

Simulation Based Training and NOSTRA

Extract from upcoming White Paper
(DRAFT)

ASTech
(Atlantic Simulation & Training Technologies)

September 2007



Objective

Provide a general introduction to NOSTRA including:

- ▶ What need is being addressed
- ▶ Explain Context - SBT
- ▶ What is NOSTRA?
- ▶ Main Features
- ▶ Usage Scenarios
- ▶ Deployment Options
- ▶ How to get more information

Switching operations in Power System Networks:

- ▶ Very Specialised
- ▶ Correct procedures must be followed to ensure both personnel safety and supply continuity
- ▶ Errors can be very costly
- ▶ Huge time and expense goes into training and assessing network technicians on c
- ▶ Some OTJ (On the Job) training is necessary - this is augmented by classroom sessions

What can we do to reduce costs while improving training effectiveness?

Web-Based Special Purpose Simulators or STDs (Synthetic Training Devices)

Confucius (c. 450 BC) said:

*I hear and I forget,
I see and I remember,
I do and I understand.*

Educators say that students typically remember:

10% of what they read

20% of what they hear

30% if they see visuals related what they are hearing

50% if they watch someone doing something while explaining it

90% if they do it themselves, even if only as a simulation

Simulation Based Training



Studies have shown:

Current training tools fail to allow engineers/technicians to develop a simple, accurate mental model upon which to build knowledge and skills during training and line operating experience.

Engineers/technicians need a tool that can support the long-term acquisition of automation skills and an accurate mental model.

Simulation allows engineers/technicians to understand:

HOW: procedural skills

WHY: this requires an accurate mental model

WHEN: automation skills

Simulation model is at the center of a tool that allows the technicians to understand the WHY, WHEN and HOW (The Boeing Company, Dr Mumaw, D. Boorman and J. Griffin, March 2001)



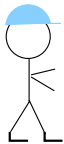
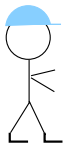
Pedagogical Approaches

Next slides show spectrum of approaches which are possible:

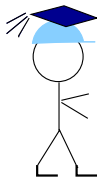
- ▶ Traditional
- ▶ Simulator (Hardware)
- ▶ Simulator (Software)
- ▶ Simulation Based Training with LMS
- ▶ "Next Generation" - LMS with SBT + AI

Pedagogy 1 - Training on Real Plant

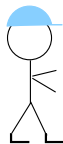
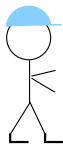
Trainees



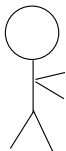
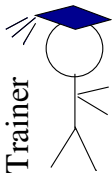
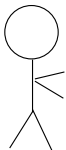
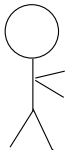
Trainer



