

Smart tools for efficient earthing studies

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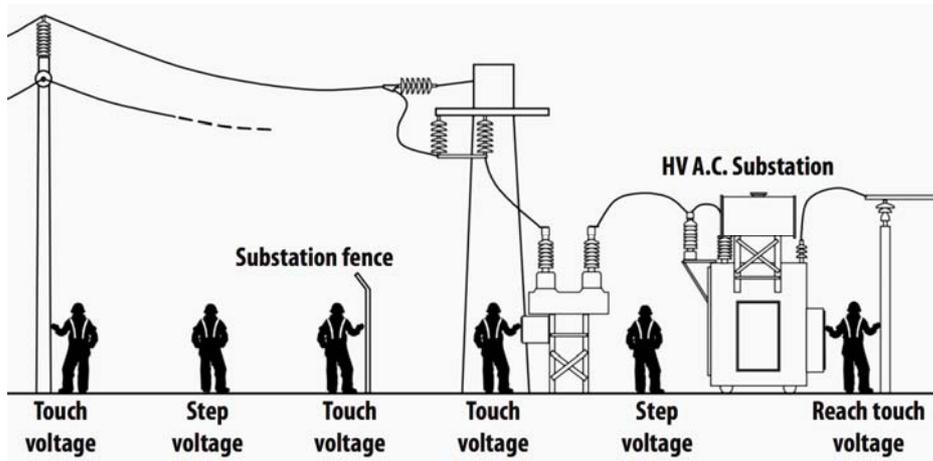


Earth Testing 101

1. Assess the integrity of the earth system for an electrical site
2. Test safety around the site during an earth fault
 - Touch measurements within restricted areas
 - Transferred touch and step measurements in public areas
 - Bonding, current splits, etc.
3. Perform desktop assessment of site measurements
4. Produce report summarising hazards, and mitigation options



Earth Testing 101



Earth Testing 101



Earth Testing 101



How things were...

