Simulations of Mechanized Planting

-Modelling Terrain and Crane-Mounted Planting Devices

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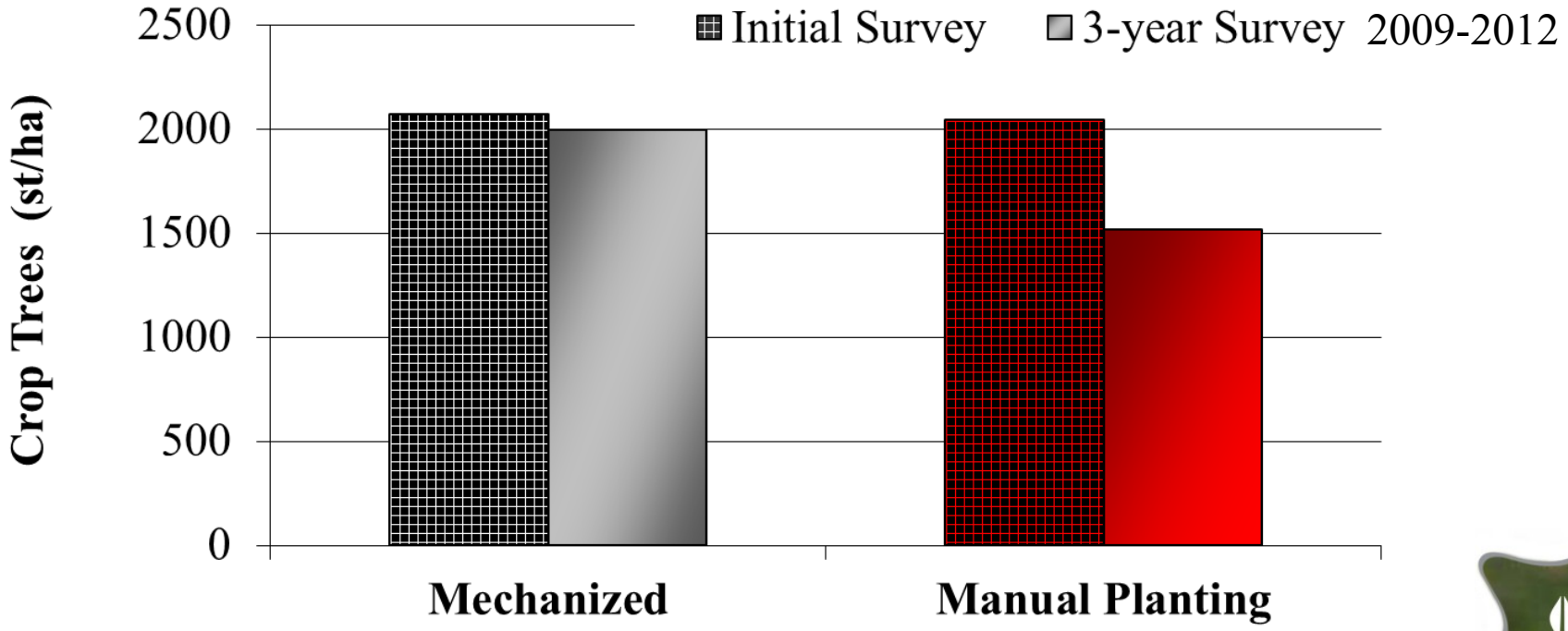
Overview

1. Background
2. Objective
3. Materials and Methods
4. Results
5. Summary

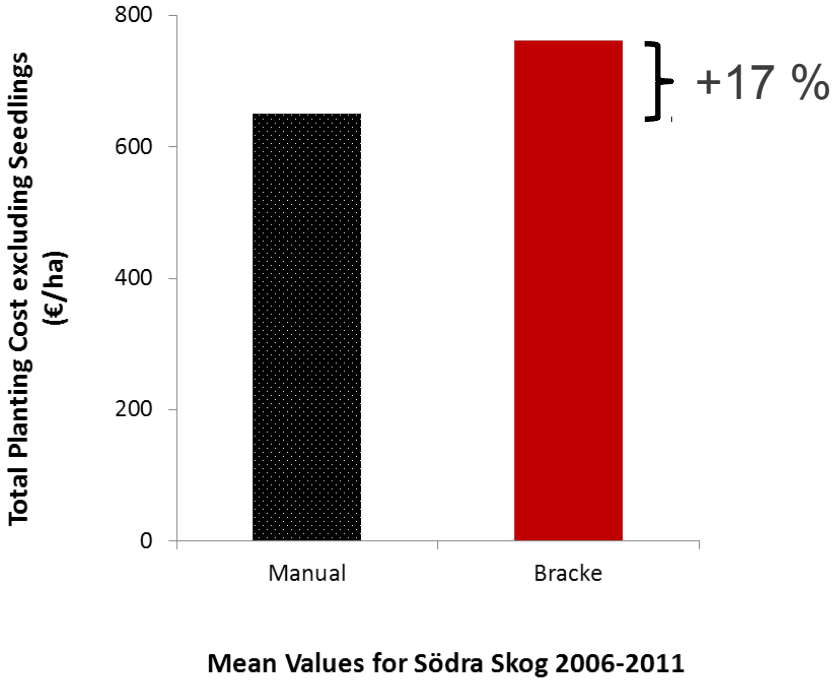
Why Mechanized Tree Planting?