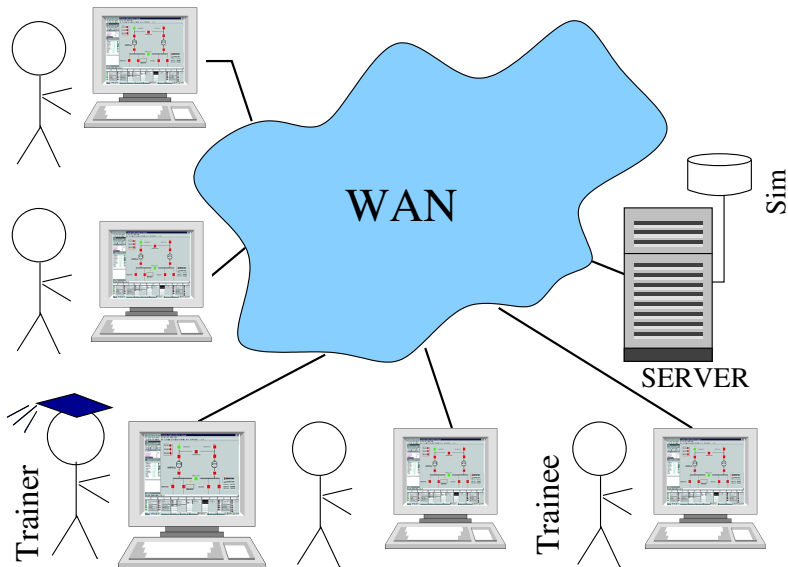
Trainees



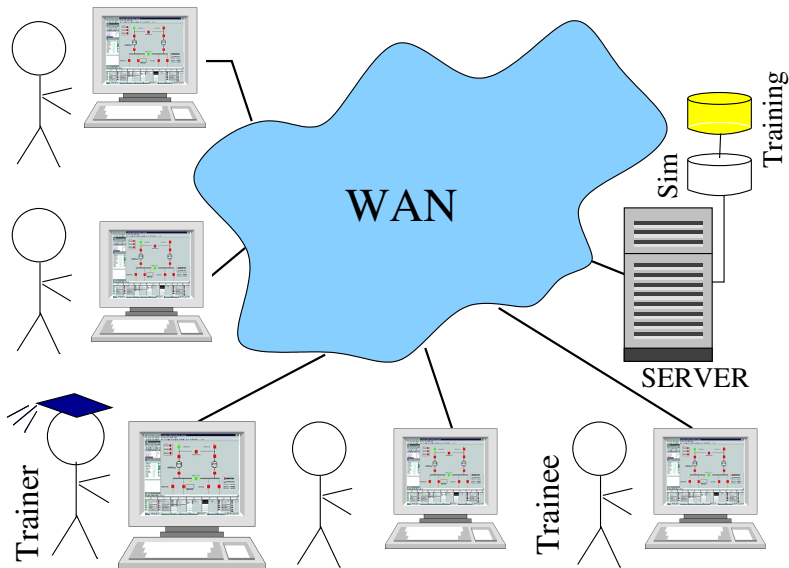
Pedagogy 2 - Training on a Simulator (Hardware)



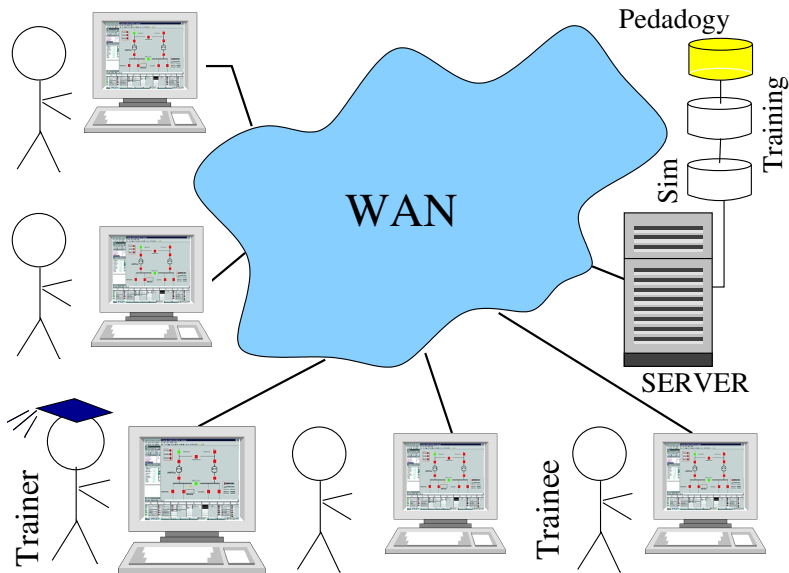
Pedagogy 3 - Training on Simulator



Pedagogy 4 - Using Simulation Based Training



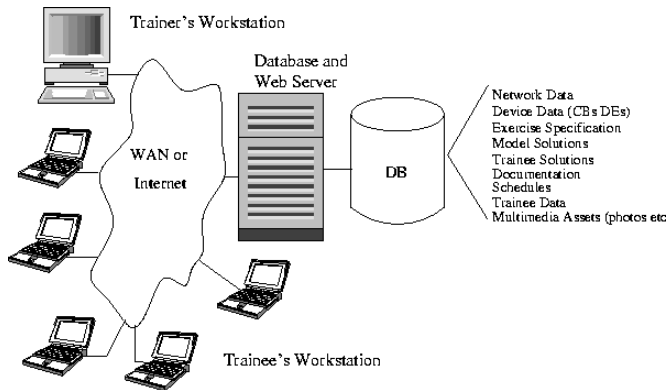
Pedagogy 5 - Using Simulation Based Training + AI



What is NOSTRA

The Acronym:

NOSTRA (Network Operation Switching TRaining Aid)



What is allows

TRAINEE

Network
Familiarisation

Free-Play
Practice Exercises

Perform
Scheduled
Exercise

Schedule
Exercises

Demo in
Classroom

Supervisory Mode
Monitor Exercises

Debrief Session
Playback
fb on Exercises

Author New
Exercises
Analysis

TRAINER

Using Simulation in Training - Intro

Similar Work

Although it evolved independently, our recent research has found that many of the underlying capabilities in NOSTRA, are employed in the best STDs used in other industries specifically in aviation industry.

