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EARS Tutorial

Easy Approach to Requirements Syntax

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Outline

- Motivation
- Concepts
- EARS templates, for each:
 - “Theory”
 - Examples
 - Exercises
- Strengths and weaknesses of EARS
- Summary

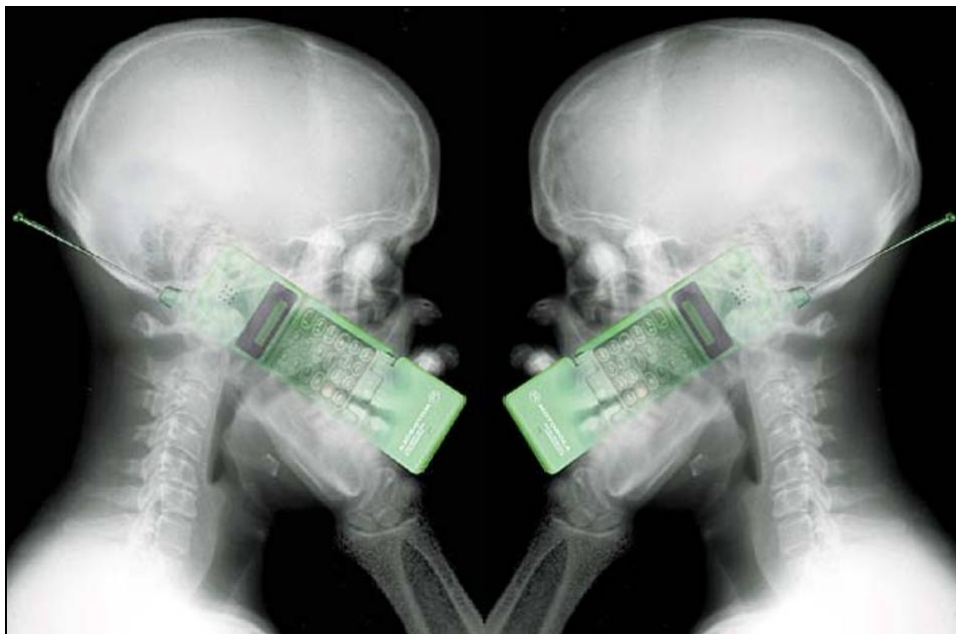
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Motivation

- Top-level system requirements are typically written in *Natural Language* (NL) by individuals who are not requirements experts
- Unconstrained NL can cause problems.
- There is a need for simple, easy to apply guidance
- EARS Templates are based on industry best practice and many years of experience

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http://www.artsandopinion.com/2006_v5_n3/volume_images/cell%20phone-2.jpg

Concepts (1 of 3)

- There are two *classes* of requirement
 - *Normal operation*
 - *Unwanted behaviour*
- All NL requirements can be defined using one of 5 simple templates
 - 4 *normal operation* templates
 - 1 *unwanted behaviour* template

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Concepts (2 of 3)

- *Normal operation* requirements
 - Define the required system behaviour during *sunny day* operation
 - All users and all interacting systems behave as expected to meet the goals of the user

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Concepts (3 of 3)

- **Unwanted behaviour** requirements
 - A general term used to cover all deviations from **sunny day** operation
 - Define the **required response** of the system to
 - Failures and disturbances
 - Deviations from desired user behaviour
 - Unexpected behaviour of interacting systems

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http://www.ericsson.com/ericsson/press/photos/mobile_telephony/woman_car_highres.jpg

Normal operation (1 of 2)

- Generic syntax is
<optional preconditions> <optional trigger> the <system name> shall <system response>
- Simple structure adds rigour & clarity
- System response describes what the system must actually do that is *visible* at the boundary of the system

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Normal operation (2 of 2)

- **Ubiquitous**
 - Requirement is always active
- **Event-driven** (keyword *When*)
 - Required response to a triggering event
- **State-driven** (keyword *While*)
 - Required response in a specified state
- **Option** (keyword *Where*)
 - Applicable only if *feature* is included
- *(can use combinations of When, While and Where for requirements with complex conditional clauses)*