Better planting quality

- Spot mounding, deep planting, educated operators



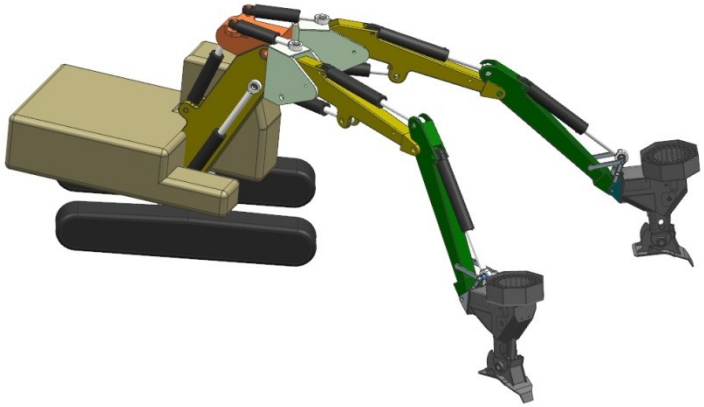
Planting Machines in Sweden Today

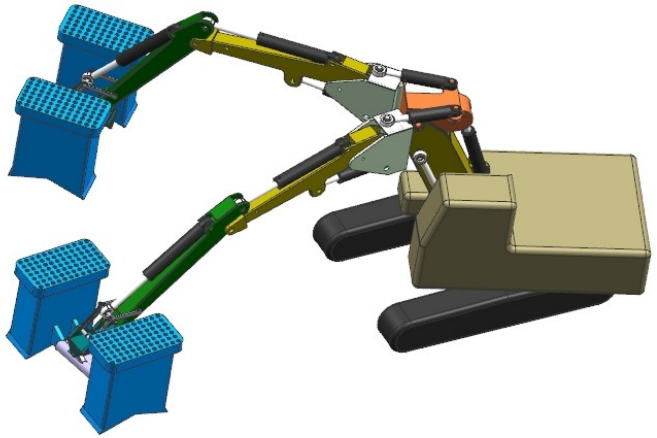


How to Increase Productivity?

One Two heads per device

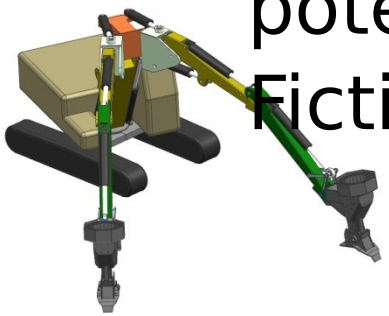
– One Two arms per excavator



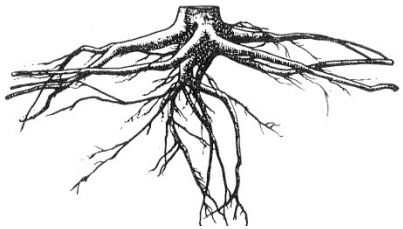


Objective

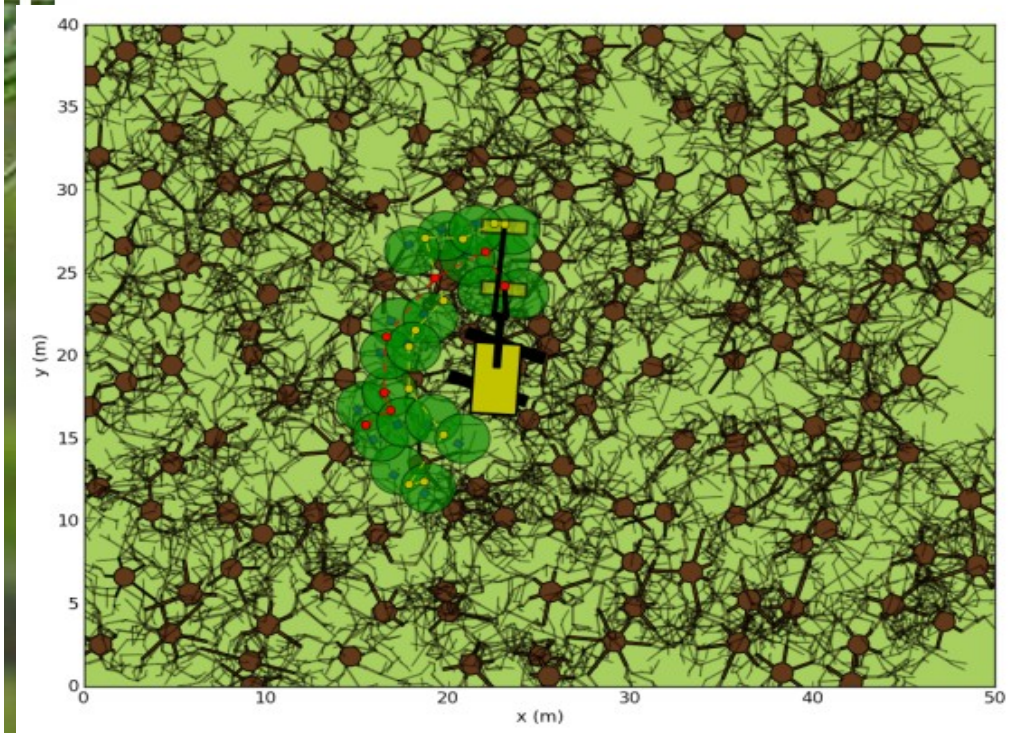
Determine if 2-armed excavators are potentially more than just Science Fiction!

