Managing the Verification of Food Authenticity and Integrity

Assuring food authenticity and integrity - protecting the food sector from threats and vulnerabilities

A Seafish/REHIS Joint Award

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BSc (hons) BSc. Pg Dip (Food Safety) CSci (Food Sci & Tech) FIFST FS Prin (IFST)

Date

Here to give the UK seafood sector **the support it needs to thrive.**

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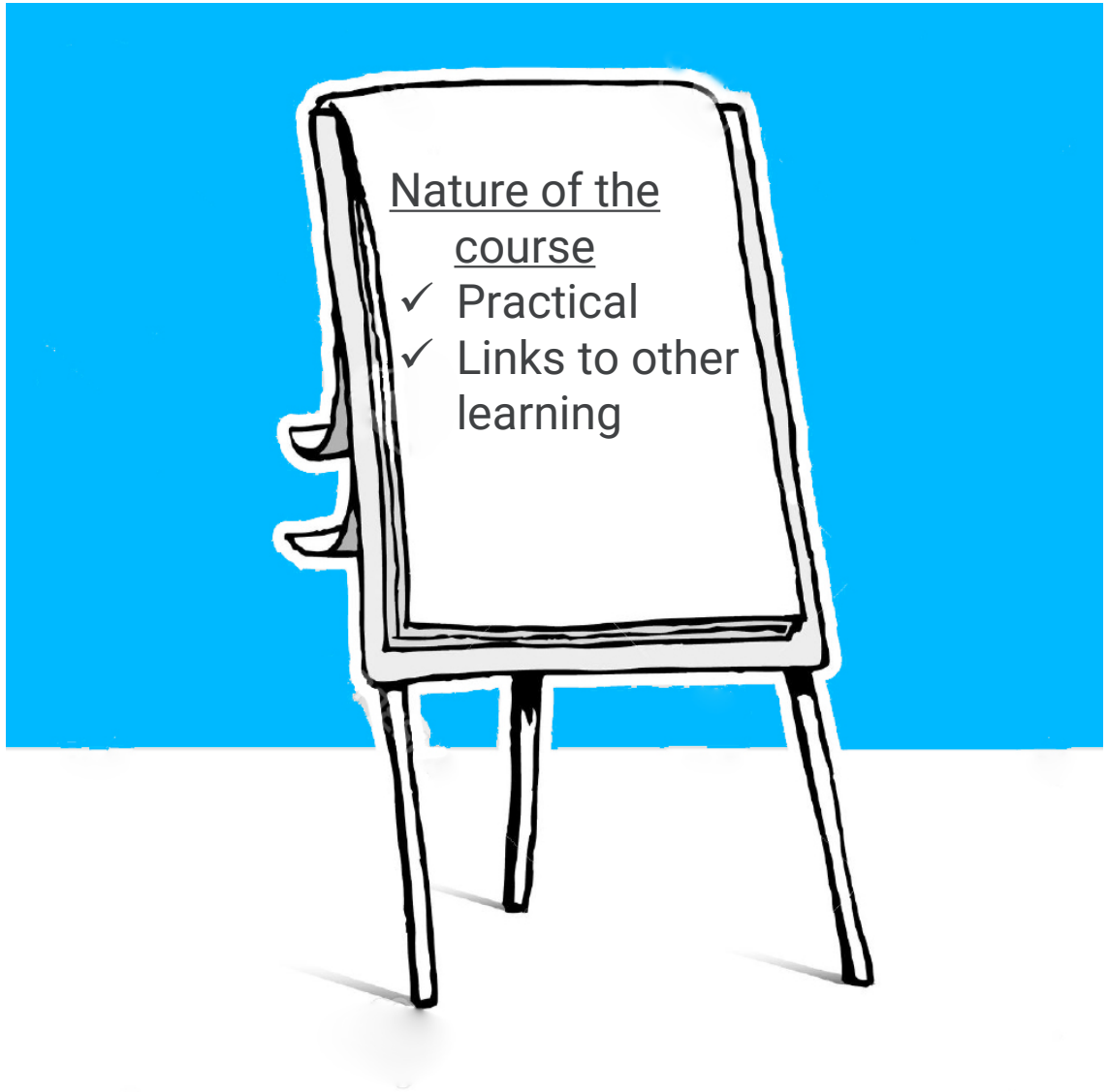
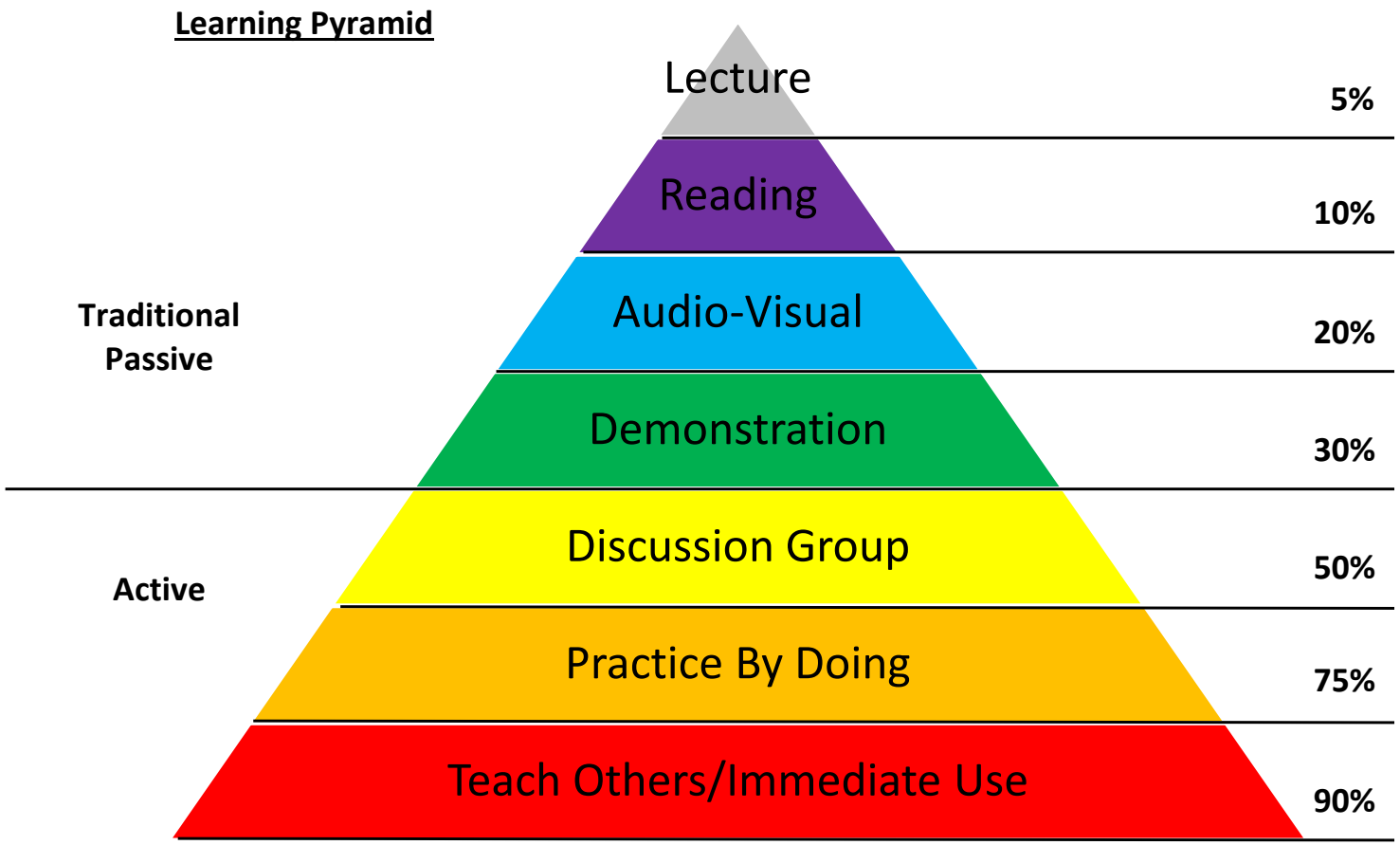
Introductions