Test	Location Description	Weather: Fine	Voltage Over Current (V)	Voltage 1 MΩ loaded (V)	Surface Type	Access (PA/RA)
1	Controlled 110V door		50.2	0.3	Comp	PA
2	Shed - Shed 1		0.9	0.1	Gr	RA
3	Shed - Shed 2		17.0	1.6	Gr	RA
4	Control Tower		70.4	0.1	Gr	RA
5	RF tower 1		1.1	0.3	Comp	RA
6	Security Fence		78.7	0.6	Gr	RA
7	"		12.5	0.0	Gr	RA
8	"		19.5	0.1	Gr	RA
9	"		32.0	0.4	Gr	RA
10	"		40.5	0.6	Gr	RA
11	RF tower 2		18.9	0.5	Gr	RA
12	RF tower 3		17.7	0.2	Gr	RA
13	Control Tower		69.3	1.7	Gr	RA
14	Security Fence		2.5	0.1	Gr	RA
15	Researcher door		10.7	0.3	Gr	RA
16	"		1.0	0.2	Comp	RA
17	"		8.3	0.2	Gr	RA
18	Shed - Shed 3		2.0	0.0	Gr	RA
19	Shed - Shed 4		10.3	0.0	Gr	RA
20	Shed - Shed 5		32.7	0.7	Gr	RA
21	Shed - Shed 6		2.4	0.4	Gr	RA
22	Shed - Shed 7		0.8	0.0	Gr	RA
23	Shed - Shed 8		4.7	0.7	Gr	RA
24	Shed - Shed 9		5.6	0.6	Gr	RA
25	Shed - Shed 10		2.9	0.2	Gr	RA
26	Shed - Shed 11		0.9	0.0	Gr	RA
27	Shed - Shed 12		8.1	0.1	Gr	RA
28	Shed - Shed 13		7.9	1.4	Gr	RA
29	Shed - Shed 14		1.0	0.0	Gr	RA
30	Shed - Shed 15		0.0	0.0	Gr	RA
31	Shed - Shed 16		0.0	0.0	Gr	RA
32	Shed - Shed 17		4.0	0.0	Gr	RA
33	Shed - Shed 18		2.0	0.0	Gr	RA
34	Shed - Shed 19		2.0	0.0	Gr	RA
35	Shed - Shed 20		2.0	0.0	Gr	RA
36	Shed - Shed 21		2.0	0.0	Gr	RA
37	Shed - Shed 22		2.0	0.0	Gr	RA
38	Shed - Shed 23		2.0	0.0	Gr	RA
39	Shed - Shed 24		2.0	0.0	Gr	RA
40	Shed - Shed 25		2.0	0.0	Gr	RA
41	Shed - Shed 26		2.0	0.0	Gr	RA
42	Shed - Shed 27		2.0	0.0	Gr	RA
43	Shed - Shed 28		2.0	0.0	Gr	RA
44	Shed - Shed 29		2.0	0.0	Gr	RA
45	Shed - Shed 30		2.0	0.0	Gr	RA
46	Shed - Shed 31		2.0	0.0	Gr	RA
47	Shed - Shed 32		2.0	0.0	Gr	RA
48	Shed - Shed 33		2.0	0.0	Gr	RA
49	Shed - Shed 34		2.0	0.0	Gr	RA
50	Shed - Shed 35		2.0	0.0	Gr	RA
51	Shed - Shed 36		2.0	0.0	Gr	RA
52	Shed - Shed 37		2.0	0.0	Gr	RA
53	Shed - Shed 38		2.0	0.0	Gr	RA
54	Shed - Shed 39		2.0	0.0	Gr	RA
55	Shed - Shed 40		2.0	0.0	Gr	RA
56	Shed - Shed 41		2.0	0.0	Gr	RA
57	Shed - Shed 42		2.0	0.0	Gr	RA
58	Shed - Shed 43		2.0	0.0	Gr	RA
59	Shed - Shed 44		2.0	0.0	Gr	RA
60	Shed - Shed 45		2.0	0.0	Gr	RA
61	Shed - Shed 46		2.0	0.0	Gr	RA
62	Shed - Shed 47		2.0	0.0	Gr	RA
63	Shed - Shed 48		2.0	0.0	Gr	RA
64	Shed - Shed 49		2.0	0.0	Gr	RA
65	Shed - Shed 50		2.0	0.0	Gr	RA

Test	Location Description	Weather	Voltage Over Current (V)	Voltage 1 MΩ loaded (V)	Surface Type	Access (PA/RA)
101	Control Tower		70.4	0.1	Gr	RA
102	Control Tower		70.4	0.1	Gr	RA
103	Control Tower		70.4	0.1	Gr	RA
104	Control Tower		70.4	0.1	Gr	RA
105	Control Tower		70.4	0.1	Gr	RA
106	Control Tower		70.4	0.1	Gr	RA
107	Control Tower		70.4	0.1	Gr	RA
108	Control Tower		70.4	0.1	Gr	RA
109	Control Tower		70.4	0.1	Gr	RA
110	Control Tower		70.4	0.1	Gr	RA
111	Control Tower		70.4	0.1	Gr	RA
112	Control Tower		70.4	0.1	Gr	RA
113	Control Tower		70.4	0.1	Gr	RA
114	Control Tower		70.4	0.1	Gr	RA
115	Control Tower		70.4	0.1	Gr	RA
116	Control Tower		70.4	0.1	Gr	RA
117	Control Tower		70.4	0.1	Gr	RA
118	Control Tower		70.4	0.1	Gr	RA
119	Control Tower		70.4	0.1	Gr	RA
120	Control Tower		70.4	0.1	Gr	RA
121	Control Tower		70.4	0.1	Gr	RA
122	Control Tower		70.4	0.1	Gr	RA
123	Control Tower		70.4	0.1	Gr	RA
124	Control Tower		70.4	0.1	Gr	RA
125	Control Tower		70.4	0.1	Gr	RA
126	Control Tower		70.4	0.1	Gr	RA
127	Control Tower		70.4	0.1	Gr	RA
128	Control Tower		70.4	0.1	Gr	RA
129	Control Tower		70.4	0.1	Gr	RA
130	Control Tower		70.4	0.1	Gr	RA
131	Control Tower		70.4	0.1	Gr	RA
132	Control Tower		70.4	0.1	Gr	RA
133	Control Tower		70.4	0.1	Gr	RA
134	Control Tower		70.4	0.1	Gr	RA
135	Control Tower		70.4	0.1	Gr	RA
136	Control Tower		70.4	0.1	Gr	RA
137	Control Tower		70.4	0.1	Gr	RA
138	Control Tower		70.4	0.1	Gr	RA
139	Control Tower		70.4	0.1	Gr	RA
140	Control Tower		70.4	0.1	Gr	RA
141	Control Tower		70.4	0.1	Gr	RA
142	Control Tower		70.4	0.1	Gr	RA
143	Control Tower		70.4	0.1	Gr	RA
144	Control Tower		70.4	0.1	Gr	RA
145	Control Tower		70.4	0.1	Gr	RA
146	Control Tower		70.4	0.1	Gr	RA
147	Control Tower		70.4	0.1	Gr	RA
148	Control Tower		70.4	0.1	Gr	RA
149	Control Tower		70.4	0.1	Gr	RA
150	Control Tower		70.4	0.1	Gr	RA