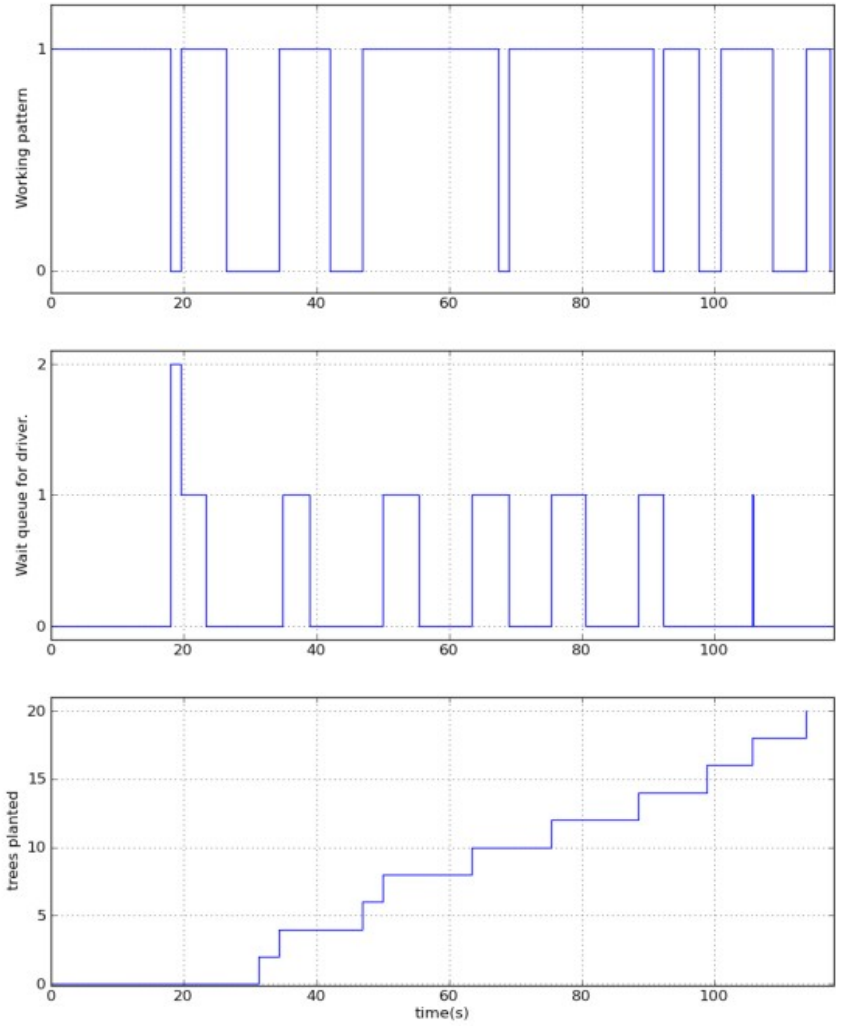


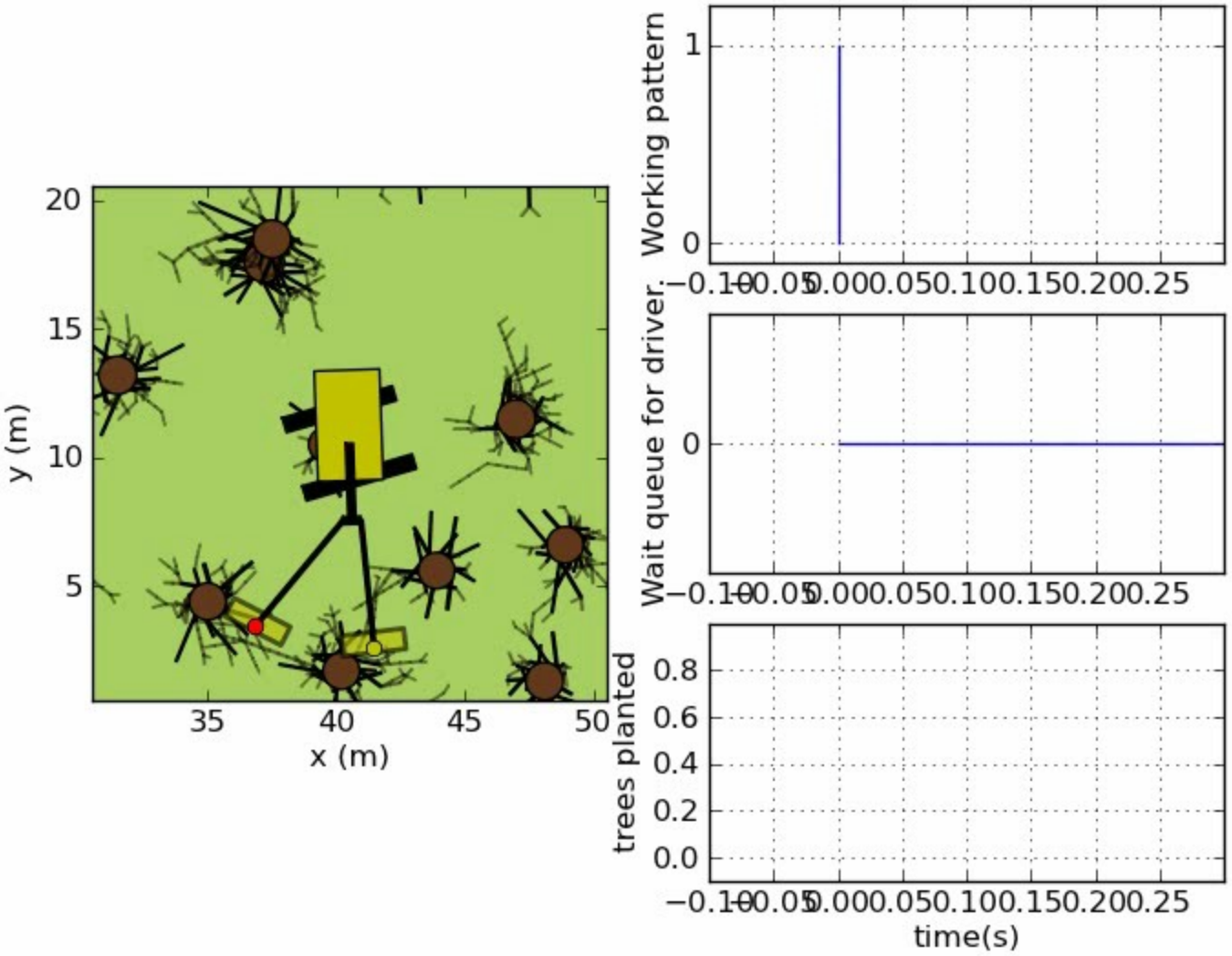
- ✓ **Under Nordic clearcut conditions** = various quantities, distributions and sizes of stones, roots and stun



SimPy Discrete-Event Simulator



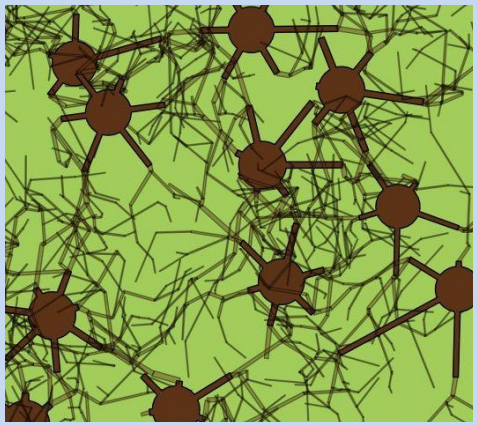



20
15
10
5
y (m)
35
40
45
50
x (m)
Working pattern
1
0
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20
0.25
Wait queue for driver
0
trees planted
0.8
0.6
0.4
0.2
0.0
time(s)

Materials and Methods

Three main models:

