THE INTEGRATION OF PATH DETECTION AND MODELLING
STATE-OF-THE-ART AND FUTURE PROSPECTS

SEMINAR ‘DETECTION AND MODELLING OF ANCIENT PATHWAYS’
AMSTERDAM, 27 JUNE 2016

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OUTLINE

- introduction: at the crossroad?
- trends in path detection
- trends in path modelling
- terminology: path, trail, road & network
- state-of-the-art: a comparison
- bridging the gap(s)
- final discussion: a tentative research agenda
settlement pattern studies focus on place

road systems are often based on historical or military pathways

archaeology of movement is agent-based

paths and networks are shaped by human activities
TRENDS IN DETECTION

- **photo-interpretation & old planimetry**
  > long tradition based on aerial photography
  > overlay using mapping & GIS
  > driven by thematic approach
  > network – road system approach vs. indicators to find sites

- **(semi-)automated detection**
  > described as ‘taboo’ (Bennett et al. 2014)
  > driven by need to deal with ‘big data’
  > very technical approach (Vletter 2014, 2015)
  > lacking ontology

- **ground-truthing: what do we detect?**
  > unexploited potential of historical mapping and documentation
  > procedures for field testing needed (cf. predictive modelling)
  > linking to other prospection tools (field survey, RS, geophysics …)
  > connecting isolated “path sites” (excavation)
TRENDS IN MODELLING

- **from LCPs to accessibility maps**
  - movement potential (Llobera 2000, Mlekuž 2014) – landscape based
  - mobility basins (Llobera et al. 2011) – site centered
  - corridors (Fovet 2010, Howey 2011) – connection-based
  - cumulative cost paths (Whitley & Hicks 2003, Verhagen 2013) – landscape/connection-based

- **sensitivity analysis**
  - comparison of technical solutions (Herzog 2014)
  - comparison of input parameters
  - scale effects (Verhagen 2013, Llobera 2015)
  - efficiency of paths and network structures

- **network analysis**
  - robustness of structure
  - centrality potential

- **agent-based modelling**
  - models individual decision-making processes
  - simulations can explore potential routes
TERMINOLOGY: PATH, TRAIL, ROAD


- Chapter 12
  > Routes through the Landscape: A Comparative Approach, by Timothy Earle
# TERMINOLOGY: PATH, TRAIL, ROAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Earle's definition</th>
<th>Archaeological evidence</th>
<th>LiDAR and/or modelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path</td>
<td>Local trodden ways, unmodified and unmarked except in difficult terrain, provide the routes of general movement between houses, field... They exist in all societies, their functions are essentially individual, made by personal movement. Can be stable when constrained by specific landscape characteristics but no more permanent than the pattern of household movements.</td>
<td>Archaeologically, the recognition of path is difficult because of their ephemeral. Openings in a wall or steps up a terrace may identify waypoints on path but not paths themselves. In ploughed fields, paths are largely unrecognizable.</td>
<td>LiDAR remote sensing opens new perspectives to recognise this type of routes of movement (Štular 2011, Mlekuž 2013). New interest in modelling these paths, like hollow ways (Mlekuž 2014); reticular patterns left by animals/people (Lefebvre 1991), meshworks (Ingold 2007), field system paths (Georges-Leroy et al. 2011)</td>
</tr>
<tr>
<td>Trail</td>
<td>Regional and long-distance routes marked by repeated use, by signs and on maps. Movement by people often through unfamiliar foreign lands, trail must have those marking to aid direction. Trails reflect the particular constraints of a region’s topography, periodic movement (trade, seasonal movement, sacred journey...) and land tenure practices. Trail use is both individual and group oriented (moving greater distance from home intimate knowledge of route decreases and marks are increasingly important).</td>
<td>Trails are accessible for detailed study but the lack of construction makes them difficult to document archaeologically.</td>
<td>Detection using imagery (Ur 2003, Kennedy 1998, Altaweel 2003). Long-standing interest in LCP modelling, often approached as ‘corridors’ (White 2007, Howey 2011, Murrieta-Flores 2012, Llobera 2015) and coupled to visibility analysis.</td>
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<td>Road</td>
<td>Regional and sometimes long-distance routes built by chiefdoms and states. Roads have major capital improvements that include bridges, culverts, causeways, and pavements that facilitate and formalize movement.</td>
<td>Because of their built facilities and infrastructure, roads are relatively easy to document archaeologically (linear form).</td>
<td>Detection: new perspectives under forest canopies to detect border and causeways (Chase et al. 2011, Argote-Espino &amp; Chávez 2005). LCP modelling focusing on roads that are not very well recognized (Verhagen &amp; Jeneson 2012, Verhagen et al. 2014, Güimil-Fariña &amp; Parcero-Oubiña 2015).</td>
</tr>
<tr>
<td>Water ways</td>
<td>Not specifically defined</td>
<td>Can only be derived from infrastructure offering access to waterways (quays, harbours, jetties), and remains of vessels.</td>
<td>Detection: canals associated to trackways - local approach (Keay et al. 2014). Few modelling applications (Whitley et al. 2010), but same principles apply. Extra complications are waves, currents and tides.</td>
</tr>
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</table>
THE 3 DIMENSIONS OF EARLE'S TERMINOLOGY