How things were...

Touch & Step						
87	VJB82 Yellow Φ Structure	-38.981955	175.770827	4.6	0	Crushed Rocl Restricted Touch
88	VJB82 Red Φ Structure	-38.981966	175.770775	9.8	0	Crushed Rocl Restricted Touch
89	ODJB R	-38.982105	175.770698	1	0	Natural Groun Restricted Touch
90	1074 OP Handle	-38.982107	175.770696	2.4	0	Natural Groun Restricted Touch
91	1072 Box	-38.982109	175.770696	2.7	0	Crushed Rocl Restricted Touch
92	1094 OP Handle	-38.982126	175.770651	3.2	0.3	Crushed Rocl Restricted Touch
93	1092 Box	-38.982143	175.770619	3	0	Crushed Rocl Restricted Touch
94	DS 1114 Op Handle	-38.982154	175.770568	3.5	0	Crushed Rocl Restricted Touch
95	CB 1112 Structure	-38.982156	175.770576	2.5	0	Crushed Rocl Restricted Touch
96	ODJB U	-38.982161	175.770582	5.7	0	Crushed Rocl Restricted Touch
97	ODJB T	-38.982164	175.770601	5.7	0	Crushed Rocl Restricted Touch
98	ODJB S	-38.982147	175.770629	15.6	0.4	Crushed Rocl Restricted Touch
99	1062 Box	-38.982142	175.770643	8.1	0	Crushed Rocl Restricted Touch
100	1064 Op Handle	-38.982143	175.770645	7	0	Crushed Rocl Restricted Touch
101	CB1082 Structure	-38.982147	175.770635	4.7	0	Crushed Rocl Restricted Touch
102	1084 Op Handle	-38.982152	175.770619	11.6	0.1	Natural Groun Restricted Touch
103	1102 JUG Handle	-38.982172	175.770567	10.4	0	Crushed Rocl Restricted Touch
104	1104 Op Handle	-38.982172	175.770566	1	0	Natural Groun Restricted Touch
105	1106 Op Handle	-38.982185	175.77056	8.6	0	Crushed Rocl Restricted Touch
106	CT 1102 STR	-38.982197	175.770568	10.4	0	Crushed Rocl Restricted Touch
107	CB1082 Check Box	-38.982205	175.770611	1.5	0	Crushed Rocl Restricted Touch
108	Reach Touch 106 & 107	-38.982207	175.770633	0	0	Crushed Rocl Restricted Transfer
109	1066 Op Handle	-38.982194	175.770637	2.3	0	Crushed Rocl Restricted Touch
110	CT 1062 STR	-38.982189	175.770647	9.9	0	Crushed Rocl Restricted Touch



What this does to Engineers...