Summary overview



The learning pyramid

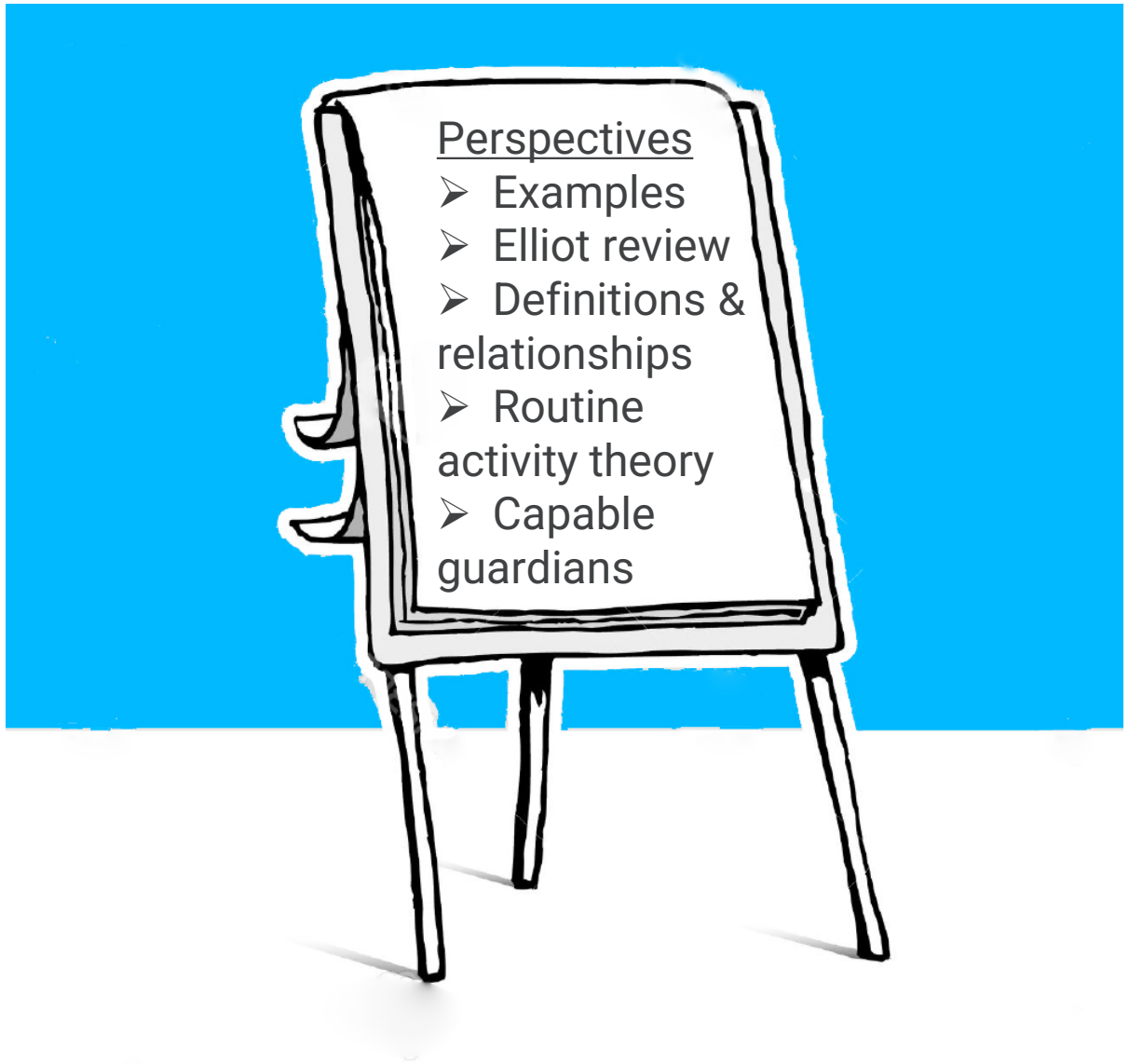


Course relationships


Ploys and hacks

Perspectives

Perspectives overview



Food Authenticity
"The quality of a food to be genuine and undisputed in its nature, origin, identity, and claims, and to meet expected properties"

Food Integrity
"The status of a food product where it is authentic and not altered or modified with respect to expected characteristics including, safety, quality, and nutrition"

CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda item 7

CX/FICS 18/24/7
August 2018

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD IMPORT AND EXPORT INSPECTION AND CERTIFICATION SYSTEMS

Twenty- Fourth Session

Brisbane, Australia, 22 - 26October 2018

DISCUSSION PAPER ON FOOD INTEGRITY AND FOOD AUTHENTICITY

Food Fraud
"Any deliberate action of businesses or individuals to deceive others in regards to the integrity of food to gain undue advantage. Types of food fraud include but not limited to: adulteration, substitution, dilution, tampering, simulation, counterfeiting, and misrepresentation"

Economically Motivated Adulteration
"is a subset of food fraud. It is the intentional substitution or addition of a substance in a product for the purpose of increasing the apparent value of the product or reducing the cost of its production, for economic gain".

Dying for a sweet? –The *'Bradford and Punjabi' sweet incidents*

THE GREAT LOZENGE-MAKER.
A Hint to Paterfamilias.