1. Terrain



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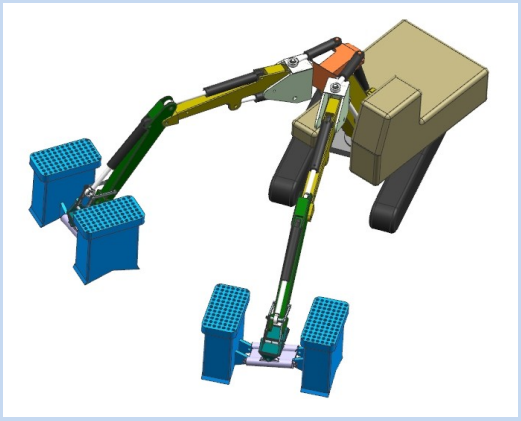
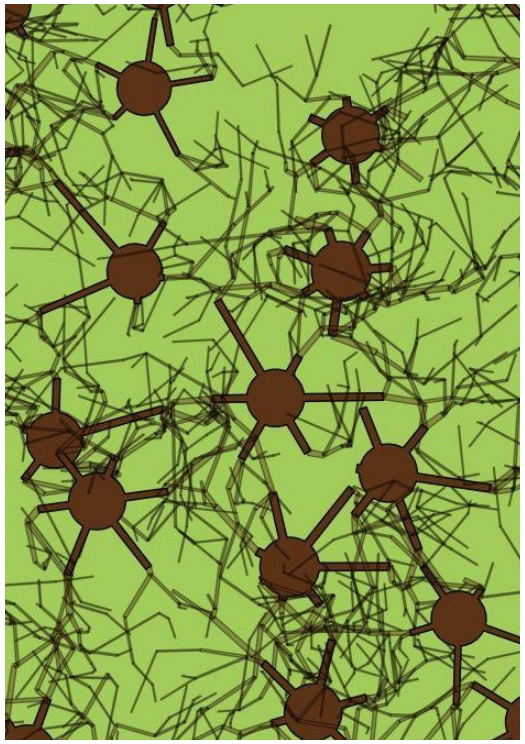
2. Machine



3. Simulation

Terrain Models



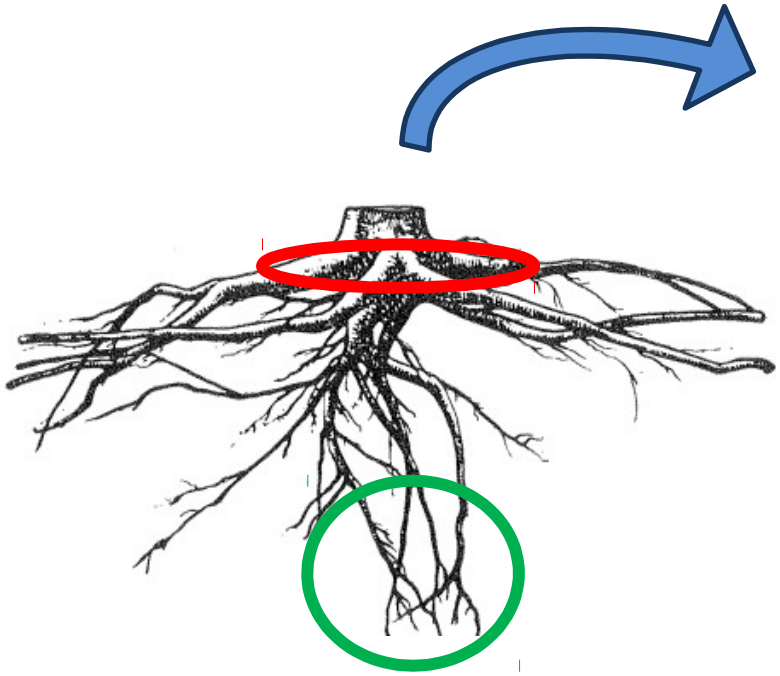
Type stands from Herlitz 1975

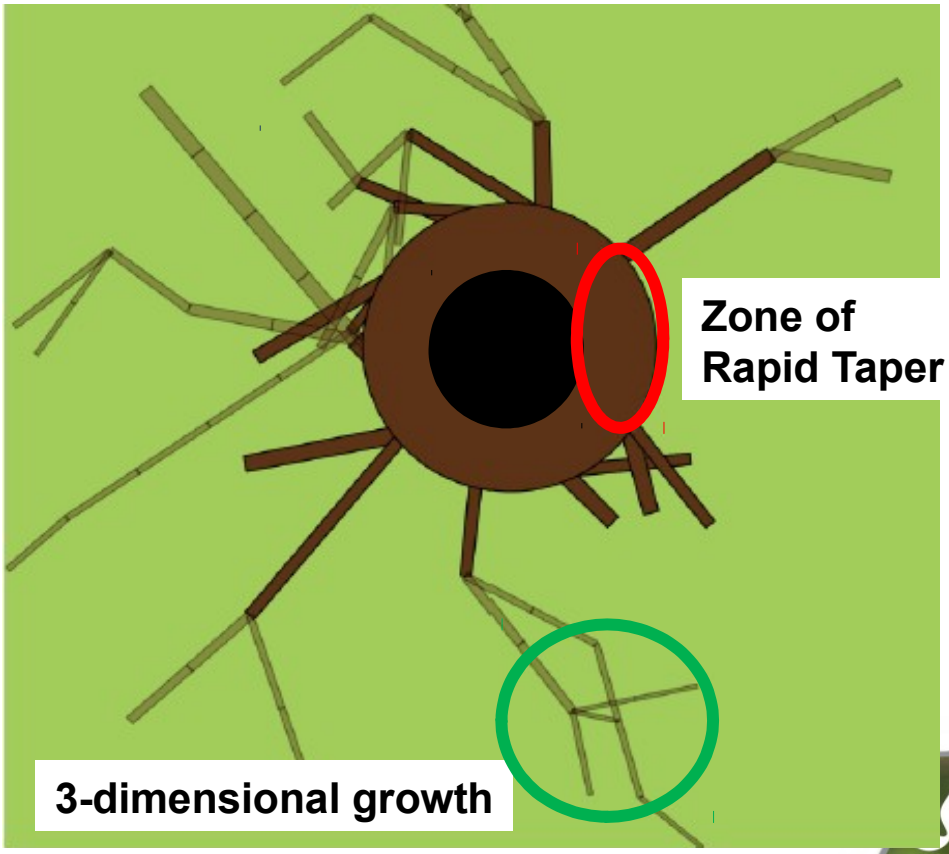
Terrain Model	Description	Stumps/ha	Boulder Quota
1-4	Few-many stumps, Few-many stones	230 - 635	25 - 75%