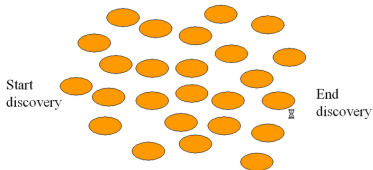
next slides show

An array of ellipses - each representing a network state. A switching action brings us from one state to the next. We can transition in a number of ways:

- ▶ Free-play Learning
- ▶ Demo
- ▶ Practice
- ▶ Goal Oriented Practice
- ▶ Intelligent Tutoring

Using Simulation in Training - Free-play Learning

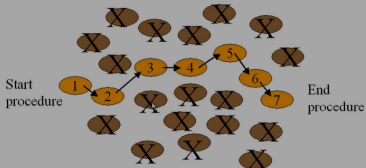
Free-play Learning



This mode is immediately available once a simulation has been authored.

Demo a Procedure

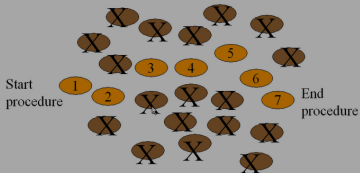
System performs steps for student.



Comments (instruction) may accompany each step. This mode is available as a result of 'authoring by doing'.

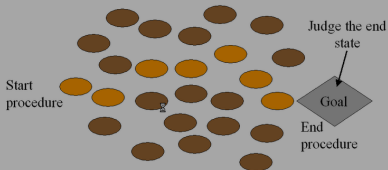
Practice a Procedure

Each oval represents a possible step



Step on an X or a step out of sequence is not permitted; instructional remediation results.

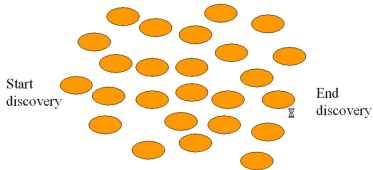
Goal Oriented Practice



Trainee may step anywhere. Two judging modes are available – (1) Automatically and (2) User Specified

Using Simulation in Training - Demo Procedure

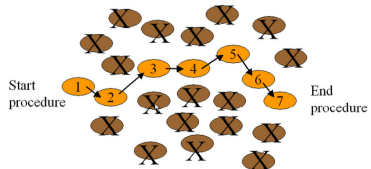
Free-play Learning



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Demo a Procedure

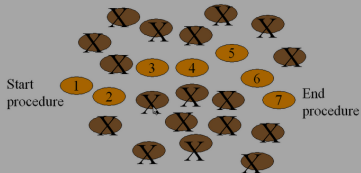
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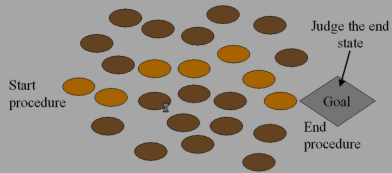
Practice a Procedure

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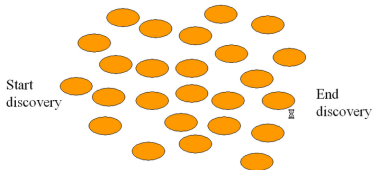
Goal Oriented Practice



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Using Simulation in Training - Practice Procedure

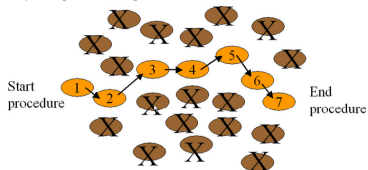
Free-play Learning



This mode is immediately available once a simulation has been authored.

