-dependent (spatially explicit) model.
First version, for white spruce from Prince George, published in 1969. Douglas-fir 1975. Later extended to other species.
Main BC model for managed stands. TIPSY handles yield tables generated by TASS.

TASS



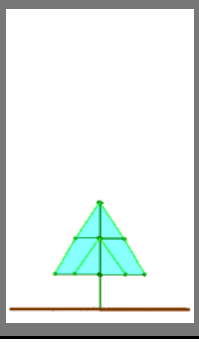
Annual height increment.

TASS



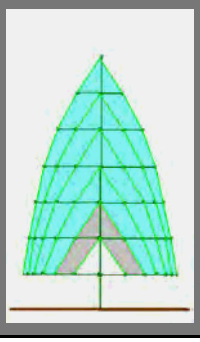
Branches grow proportionally to the height increment.

TASS



Crown radial growth (branch growth) is a proportion of the height increment, decreasing with distance from the tip.

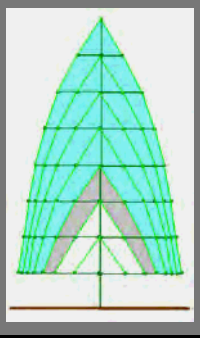
TASS



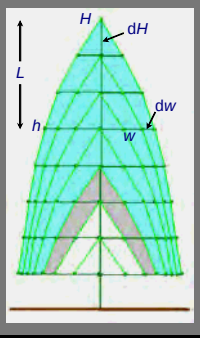
Only depends of distance from the tip, so that crown just shifts upwards.

Assumes foliage alive for 5 years (partially in the fifth layer).

TASS



TASS



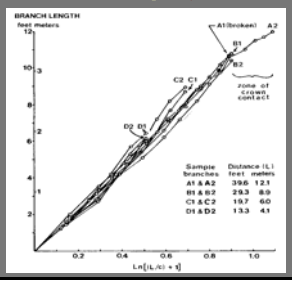
$$\frac{dw}{dH} = \frac{dw}{dL} = \frac{b}{L+c}$$

$$w = b\ln\left(\frac{L}{c} + 1\right)$$

Crown radius (w) increment decreases with L. Integration gives the crown profile equation shown.

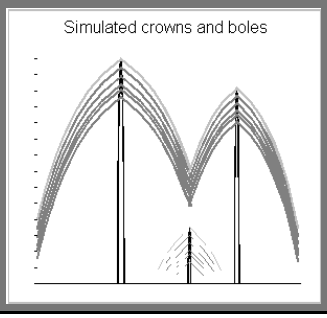
Branch length (crown width)

$$w = b\ln\left(\frac{L}{c} + 1\right)$$



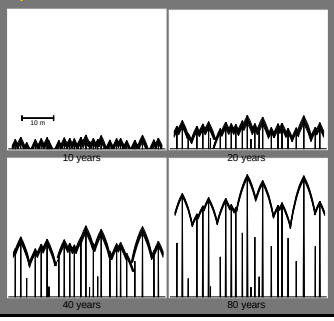
Example data.

Competition



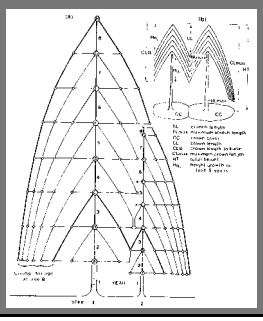
Branch length growth stops on contact.
Stem volume growth rate depends of the weighted foliage volume (weights varying with foliage age and retention).
Uses random distribution of height (and branch) growth rates.
Overtopped trees die after a certain delay.

TASS, 2-D simulation



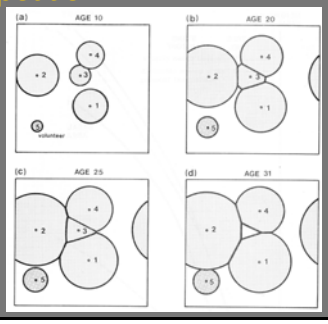
See animations at http://forestgrowth.unbc.ca/tadam.