Transitioning to electronic work-flow

- ▶ Some objectives:
 1. Maximise user experience (UX)
 2. Provide real-time feedback
 3. Allow export/backup of data
 4. Leverage the internet
 5. Allow for future interoperability



Early days

- ▶ Develop an iOS app?
 - ▶ Scary / Expensive / Difficult
- ▶ Off the shelf apps (for earthing!?)
 - ▶ Generic, sacrifices UX
- ▶ Other options?



Off the shelf options



A screenshot of a mobile application form titled 'Engineering: Manhole Inspection'. The form contains the following fields:

- Name of Inspector *: Ryan
- Inspection ID: 34-678
- Manhole(s):
- Date of Signature *: Jul 7, 2016
- Inspector Signature *: [Handwritten Signature]
- Date of Next Inspection: Jul 7, 2017



The Engineer's solution

A screenshot of a web application interface for 'Mitton ElectroNet Earth Testing'. The interface includes the Mitton ElectroNet logo and a grid of functional buttons with descriptions:

Preparation	Pre-fills test procedure/test sheets	Bonding Tests	Enter bonding measurements
Voltage Traverse	Enter voltage traverse measurements	Soil Resistivity	Enter soil resistivity measurements
Touch & Step	Enter step and touch measurements (and view safety limits)	Safety Limits	View Safety Limits
Create KML File	Creates a KML file with all touch and step information	Auto Transformer	Updates the content in the report based on entered data
Create Procedure	Additional tasks (can be done in the office)	Create Report	Updates the content in the report based on entered data



Touch friendly - with instant feedback

B140 : Transmission Pole

Home Add New Edit Active Row Safety Limits

Touch & Step										
Meas ID	Description	Device ID	Latitude	Longitude	V Open (mV)	V Loaded (mV)	Surface Type	Restricted/Public Area	Measurement Type	Comments
130	Pipeline		-28.951971	143.792442	46.7	8.9	Natural Groun	Public	Transfer	
131	Pipeline		-28.951821	143.792267	190	18.6	Natural Groun	Public	Transfer	
132	Pipeline		-28.952090	143.792524	80.6	48.6	Natural Groun	Public	Touch	
133	Pylon		-28.952628	143.792777	32.6	5.2	Natural Groun	Public	Touch	
134	Outer security fence		-28.952985	143.792889	42	2.9	Natural Groun	Public	Touch	
135	Stock Fence		-28.953146	143.793045	27.5	0.2	Natural Groun	Public	Touch	
136	Stock Fence		-28.953343	143.792922	9.2	0	Natural Groun	Public	Touch	
137	Transmission Pole		-28.953278	143.793202	58.4	17.9	Natural Groun	Public	Touch	
138	Security Fence	cnr	-28.952990	143.793534	8.8	0	Natural Groun	Public	Step	
139	Security Fence	cnr	-28.952605	143.793790	6	0.2	Natural Groun	Public	Step	
140	Security Fence	cnr	-28.952448	143.793449	1	0	Natural Groun	Public	Step	
141	Security Fence	cnr	-28.952930	143.793135	2.6	0	Natural Groun	Public	Step	



Custom VBA forms

Touch and Step Voltages

Key Information Measurements

Description: Transmission Pole ID: 137

Device ID: [] measured (mV) limit (mV)

Surface: Natural Ground mV Open: 58.4 14

Location: Public mV Loaded: 17.9 12

Type: Touch Resistivity: 1509 Ωm

Comments: []

Get GPS Data

Update



Equipment to be carried



Success?

Not quite...