Nature, substance and quality

- S14 FSA - offence to sell to the purchaser's prejudice food not of:
  - **Nature** ('Difference') *Riley Bros (Halifax) Ltd vs (Hallimond)* (19270 44 TLR 238 Butter toffee containing coconut fat. Held - butter toffee. Implied only butterfat.
  - **Substance** – (*'Compatible with the demand'). Hall v Owen Jones & Jones (1967)* ALL ER 209 – Penicillin in milk.
  - **Quality** – ('Commercial Quality - including description"). Goldrup v John Manson Ltd [1981] 3 All ER 257 – S 2 FDA 1955 - (s 14(1) FSA) Re fat in minced beef.
    1) purchaser's "demand" depends on express contractual terms or on what is inferred from all surrounding circumstances
    2) quality demanded is that of the purchaser not of the analyst
    3) quality demanded, where displayed on a notice, is the quality so declared
    4) de minimis deficiency in quality is not to the purchaser's prejudice
- **Disjunctive**
- **Well established longstanding provisions of Food Law**

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Falsely advertising/describing/presenting food etc

- S15 FSA S14 FSA - Offence to :
- Falsely Describe – e.g. Port not Portuguese provenance Sandeman v Gold (1924) 1 KB 107
  - **Includes omissions** – R vs Kyslant (1932) 1 KB 442, Re share prospectuses – an analogous law provision

- Likely to mislead - Arlidge vs Blue Cap Foods (Kent) ltd (1965) 63 LGR 167 – re fully prepared sliced selected tins of apples 25% solids lost & added water

- **Derived - well established longstanding provisions of Food Law**

Sudan dye incidents

Pak. J. Biochem. Mol. Biol. 2016; 49(1): 29-35

Review

SUDAN DYES AND THEIR POTENTIAL HEALTH EFFECTS

*[1]Alim-un-Nisa, [2]Naseem Zahra, [3]Yasha Nazir Butt
[1, 2] Food and Biotechnology Research Centre (FBRC)
PCSIR Laboratories Complex, Ferozepur Road Lahore-54600, Pakistan
[3]Institute of Biochemistry and Biotechnology, University of the Punjab, Lahore.

Abstract: Sudan dyes are synthetic, oil-soluble, red coloured azo dyes which are not permitted by the authorities in Switzerland, Japan, Europe, and the United States for the purpose of food colouring. Sudan dyes I, II, III, IV, and their degradation products are considered harmful to human health due to their teratogenicity, genotoxicity, and carcinogenicity which leads to cancer. Many experimental studies on animal specimen have confirmed the formation of tumour due to the presence of different Sudan dyes in food products. Sudan dyes are described to have sensitising characteristics; they easily get absorbed through dermal route and airways and causes health problems. This paper discusses the harmful effects of Sudan dyes on human health which is now greatly used in foodstuffs.

Keywords: Sudan dyes, Illegal, Health effects
Received: January 11, 2016 Accepted: February 15, 2016
***Author for Correspondence**: nisaalim64@yahoo.com

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Melamine in milk

Operation Tacanna and scallop fraud


DAILY Mirror
FREE Ladybird BOOKS
8inches of snow
UK'S BIGGEST FOOD FRAUD
FINDUS KNEW OF HORSE LASAGNE 12 DAYS AGO
But bosses kept meals on the shelves for a week
Police probe more products withdrawn
DAILY Mirror
The shark
GIANT THRILLER
PLUS
HORSE MEAT IS FOUND IN TESCO BURGERS
Supermarkets clear shelves
Inquiry at supply plants
Daily Mail
£140K ALREADY WON!
E'RE GIVING AWAY £1M in the Daily Mail Daily Lottery...
WIN OUR £25,000 JACKPOT TODAY
SEE PAGE TWO TO PLAY
Supermarket apologises after food watchdog's findings
HORSE MEAT IN TESCO BURGERS
FREE FAMILY CINEMA PASS
FOOD SCANDAL: NEW ALERT
HORSE 'IN SCHOOL DINNERS'
Govt order tests over meat fears
London Evening Standard
BIRDS EYE MEALS HIT BY HORSE MEAT FEAR
OSCARS A BREEZE FOR STAR JESSICA
"Sony reinvents the phone"