Demo a Procedure

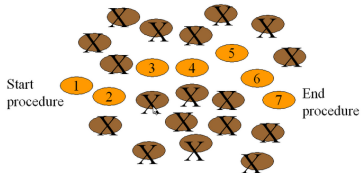
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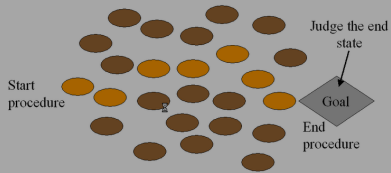
Practice a Procedure

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Goal Oriented Practice

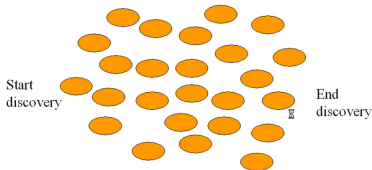


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Using Simulation in Training - Goal Oriented Practice

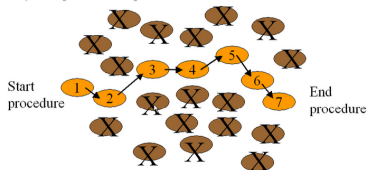
Free-play Learning



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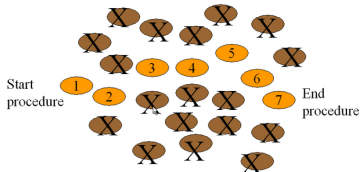
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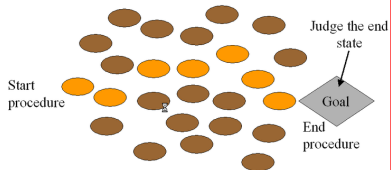
Practice a Procedure

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Goal Oriented Practice

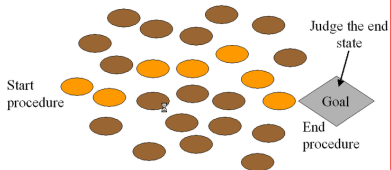


Trainee may step anywhere. Two judging modes are available – (1) Automatically and (2) User Specified



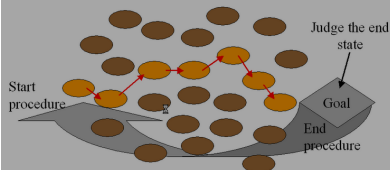
Using Simulation in Training - Goal Oriented Practice

Goal Oriented Practice



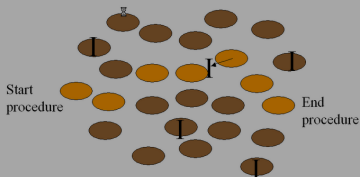
Trainee may step anywhere. Two judging modes are available – (1) Automatically and (2) User Specified

Goal Practice Remediation



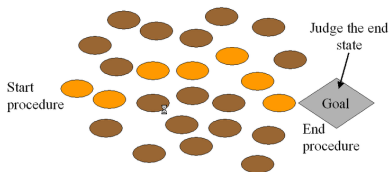
Failure to achieve goal can be automatically remediated using data created when the Goal exercise was authored.

Intelligent Tutoring



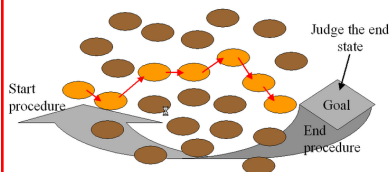
Intervention when appropriate. Some additional authoring effort: requires specifying intervention conditions.

Goal Oriented Practice



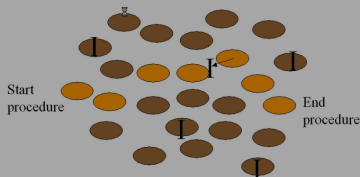
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Goal Practice Remediation



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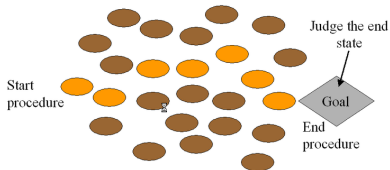
Intelligent Tutoring



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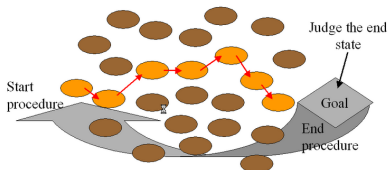
Using Simulation in Training - Intelligent Tutoring