Competition



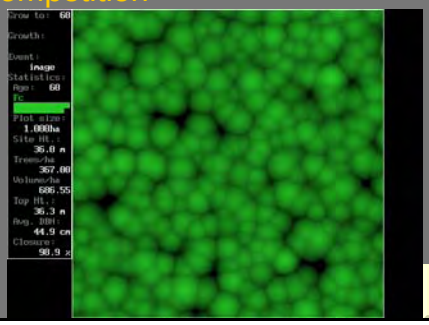
Partitioning of crown horizontal projection.

Competition



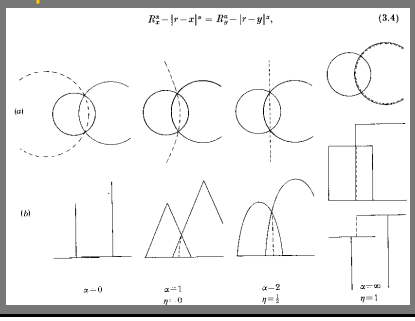
Seen from above.

Competition



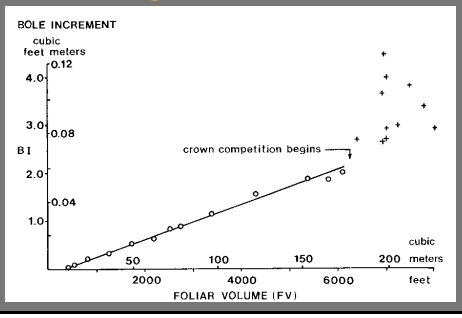
TASS display of space partitioning.
Foliage vertical thickness is constant, except near any open-growing edges. Therefore, foliage volume is proportional to crown projection (or close to that, except possibly in small trees). Turns out to be similar to tessellation (weighted APA) models, although weighted by height rather than the more usual dbh.

Competition



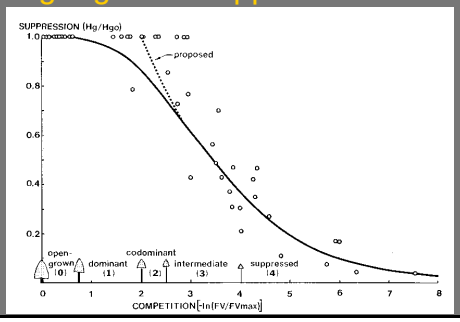
Gates & Westcott worked out relationships between tessellation (APA) boundary curves and "competitive pressure" profiles, which they interpret as crown shapes:
Gates, D.J. and Westcott , M. "Zone of influence models for competition in plantations". Adv.Appl.Prob. 10:499-537. 1978.
Gates, D.J., O'Connor, A.J. and Westcott, M. "Partitioning the union of disks in plant competition models". Proc.R.Soc.Lond.A. 367:59-79. 1979.

Total bole growth



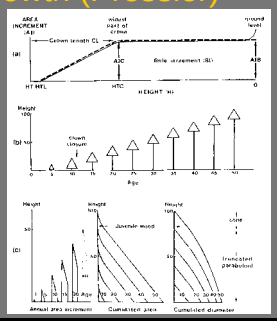
Amount of foliage is used to predict bole volume growth.
Initial relationship with amount of foliage breaks down when competition starts. Therefore, the potential foliage was also included in the relationship.
Thus, tree growth is assumed to depend also of the ratio of actual to potential (open-tree) weighted foliage volume. May be seen as a competition index.

Height growth suppression



Height growth is also related to the foliage ratio.

Bole growth (Pressler)

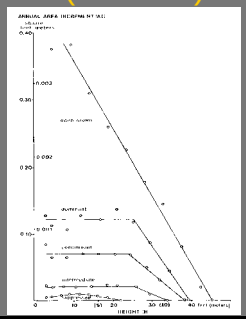


After predicting total tree volume increment, the model estimates its distribution over the bole length.