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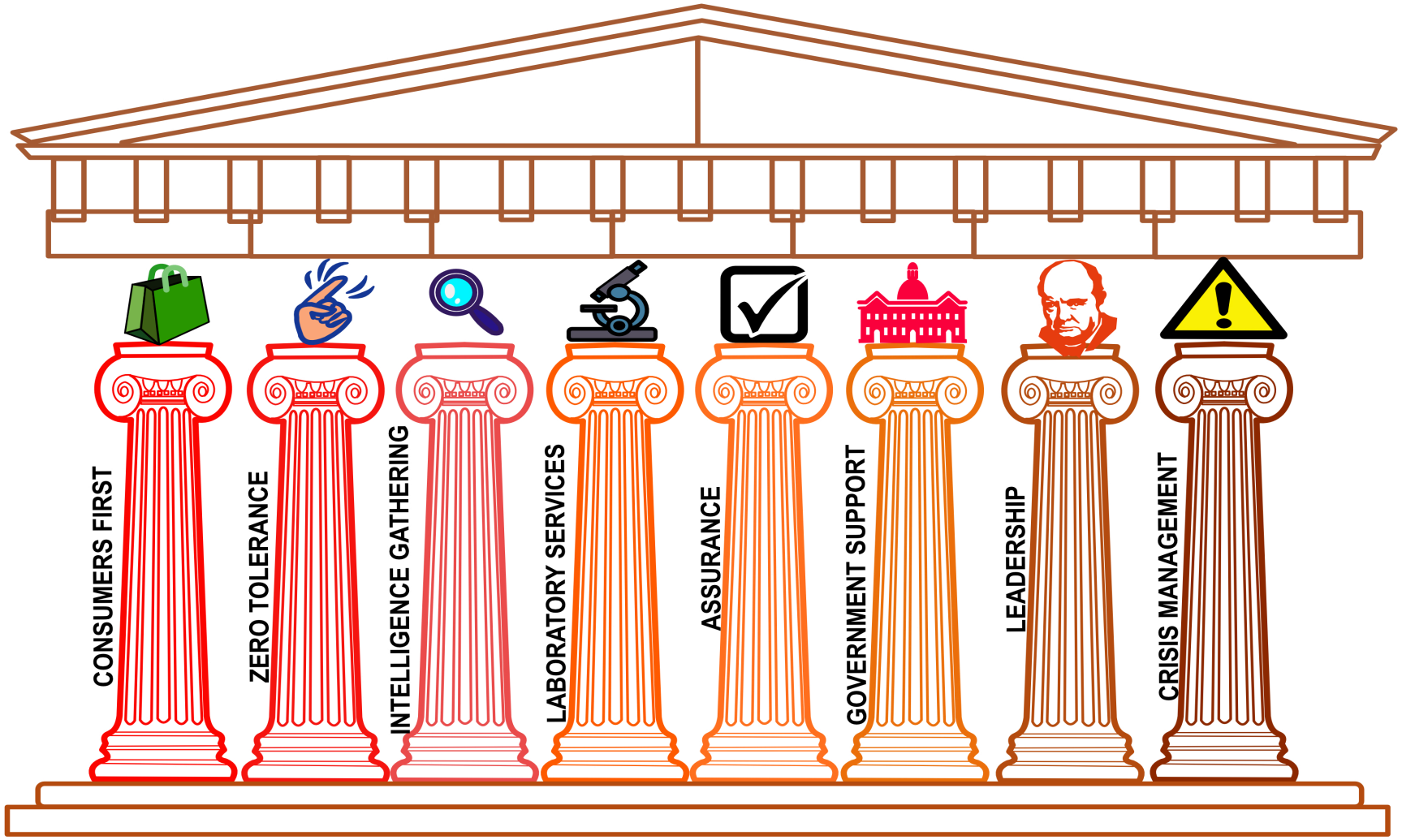
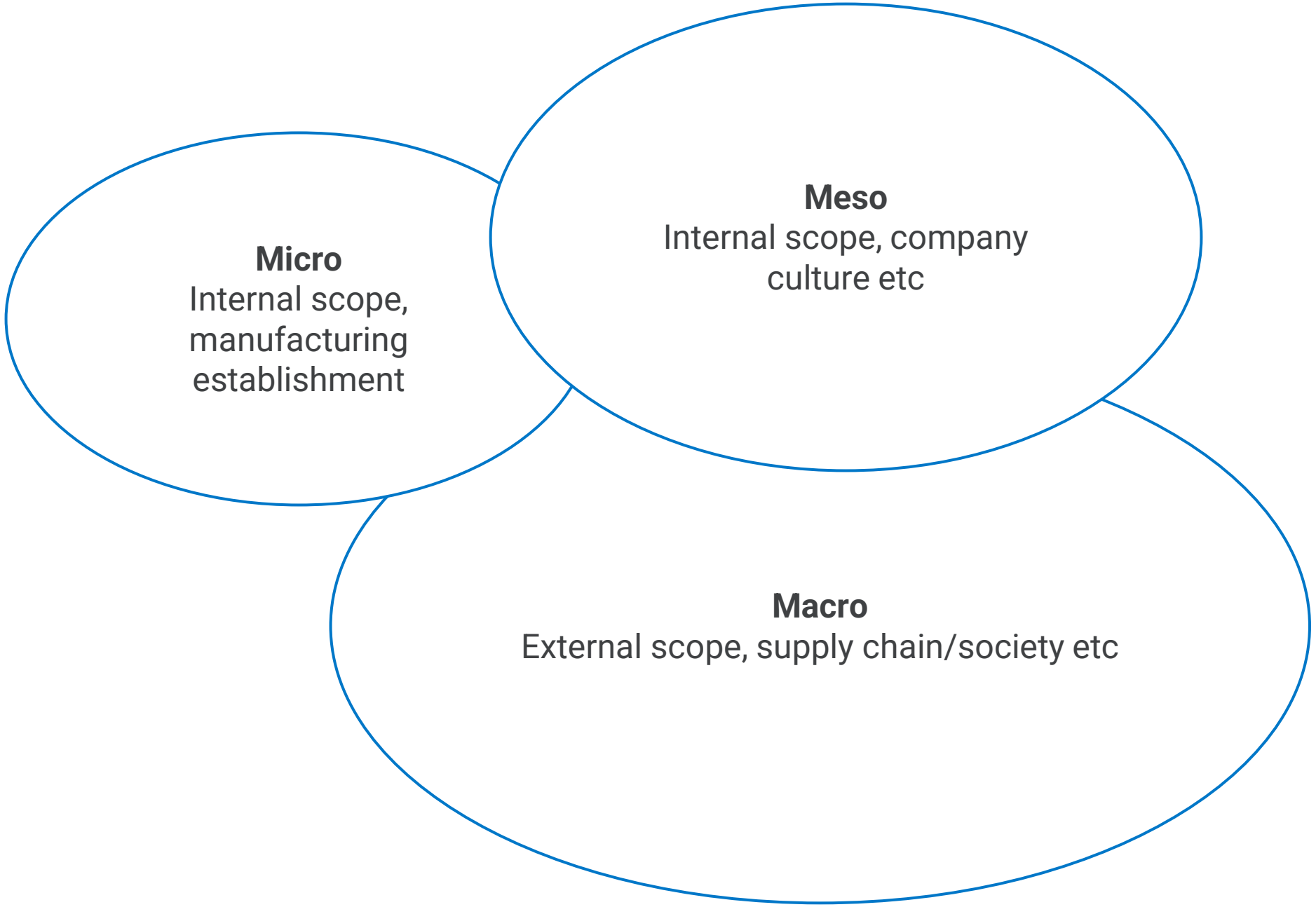