Goal Oriented Practice



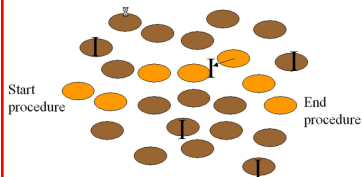
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Goal Practice Remediation



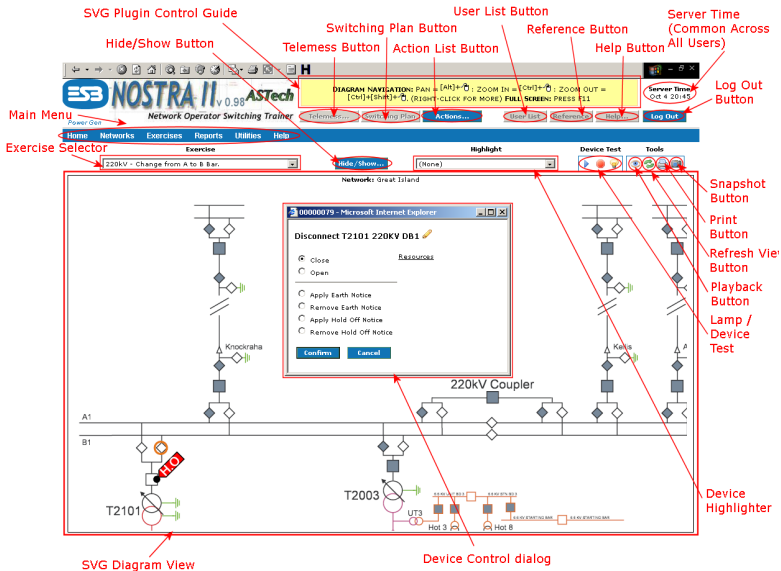
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Intelligent Tutoring



Intervention when appropriate. Some additional authoring effort: requires specifying intervention conditions.

Screengrab of NOSTRA Interface



SVG Plugin Control Guide

Hide/Show Button

Switching Plan Button

Telemess Button

Action List Button

User List Button

Reference Button

Help Button

Server Time (Common Across All Users)

Log Out Button

Main Menu

Exercise Selector

220kV - Change from A to B Bar

Hide/Show

Highlight

Device Test

Tools

Snapshot Button

Print Button

Refresh View Button

Playback Button

Lamp / Device Test

Device Highlighter

SVG Diagram View

Device Control dialog

00000079 - Microsoft Internet Explorer

Disconnect T2101 220kV DB1

Close

Open

Resources

Apply Earth Notice

Remove Earth Notice

Apply Hold OFF Notice

Remove Hold OFF Notice

Confirm

Cancel

Knockkraha

Kerk

220kV Coupler

T2101

T2003

UT3

Hot 3

Hot 8

Hot 4

Hot 5

Hot 6

Hot 7

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Hot 100

Intuitive User Interface

- ▶ IE Web Browser provides intuitive interface
- ▶ SVG (scalable vector graphics) allows network zoom, pan etc.
- ▶ 'Tooltips' for easy identification of network elements
- ▶ Mouse clicks used to open/close CBs and DCs diagram modified (CBs and DCs opened/closed) as exercise progresses
- ▶ Regions of network can be displayed/hidden
- ▶ Lookup facility for location of individual devices
- ▶ Hyperlinks from network diagram to on-line documentation
- ▶ As exercises being performed, trainer can selectively monitor different trainees or groups

Features - 1

- ▶ Fill-in forms for creation and modification of exercises
- ▶ Graphical editor for branched solutions
- ▶ Use of Switching Plan (optional)
- ▶ Use of Telemess Form (optional)
- ▶ Interlocking enabled/disabled
- ▶ Automatic grading
- ▶ Individual (1 trainee) and collaborative (2 trainees) exercises

Features - 2

- ▶ Multiple network diagrams
- ▶ Multiple exercises per network
- ▶ Exercise schedule
- ▶ Model solutions (including alternatives)
- ▶ Trainee details
- ▶ Trainee solution steps on exercise basis
- ▶ Annotated labels for CBs and DCs (circuit breakers and disconnects)