Development using iOS Swift

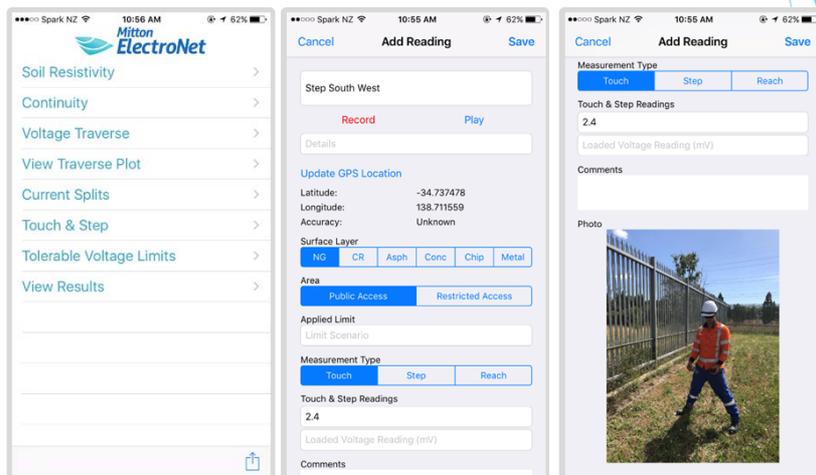
1. Swift released in July 2014 for Xcode
2. Proliferation of online courses by Dec 2015



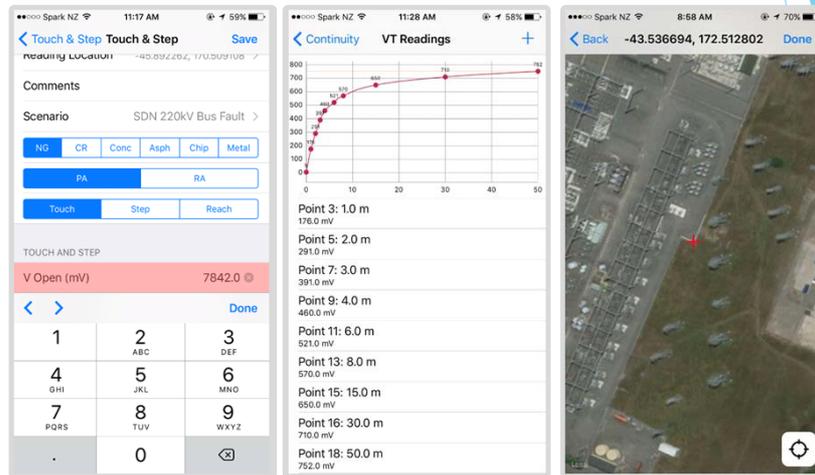
3. Significant online resources available.



The iOS Earth Testing App - V1.0 (Oct '16)



The iOS Earth Testing App - V2.0 (Mar '17)