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Ubiquitous

- *The <system name> shall <system response>*
- Used to define system behaviour that must be active at all times
 - *“continuous”*
- No preconditions or trigger
 - *“unconditional”*

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http://fotosa.ru/stock_photo/Fancy%20by%20Veer/p_2712847.jpg

Ubiquitous examples

- Car

- *The car shall have a maximum retail sale price of XXX*
- *The car shall be compliant with the safety requirements defined in XXX*

- Laptop

- *The laptop shall have a mass of no more than XXX grams*
- *The laptop shall have a minimum battery life of XXX hours*

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Exercise: write some ubiquitous requirements for a mobile phone



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<http://www.celt.net.org.uk/mobile-phone/img/mobile-evolution.gif>

Event-driven

- *When <trigger> the <system name> shall <system response>*
- Initiated only when a triggering event is detected at the system boundary
- The trigger must be something that the system itself can detect
 - *This often helps clarify the system boundary.*

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<http://www.simonlydeals.co.uk/pics/cell-phone-booth.jpg>

Event-driven examples (1 of 2)

● Car

- *When the clutch pedal is depressed, the car shall disengage the driving force*
- *When the "turn indicator" command is received, the car shall operate the indicator lights on the front, side and rear of the vehicle, and provide audible and visual confirmation to the driver*

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Event-driven examples (2 of 2)

● Laptop

- *When the laptop is off and the power button is pressed, the laptop shall boot up*
- *When the laptop is running and the laptop is closed, the laptop shall enter "powersave" mode*

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Exercise: write some event-driven requirements for a mobile phone



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<http://www.healthspablog.org/wp-content/uploads/2009/12/Effects-of-mobile-phone-on-children-brains.jpg>

State-driven

- *While <in a specific state> the <system name> shall <system response>*
- Requirement is active while the system is in a defined state
 - *Requirement is “continuous”, but only while the system is in the specified state*

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<http://www.sciencedaily.com/images/2008/06/080609071402-large.jpg>

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State-driven examples (1 of 2)

● Car

- *While the ignition is on, the car shall display the fuel level and the oil level to the driver*
- *While the key is in the ignition, the car alarm shall be inhibited*
- *While the handbrake is applied, the wheels shall be locked*

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State-driven examples (2 of 2)

● Laptop

- *While the laptop is running on the battery and the battery is below XXX % charge, the laptop shall display "low battery"*
- *While an external audio output device is connected, the laptop shall mute the built-in speaker and send the audio output signal to the external audio output device*

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Exercise: write some state-driven requirements for a mobile phone



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http://www.whatsgottago.com/wp-content/uploads/2007/12/angry_phone.jpg



Option

- *Where <feature is included> the <system name> shall <system response>*
- **Applicable only in systems that include a particular *feature***
 - *The requirement will often be “ubiquitous”, but only for systems that include the specified feature*

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Option examples (1 of 2)

● Car

- *Where the car has electric windows, the electric window controls shall be on the driver's door panel*
- *Where the car includes automatic windscreen wipers, the car shall sense moisture on the windscreen and operate the windscreen wipers without driver commands*

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Option examples (2 of 2)

● Laptop

- *Where a "long life" battery is fitted, the laptop shall have a minimum battery life of XXX hours*
- *Where the laptop is a "lightweight" model, the laptop shall have a mass of no more than XXX grams*

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Exercise: write some option requirements for a mobile phone



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http://www.maclife.com/files/u32/0708_contract_200.jpg

Unwanted behaviour

- A variation of *event-driven* requirement.
- *If <optional preconditions> <trigger>, then the <system name> shall <system response>*
- This format forces the separation of
 - Circumstances in which the requirement can be invoked (*preconditions*)
 - The initiating event (*trigger*)
 - The expected system behaviour (*response*)

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<http://texassurfers.com/surf-articles/wp-content/uploads/2009/09/surfing-waterproof-cell-phone.jpg>



http://www.2dayblog.com/images/2007/july/bbq_handset_1.jpg

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Unwanted behaviour examples (1 of 2)