CONSUMERS FIRST
ZERO TOLERANCE
INTELLIGENCE GATHERING
LABORATORY SERVICES
ASSURANCE
GOVERNMENT SUPPORT
LEADERSHIP
CRISIS MANAGEMENT


Micro
Internal scope, manufacturing establishment
Meso
Internal scope, company culture etc
Macro
External scope, supply chain/society etc

Typology of food fraud

GFSI (1) type of food fraud	Definition from SSAFE (2)	Examples from GFSI FFTT (3)	General type of food fraud
Dilution	The process of mixing a liquid ingredient with high value with a liquid of lower value	• Watered down products using non-potable / unsafe water Olive oil diluted with potentially toxic tea tree oil	Adulterant- substance (adulterant)
Substitution	The process of replacing an ingredient or part of the product of high value with another ingredient or part of the product of lower value	• Sunflower oil partially substituted with mineral oil • Hydrolyzed leather protein in milk	Adulterant- substance or tampering
Concealment	The process of hiding the low quality of a food ingredients or product	• Poultry injected with hormones to conceal disease • Harmful food colouring applied to fresh fruit to cover defects	Adulterant- substance or tampering
Unapproved enhancements	The process of adding unknown and undeclared materials to food products in order to enhance their quality attributes	• Melamine added to enhance protein value • Use of unauthorized additives (Sudan dyes in spices)	Adulterant- substance or tampering
Mislabelling/ misbranding	The process of placing false claims on packaging for economic gain	• Expiry, provenance (unsafe origin) • Toxic Japanese star anise labelled as Chinese star anise • Mislabelled recycled cooking oil	Tampering
Grey market production/ theft/diversion	Outside scope of SSAFE tool	• Sale of excess unreported product, • Product allocated for the US market appearing in Korea	Over-run, theft or diversion (4)
Counterfeiting (IPR)	The process of copying the brand name, packaging concept, recipe, processing method etc. of food products for economic gain	• Copies of popular foods not produced with acceptable safety assurances • Counterfeit chocolate bars	Counterfeiting (IPR)