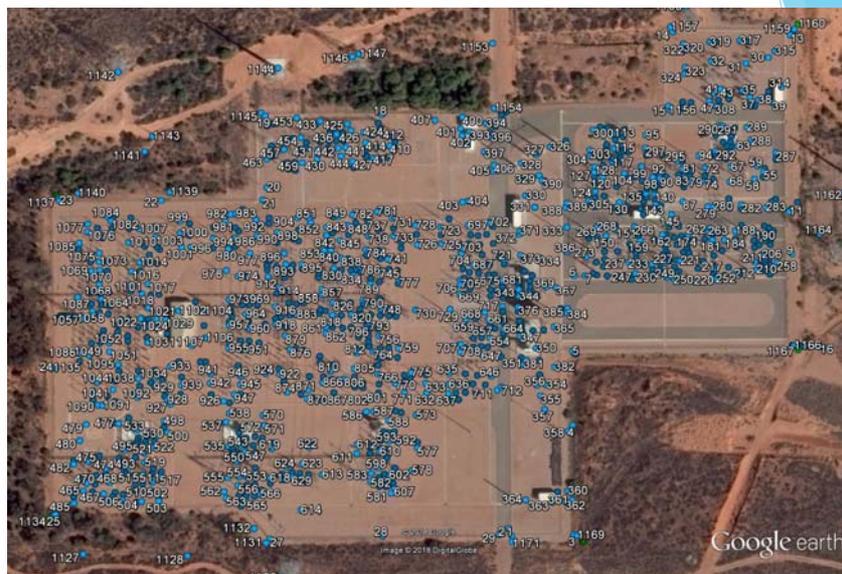


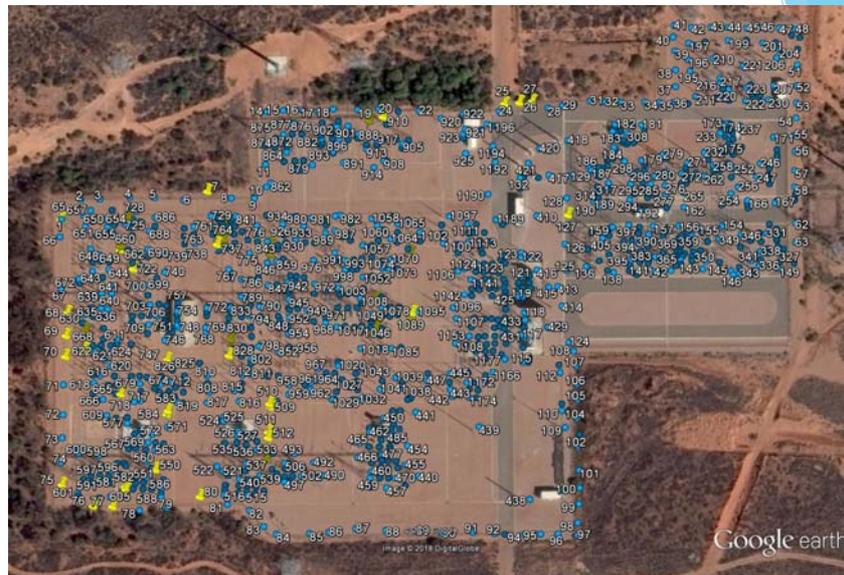
App output



Benefits

- ▶ Significant improvement in efficiency
- ▶ Real time feedback
- ▶ Less handling, less errors





 Mittan
ElectroNet

Efficiency

- ▶ Extreme case:
 - ▶ Assuming 10 seconds per point
 - ▶ 2,400 total points
 - ▶ Nearly 7 hours saved
 - ▶ Cost of test engineers?
 - ▶ Payback period?

 Mittan
ElectroNet

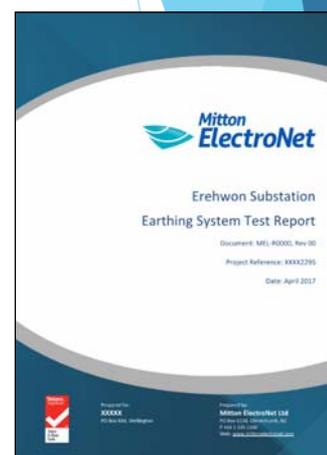
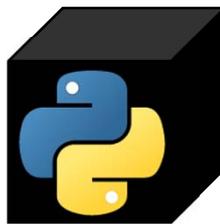
Continuing the electronic workflow

- ▶ Some more objectives:
 1. Abolish repetitive tasks
 2. Streamline the reporting process
 3. Allow archiving of results
 4. Preserve a record of the analysis

- ▶ We can easily export CSV files. Useful?



Automating the analysis



The 'Black Box'

- ▶ Automates a number of tasks:
 1. Wrangles data, applies scaling, etc.
 2. Calculates important parameters
 3. Curve matching
 4. Creates plots (traverse, EPR, splits, etc.)
 5. Computes tolerable limits
 6. Assesses site safety
 7. Summarises results (excel, KML, etc.)
 8. Collates relevant data for entry into report



Benefits

- ▶ Further improvements in efficiency, error reduction, etc.
- ▶ Engineers get to spend more time engineering
- ▶ Our services to our customers are better



Some key learnings

- ▶ The use of frameworks and libraries makes app development (and maintenance) relatively easy
- ▶ Leveraging in house experience was essential for refinement
- ▶ App/script development possible for internal processes on smaller budgets (compared with customer facing apps)
- ▶ Possible to create a basic app with cloud data storage in 2-3 months



What's next?

- ▶ Continue developing our app:
 - ▶ Now works well as a simple inspection tool
 - ▶ On-going maintenance
 - ▶ New features
 - ▶ App store?
- ▶ Find a way to fully automate data entry into reports
- ▶ Work on new ways to visualise data:
 - ▶ Are traditional styles of reports the way of the future?



Questions?

What repetitive, paper based processes
do you take for granted in your business?