● Car

- *If the car detects attempted intrusion, then the car shall operate the car alarm*
- *If the car detects low oil pressure, then the car shall display a "low oil pressure" warning*

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<http://www.puremobile.ca/communityblog/wp-content/uploads/2009/02/205.jpg>

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http://www.newlaunches.com/entry_images/0708/21/cellphone-lightning-strike.jpg

<http://qizmodo.com/assets/resources/2006/06/lightning.jpg>

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Unwanted behaviour examples (2 of 2)

● Laptop

- *If the incorrect password is entered, then the laptop shall display XXX warning message*
- *If the laptop is connected to a non-compatible device, then the laptop shall prevent transfer of data, prevent transfer of charge, display XXX warning message and not be damaged*

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Exercise: write some unwanted behaviour requirements for a mobile phone



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http://www.clickoriando.com/2006/0907/9801524_400X300.jpg

“Complex” requirement syntax

- Requirements with complex conditional clauses are defined using combinations of *When*, *While*, *Where* and *If-Then*
- The keywords can be built into more complex expressions to specify richer system behaviours
- For instance, the same event may trigger different system behaviour depending on the state of the system when the event is detected

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http://www.textually.org/textually/archives/images/set1/cell_phones.gif

Complex requirement examples (1 of 2)

● Car

- *Where the car includes an "owner alert" system, if the car detects attempted intrusion, then the car shall send a message to the owner and activate the car alarm*
- *While the car is being being driven forwards above a speed of XXX, if the driver attempts to engage reverse gear, then the car shall prevent engagement of reverse gear*

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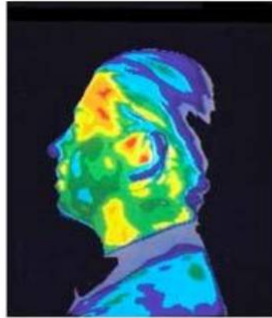
Complex requirement examples (2 of 2)

● Laptop

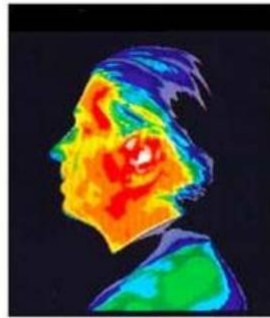
- *Where the laptop includes "voice input" option, while the voice input option is selected, the laptop shall accept voice input commands*
- *While the laptop is running on mains electrical power, if the power cable is disconnected, then the laptop shall display a warning message*

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Exercise: write some complex requirements for a mobile phone



Thermographic Image of the head with no exposure to harmful cell phone radiation.



Thermographic Image of the head after a 15-minute phone call. Yellow and red areas indicate thermal (heating) effects that can cause negative health effects.

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<http://www.passenlaw.com/blog/wp-content/uploads/2010/01/cell-phone-brain-cancer-radiation.jpg>

Strengths and weaknesses of EARS

● Strengths

- Provides rigour and consistency
- Easy to learn and apply
- No tools needed
- Common form of requirements communication

● Weaknesses

- Limited inter-requirement coupling
- Unsuitable for very complex requirements
(consider using truth tables or other non-textual notation)

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<http://resources3.news.com.au/images/2009/07/31/1225756/816983-texting-tow-truck-in-pool.jpg>

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Summary of EARS

- Provides simple, general guidance
 - Templates support complex requirements
- Widely applicable to NL requirements
- Exposes lack of understanding
 - Prevents analysts from hiding behind ambiguity and vagueness
 - Rigour forces a deeper consideration of the desired system behaviour
- Versatile, allowing a *house style*
- Aids understanding and communication

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References and contact details

- **EARS**
 - Easy Approach to Requirements Syntax
 - Proceedings of RE09
- **BIG EARS**
 - *The Return of EARS*
 - Proceedings of RE10
 - “Requirements Specifications and Processes” session, 11am Wednesday
- alistair.mavin@rolls-royce.com

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