Uses Pressler hypothesis: cross-sectional area increment is proportional to length of crown above (therefore, constant below the base of the green crown).

Tree biologists rediscovered Pressler's 19th Century theory in the 1960's, calling it the "pipe model theory".

Bole growth (Pressler)



Seems close enough.

Some more recent TASS versions have modified this.

Adds-on

- Fertilizing
- Genetics
- Wood quality
- Root rot
- Spruce weevil
- Light interception – "complex stands"

Mostly simulations from stand origin. For existing stands would need to somehow fake details of initial condition (locations and crowns of individual trees not usually known).

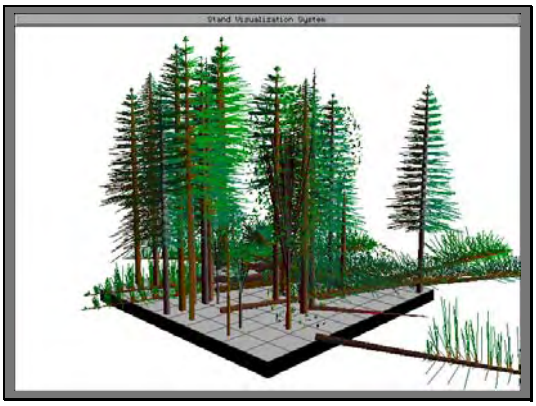
Various extensions have been added.

Current work on modelling light interception, for mixed species multi-layered stands ("TASS III").

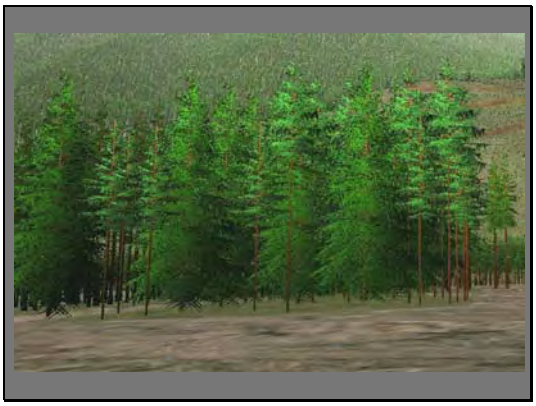
TASS

TASS predictions for the various species have been compared to PSP data, and parameters tweaked by trial-and-error to get reasonable agreement ("calibration").

For an evaluation see: J.W. Goudie, "Model validation: A search for the Magic Grove or the Magic Model". In: Bamsey, C. (ed) Stand Density Management Conference: Planning and Implementation, Edmonton, AB. 1988. (http://www.for.gov.bc.ca/hre/gymodels/TASS/VALIDATE.htm).



Various computer graphics visualization tools.
Models can simulate anything. Keep in mind assumptions, limitations, and uncertainties when interpreting outputs from any model.

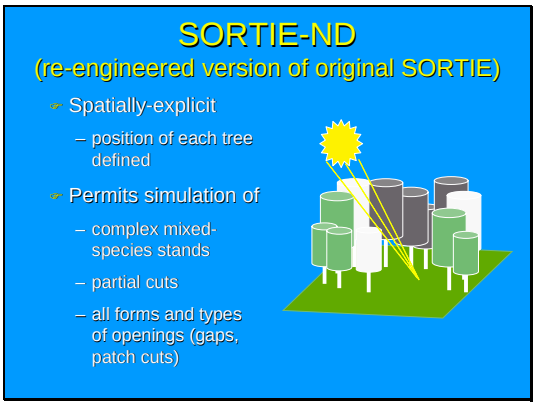


Currently, TASS is only available at MOF Research Branch in Victoria.
Printed yield tables from TASS: K.J. Mitchell and I.R. Cameron, "Managed Stand Yield Tables for Coastal Douglas-fir: Initial Density and Precommercial Thinning", BC MOF Land Management Report 31, 1985.
TADAM is a dynamic whole-stand approximation, discussed later.