- ▶ Hardcopy of network diagrams
- ▶ Model solutions
- ▶ Student solutions
- ▶ Switching plans
- ▶ Telemess forms
- ▶ Performance statistics

Trainee Operations

Role	Allowed Operations
<ul style="list-style-type: none">▶ Trainee▶ Trainer▶ Administrator	<ul style="list-style-type: none">▶ Browse Networks & Practice Switching▶ Perform Scheduled Exercises▶ Create PDFs of Networks▶ Take Snapshot of Network State▶ Create/Modify Switching Exercises▶ Create/Modify Model Solutions▶ Schedule Exercises & Assign Trainees▶ Assess Exercise Solutions▶ Playback Exercise Solutions▶ Assign/Modify Device Labels▶ Assign/Modify User Accounts▶ Print Reports

Trainer Operations



Role

Allowed Operations

- ▶ Trainer
- ▶ **Trainer**
- ▶ Administrator

- ▶ Browse Networks & Practice Switching
- ▶ Perform Scheduled Exercises
- ▶ Create PDFs of Networks
- ▶ Take Snapshot of Network State
- ▶ Create/Modify Switching Exercises
- ▶ Create/Modify Model Solutions
- ▶ Schedule Exercises & Assign Trainees
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- ▶ Assign/Modify User Accounts
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Role

Allowed Operations

- ▶ Trainee
- ▶ Trainer
- ▶ **Administrator**

- ▶ Browse Networks & Practice Switching
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Deployment Options

Hosting

- ▶ Internet
- ▶ Intranet
 - ▶ company WAN
 - ▶ ad-hoc wired
 - ▶ or wireless
- ▶ stand-alone PC

Web Server

- ▶ IIS
- ▶ Apache Web Server

Industry standard SQL database

- ▶ Oracle
- ▶ Microsoft SQL Server
- ▶ MySQL



Summary



- ▶ Uses standard "task grammar" and outputs Switching Plan / Operation Order / Switching Record employed by utilities
- ▶ Developed in close cooperation with ESB
- ▶ Can be used in classroom training and in distance education mode (time + place)
- ▶ Used for both training and assessment
- ▶ Standard web browser interface - minimal training required.
- ▶ Can work with different distribution networks - target specialised training for each customer.
- ▶ Analysis of usage logs help identify common mistakes and improve training program
- ▶ Tools like NOSTRA have been shown to significantly improve effectiveness and reduce cost of training



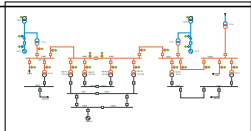
Status of ESB Power Gen Project



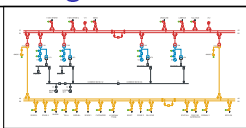
- ▶ All hosting options have been implemented + demonstrated
- ▶ Conversion from MySQL database (used by ASTech) to Oracle (using ESB mandated specs) completed. Ready to be hosted on ESB intranet.
- ▶ All features in specs completed + additional ones such as 'Playback' and 'Snapshot'
- ▶ All power stations network diagrams completed. ESB Network suggested modifications completed.
- ▶ On-line help, draft user manual and draft training materials developed.
- ▶ Interlocking implemented and comprehensively tested on Gt. Island. Report prepared.
- ▶ Interlocking logic has been generalised and captured and verifiable in "Ladder Logic" engine. This is applicable on all stations.



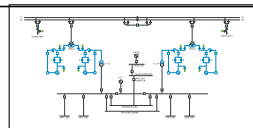
Power Station Network Diagrams



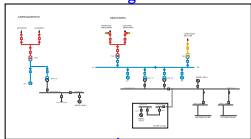
Poolbeg - cc



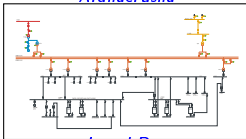
Ardnacrusha



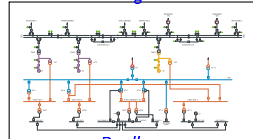
Turlough Hill



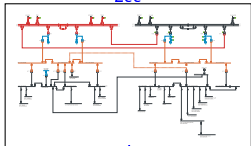
Lee



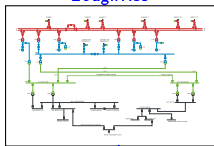
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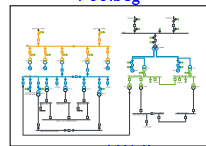
Poolbeg