SPACE

VOLUME

PATH

ROAD

TRAIL

Chase et al. 2011

Groenhuijzen Verhagen 2015

Ladefoged et al. 2011

Lock et al. 2014

Mlekuž 2014

Entwistle 2009

Fruchart 2014

Argote-Espino Chávez 2005

Vletter 2015

Ur 2003

Whitley et al. 2010

Murrieta-Flores 2012

Llobera 2015

Güimil-Fariña Parcero-Oubiña 2015

White Barber 2012

Fovet Zakšek 2014

Mlekuž 2014

Ur 2003

Modelling papers

Detection papers

every day

local

long distance

high

periodic

low

TIME

VU
PATWAYS TO NETWORKS?

- meshwork of paths
- network of communication based on trails
- road systems linked to military or political frames
- concept of connectivity (Kantner 2011)
  > how does connectivity emerge across space?
  > how is it maintained over time?
### EARLE’S VARIABLES FOR DESCRIBING PATHS

<table>
<thead>
<tr>
<th>variable</th>
<th>evidence</th>
<th>detection / modelling</th>
</tr>
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<tbody>
<tr>
<td>amount of construction / over what time</td>
<td>traces left by movement activities (erosion, construction, markers) and specific structures (walls, ditches)</td>
<td>D</td>
</tr>
<tr>
<td>technology of movement</td>
<td>walking, riding, wheeled vehicles</td>
<td>M</td>
</tr>
<tr>
<td>characteristics of terrain</td>
<td>topography, land use</td>
<td>DM</td>
</tr>
<tr>
<td>points / places of access / stewardship</td>
<td>settlements, buildings, storage areas, fields, cemeteries, crossroads, natural features</td>
<td>DM</td>
</tr>
<tr>
<td>functions</td>
<td>subsistence, resource acquisition, ceremonial, military, trade, social exchange</td>
<td>M</td>
</tr>
<tr>
<td>form / network organization</td>
<td>size, shape (radial, dendritic)</td>
<td>D</td>
</tr>
<tr>
<td>scale</td>
<td>local, regional, long-distance</td>
<td>DM</td>
</tr>
<tr>
<td>meaning</td>
<td>physical, spiritual, social, political, historical</td>
<td>??</td>
</tr>
</tbody>
</table>
the practices of movement, communication and transport
  > model will only give you partial networks, depending on model parameters
  > LiDAR will give you the full palimpsest (or almost...)

the environmental context
  > influences form (land use and microtopography) and possibility for detection
  > palaeogeography (water barrier, wetlands...)

historical trajectory
  > use and afterlife of pathways - changing of meaning
  > influence of pathways on land use and settlement

from theory to data and back
  > confront model and ‘data’
  > what does the absence of roads / networks say?
  > rethink the system using the concept of connectivity (combining different types of routes: paths, trails, roads, waterways)
FINAL DISCUSSION: A RESEARCH AGENDA?

- group discussion
  - groups of 4-5 people
  - discussion topic for groups
    - Group 1: practices of movement
    - Group 2: environmental context and trajectory
    - Group 3: historical trajectory (use and afterlife)
    - Group 4: confronting models and data (and what about absence)
    - Group 5: rethinking connectivity

- discuss the possibilities of LiDAR and modelling for your topic
  - where are the opportunities and difficulties in detection and modelling for this topic?
  - what approach should we take?

- report back in 30 minutes
AN ONTOLOGY OF PATHWAYS?

**MORPHOLOGY**

- **linear features**
  - straight or curved, but generally with low sinuosity
  - limited width, substantial length
  - may go against the gradient
  - incomplete / fragmented
  - intersections of linear features at sharp angles

- **network structures**
  - points of departure and arrival
  - additional nodes in network

- **limited vertical expression**
  - positive (talus) and negative (hollow ways)
  - sometimes very specific (ditch – talus – ditch)

**TRAJECTORY**

- **construction / practice**
  - intentional / non-intentional
  - distance of movement
  - environmental context
  - technology of movement

- **history of usage / function**
  - changes in usage
  - multiple uses
  - ownership

- **afterlife**
  - (partial) destruction
  - erosion / sedimentation
BRIDGING THE GAP(S)

Approach & scale issues

Detection
Individual oriented define 1- image resolution define 2- thematic
 group oriented

GIS Modelling
Individual oriented define define & emerge group oriented

ABM Simulation
Individual oriented define SIMULATION emerge group oriented
REFERENCES


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