from Andersson et al. 1977

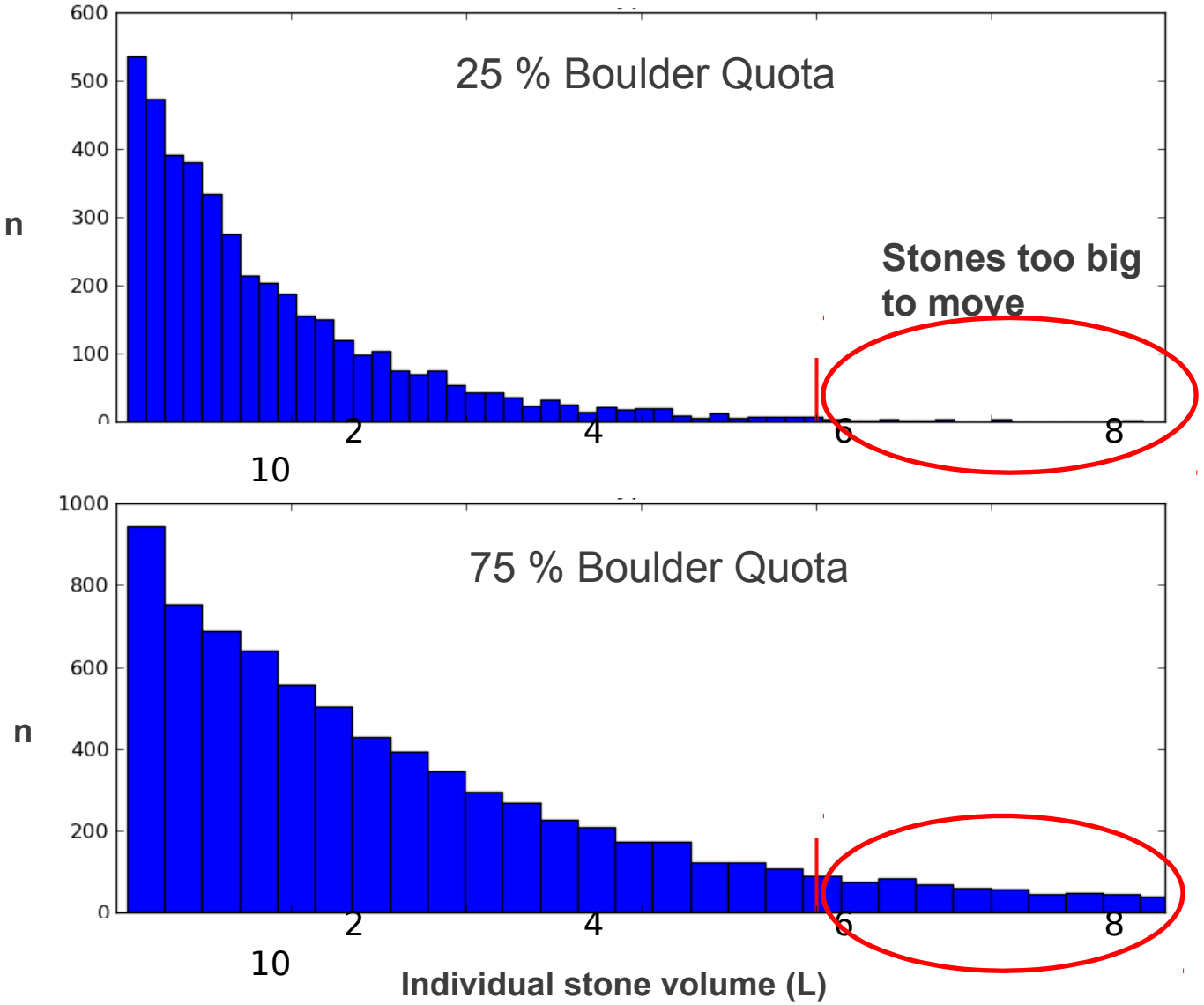
Stumps, Root Plates & Roots

Input: Dbh, DStump & species



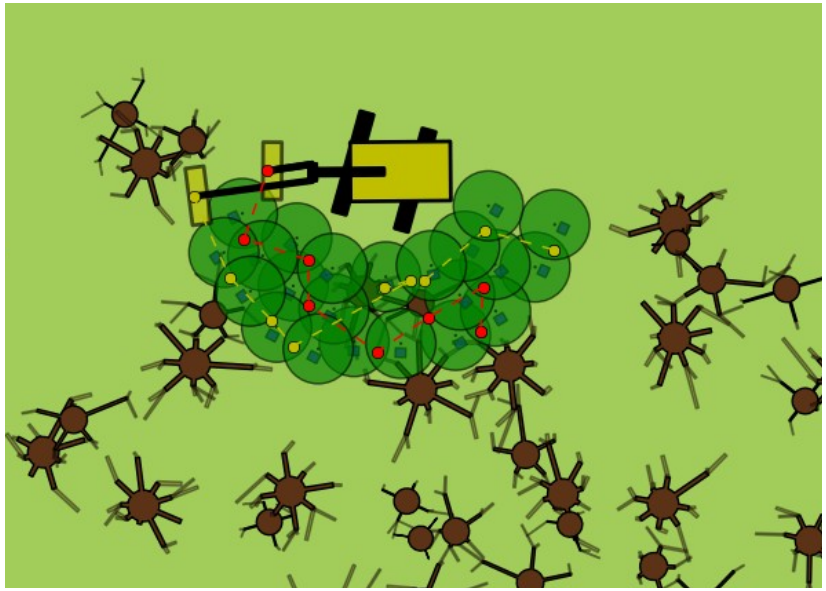


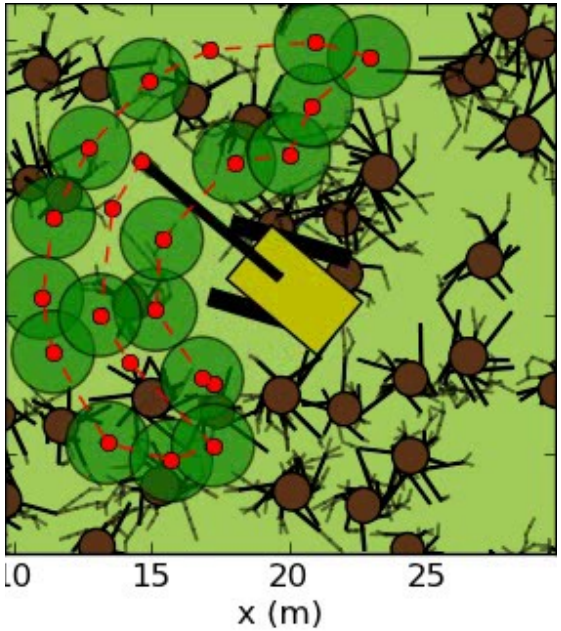
Comparing the Number of Immobile Stones on Terrain with 25% or 75% Boulder Quota