Acronyms, explanations & attribution:
GFSI – Global Food Safety Initiative, SSAFE – Safe Secure and Affordable Food For Everyone, GFSI FFTT – Global Food Safety Initiative: Food Fraud Think Tank
Gray Market -- a market employing irregular but not illegal methods; Theft -- something stolen; Diversion/Parallel Trade -- the act or an instance of diverting straying from a course, activity, or use. Adapted from (Spink and Moyer 2011, Spink 2013, SSAFE Organization 2015, PWC Price Waterhouse Cooper 2016, GFSI 2017, Spink, Ortega et al. 2017)

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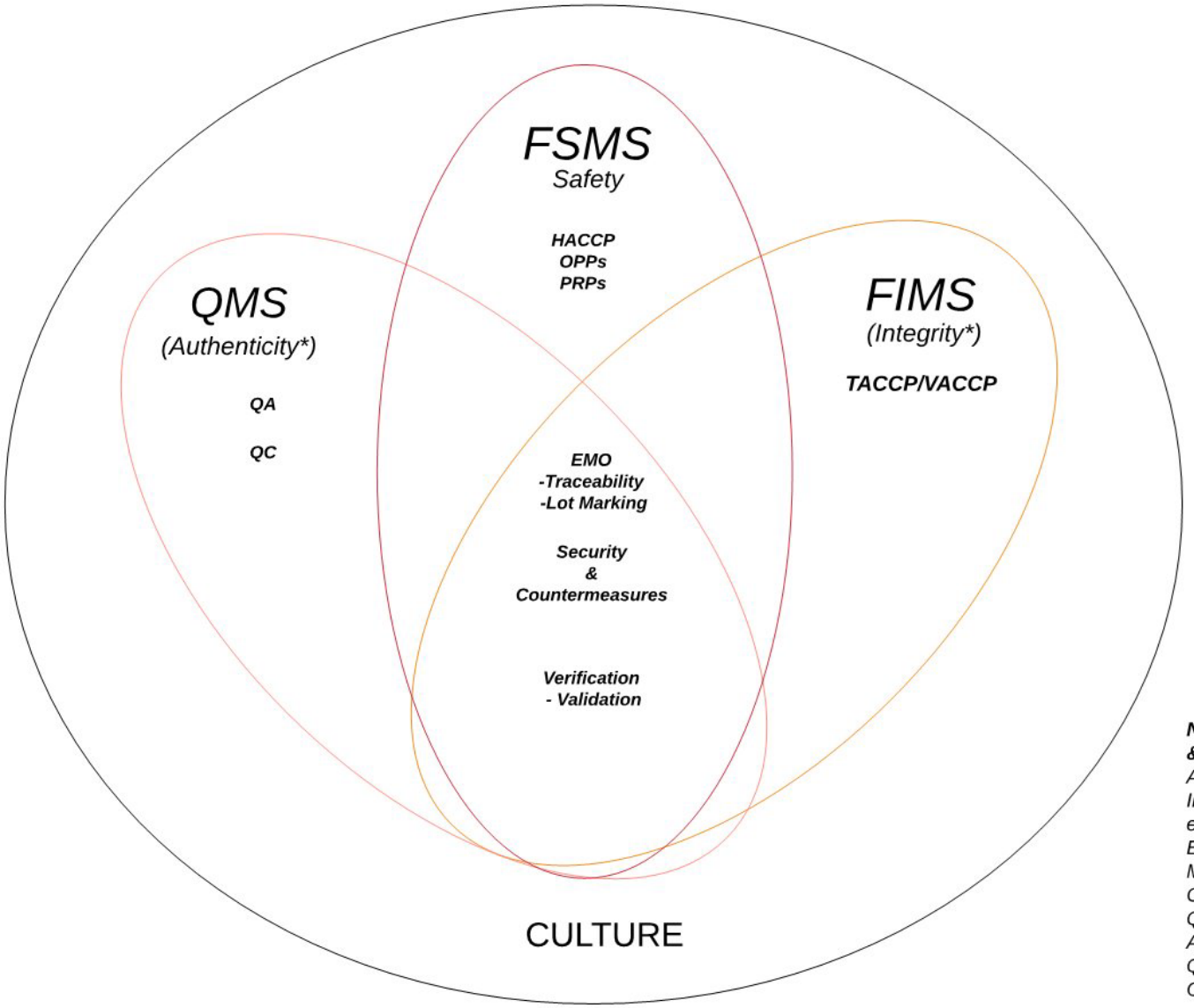
Scope of verification