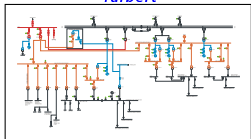
Tarbert



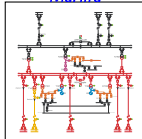
Marina



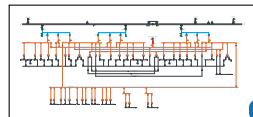
North Wall



Aghada



Gt. Island



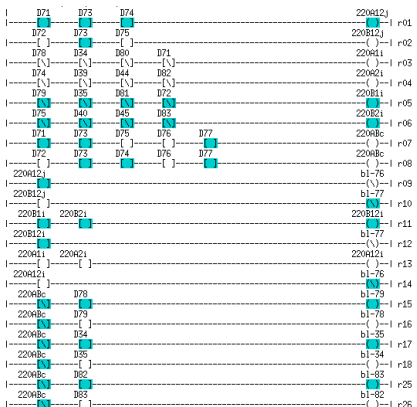
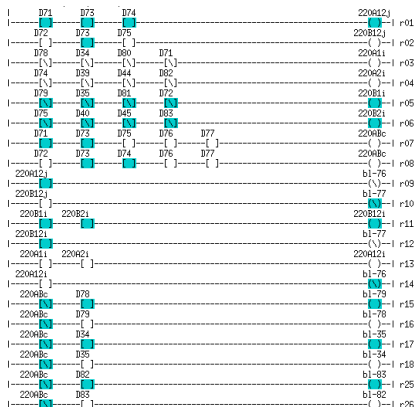
Moneypoint



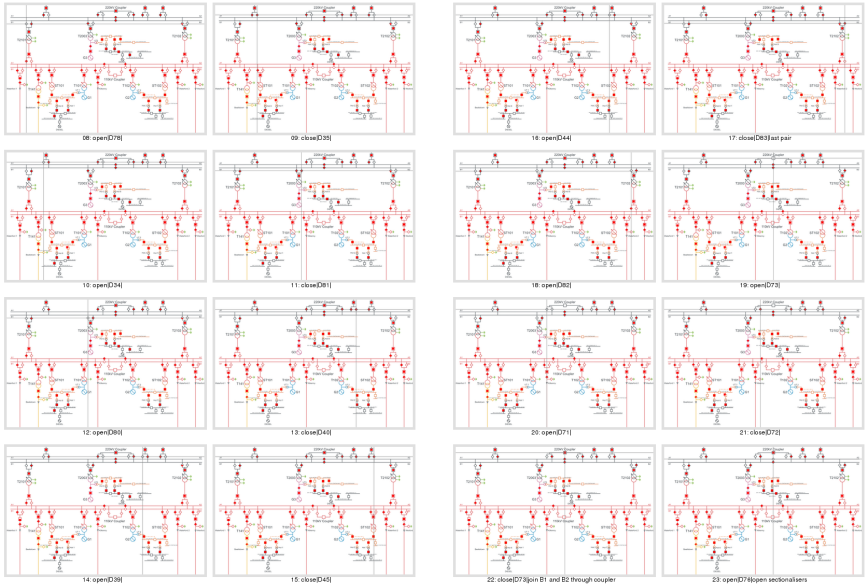
Sample of Ladder Logic Diagrams for Interlocking



Logic has been generalised and represented in "ladder diagrams". automatically generated from network data. Series of test scripts have been prepared to check out interlocking.



Montage of Annotated Diagrams Generated in Tests



Next Steps?

ASTech

- ▶ Existing system (w/o ilock except on Gt. Island) to be hosted on ESB intranet when get go-ahead.
- ▶ Special cut-down version of NOSTRA being customised for ESB Networks. Also being integrated into courses in Portlaoise Training
- ▶ ASTech planning major enhancement of NOSTRA which will involve inter-alia:
 - ▶ integration into Learning Management System.
 - ▶ inclusion of rudimentary load flow and fault analysis

Decisions for ESB Power Gen

- ▶ When to commence hosting. Support/maintenance onwards
- ▶ NOSTRA interlocking functionality required on stations?