Machine Models

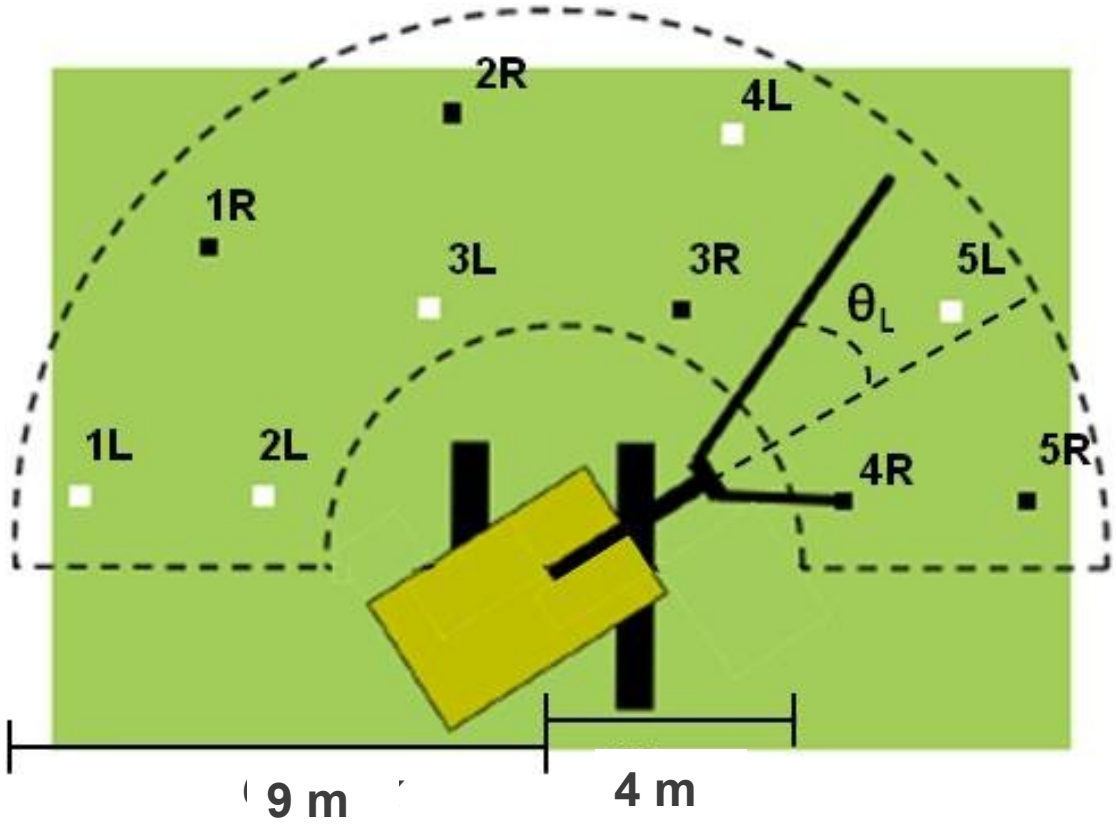
- 1- and 2-armed models
- With autonomous functions for mounding, planting and some crane movements
- 4 main tasks: moving crane, choosing microsites, mounding, planting