TIPSY

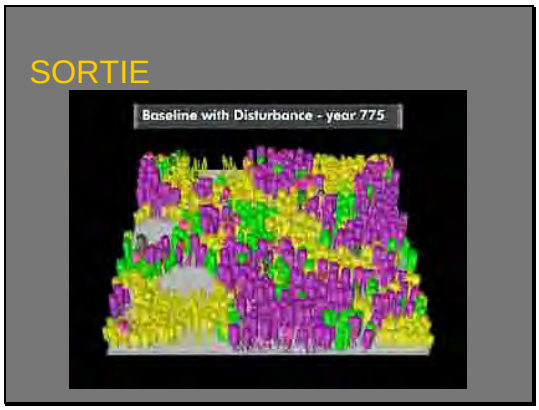
- TASS only available at MOF: Custom runs
- Yield tables from TASS: Printed, TIPSY
- Eichhorn's rule: *H* ! yields, *H* from site index model
- TIPSY databases of yield tables (species)
  - From stand origin, various initial densities
  - Up to one precommercial and one commercial thinning, several timings and intensities
  - Only one TASS run (stochastic realization)
- Can interpolate, guess an initial density for existing stands
- Numerous outputs (SYLVER), reports, graphs

"Planted" (uniform initial spacing) or "natural" (clumped).
Number of yield tables in some TIPSY databases: Coastal Douglas-fir: 176. Interior lodgeole pine: 110. Interior white spruce: 30 (no commercial thinning).
Recent TIPSY versions can choose a suitable yield table for an existing stand by estimating its initial density.
SYLVER takes output from TASS and estimates lumber quantity/quality and economic returns. Components: TASS, BUCK (simulates cutting into logs), SAWSIM (sawing simulator), GRADE (quality and value estimates), FAN$Y (logging/sawing costs, financial calculations). TIPSY includes some SYLVER outputs.
OAFs ("Operational Reduction Factors"): % yield reductions due to unproductive areas, pests, etc.
See: http://www.for.gov.bc.ca/hre/gymodels/TIPSY/features.htm



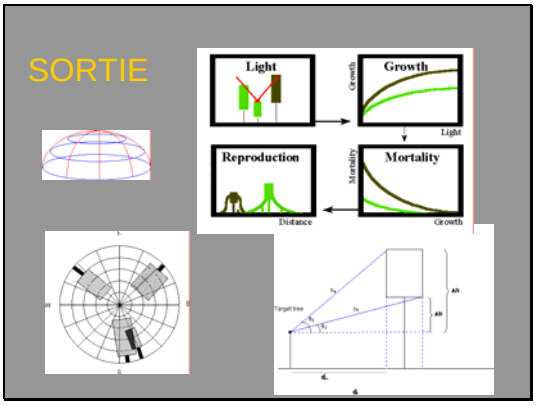
Another spatial model, SORTIE, developed in the Northeastern US. See http://www.sciencemag.org/feature/data/deutschman/

It has been adapted for use in NW BC. Slide from presentation by Coates *et al.* in http://forestgrowth.unbc.ca/bcgrowth05/. More details there.



Originally developed to study very long-term mixed-species forest succession patterns. Some tree growth relationships are rather unrealistic, which was not important for that purpose.

For instance, there is a fixed relationship between a tree height, diameter, and crown dimensions (allometry). This is unsatisfactory for stand density management, where the aim is to produce different diameters for a same height.



A strong point is the modelling of seed dispersion, regeneration, and recruitment.

Very detailed modelling of light interception, tracking the sun movements on a 1-degree azimuth-elevation grid, and 5-minute time steps. See http://www.sortie-nd.org/help/manuals/developer_documentation/cplusplus/light.html.

The software is now Open Source, making it a good foundation for future developments: http://www.sortie-nd.org/index.html.