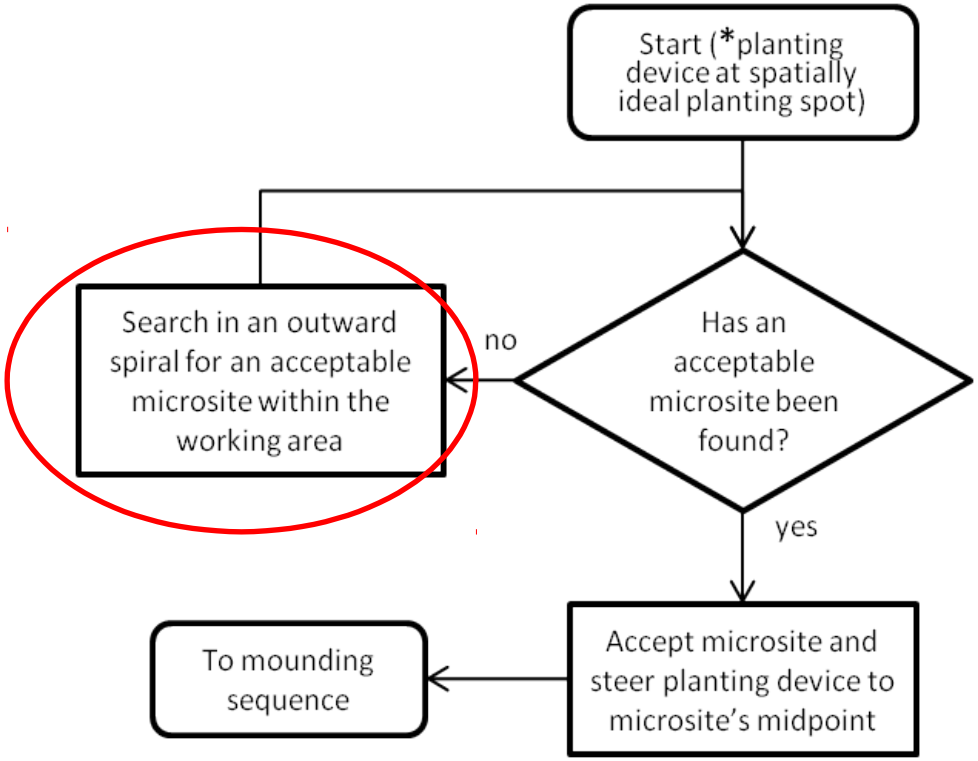


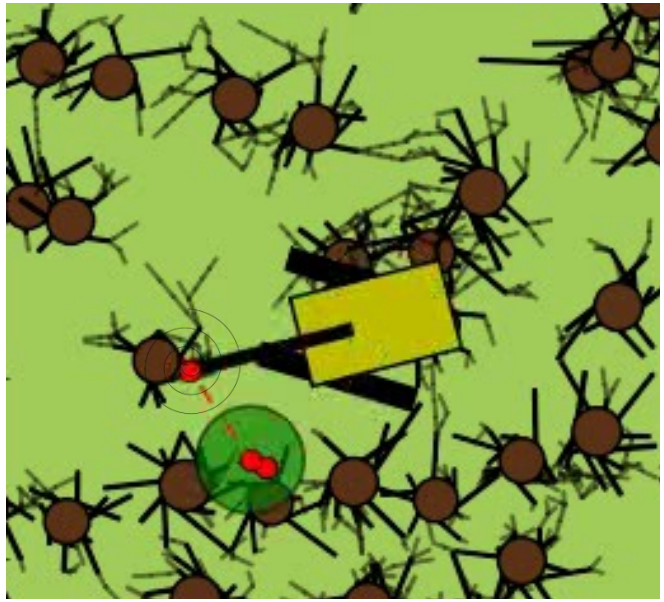
Simulation Models

Working area & Work pattern

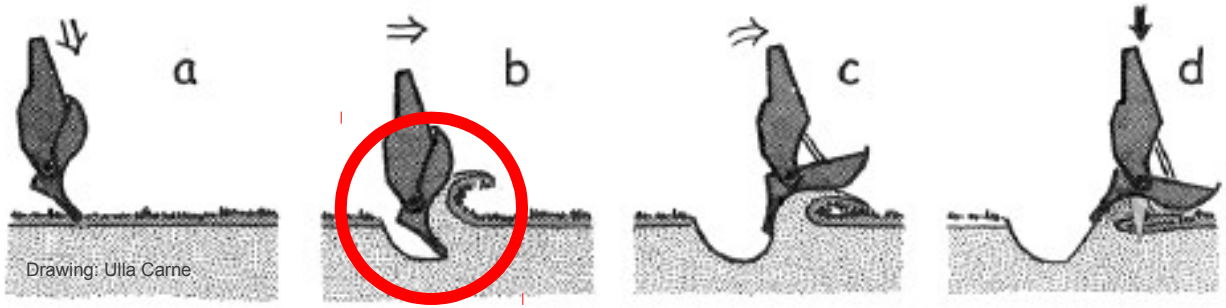


Microsite Selection Algorithm



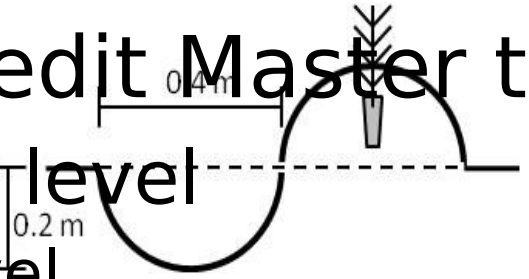


Mounding and Planting

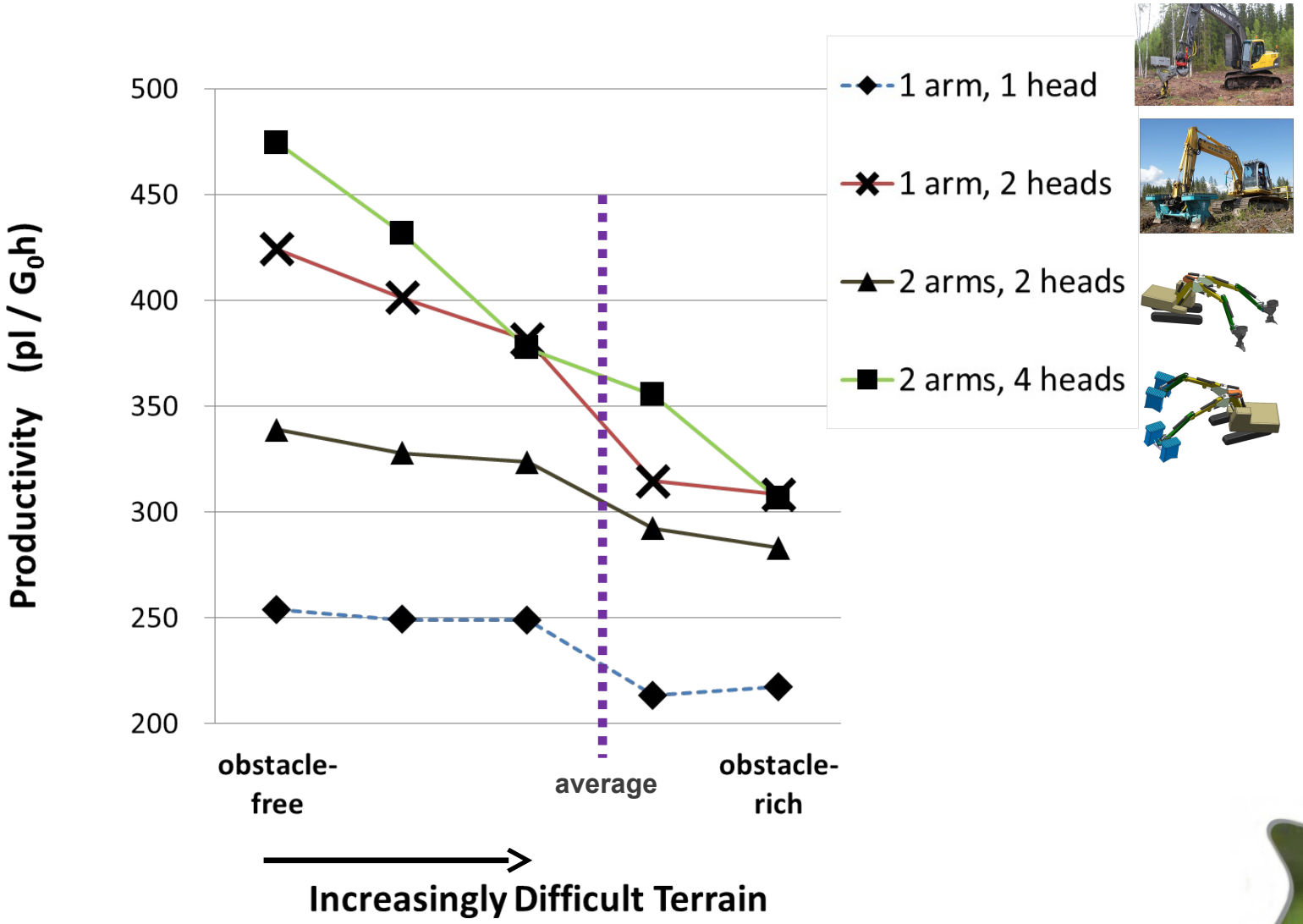


Click to edit Master text st

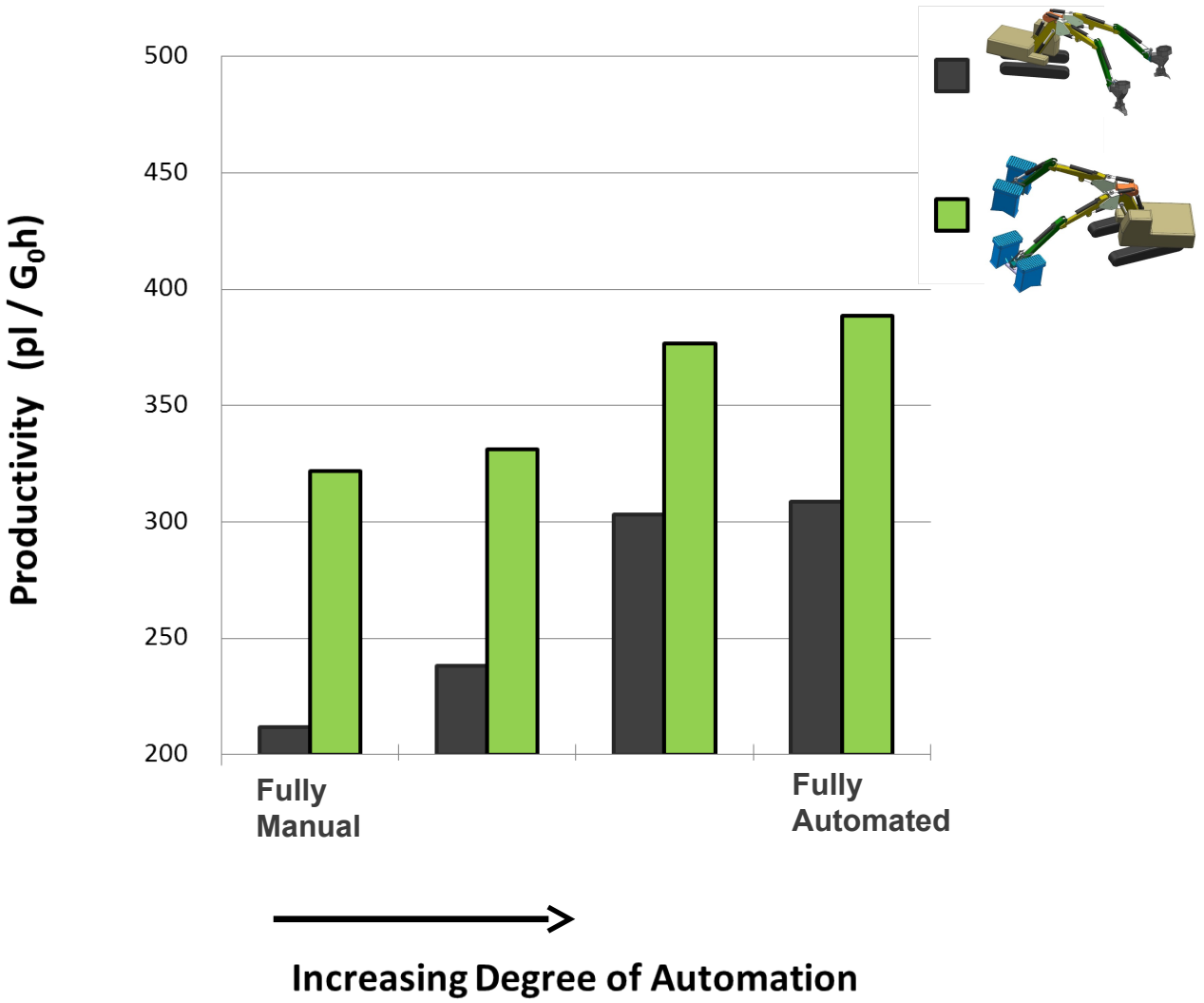
- Second level
- Third level
  - Fourth level
    - Fifth level



Results


Productivity (pl / G_0h)
500
450
400
350
300
250
200
obstacle-free
average
obstacle-rich
Increasingly Difficult Terrain
1 arm, 1 head
1 arm, 2 heads
2 arms, 2 heads
2 arms, 4 heads

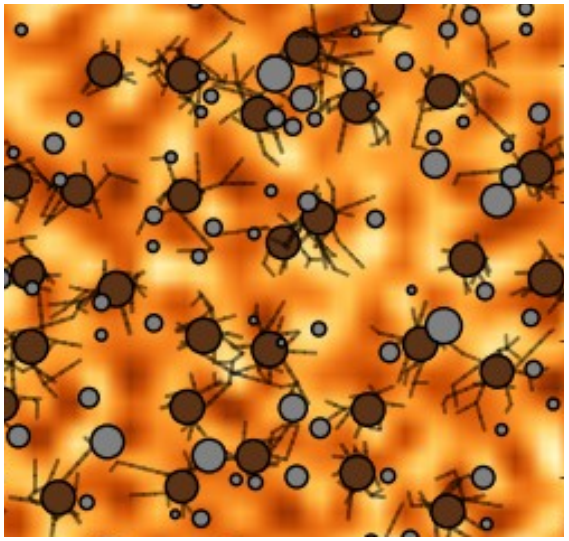
Effect of Automation on 2-armed Machine Productivity



Summary

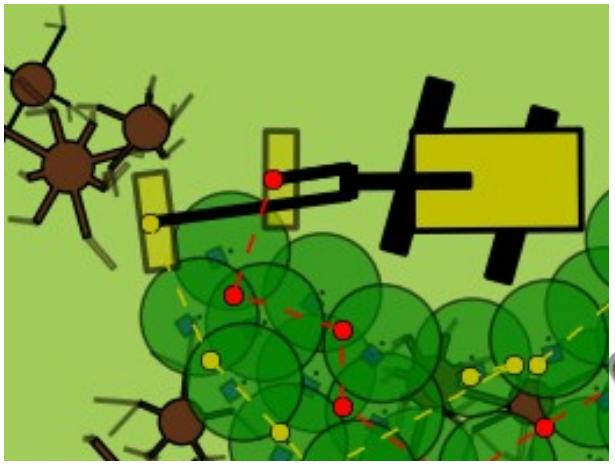
1. Functional terrain models

- Now with stumps, roots, stones, **surface boulders** and variable **humus depth**



3. Detailed machine models

- which interact with the terrain during scarification and planting



Paldies!

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