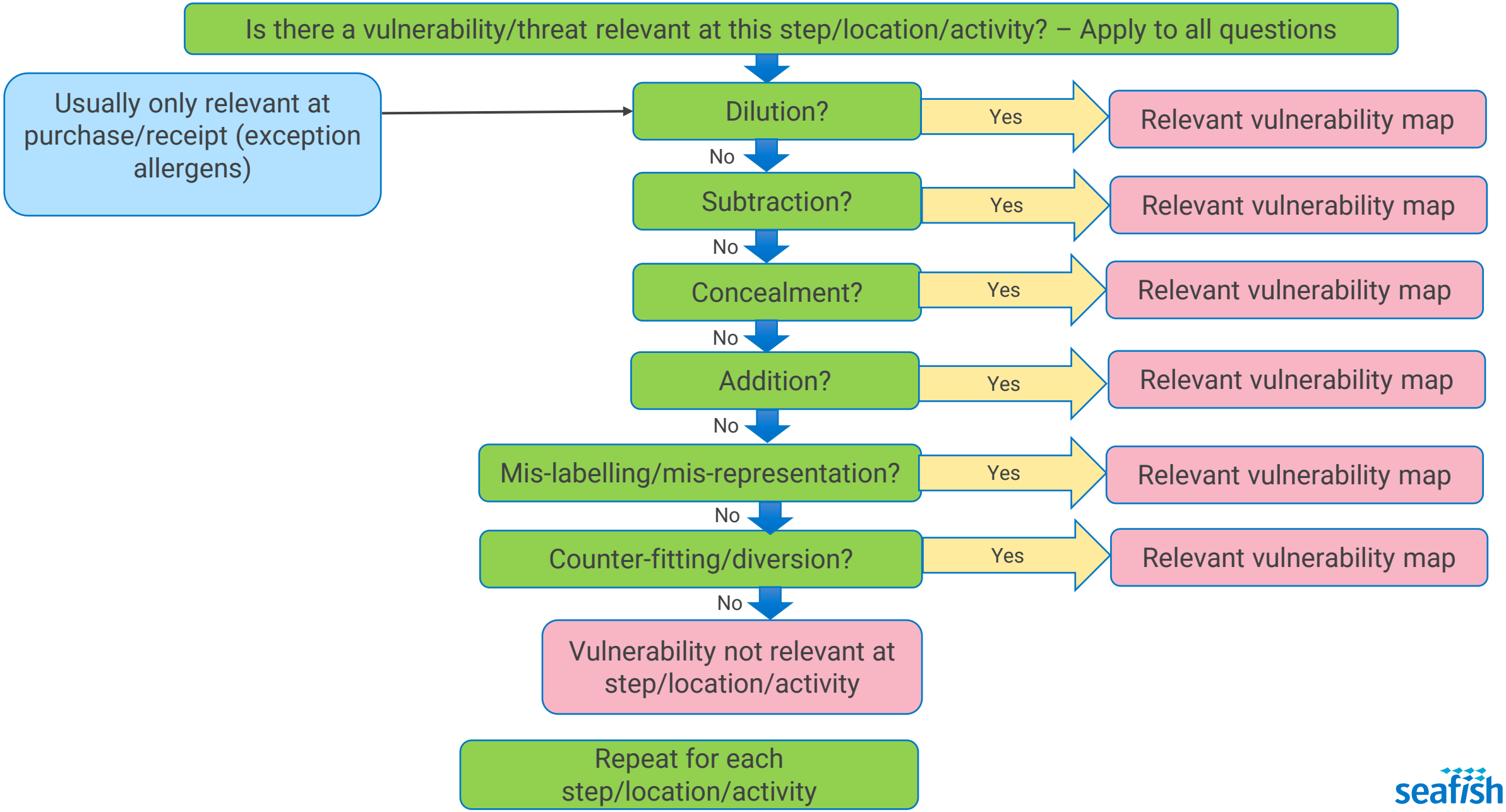
Notes on Terms & Accronyms

Authenticity & Integrity - Not exclusive*

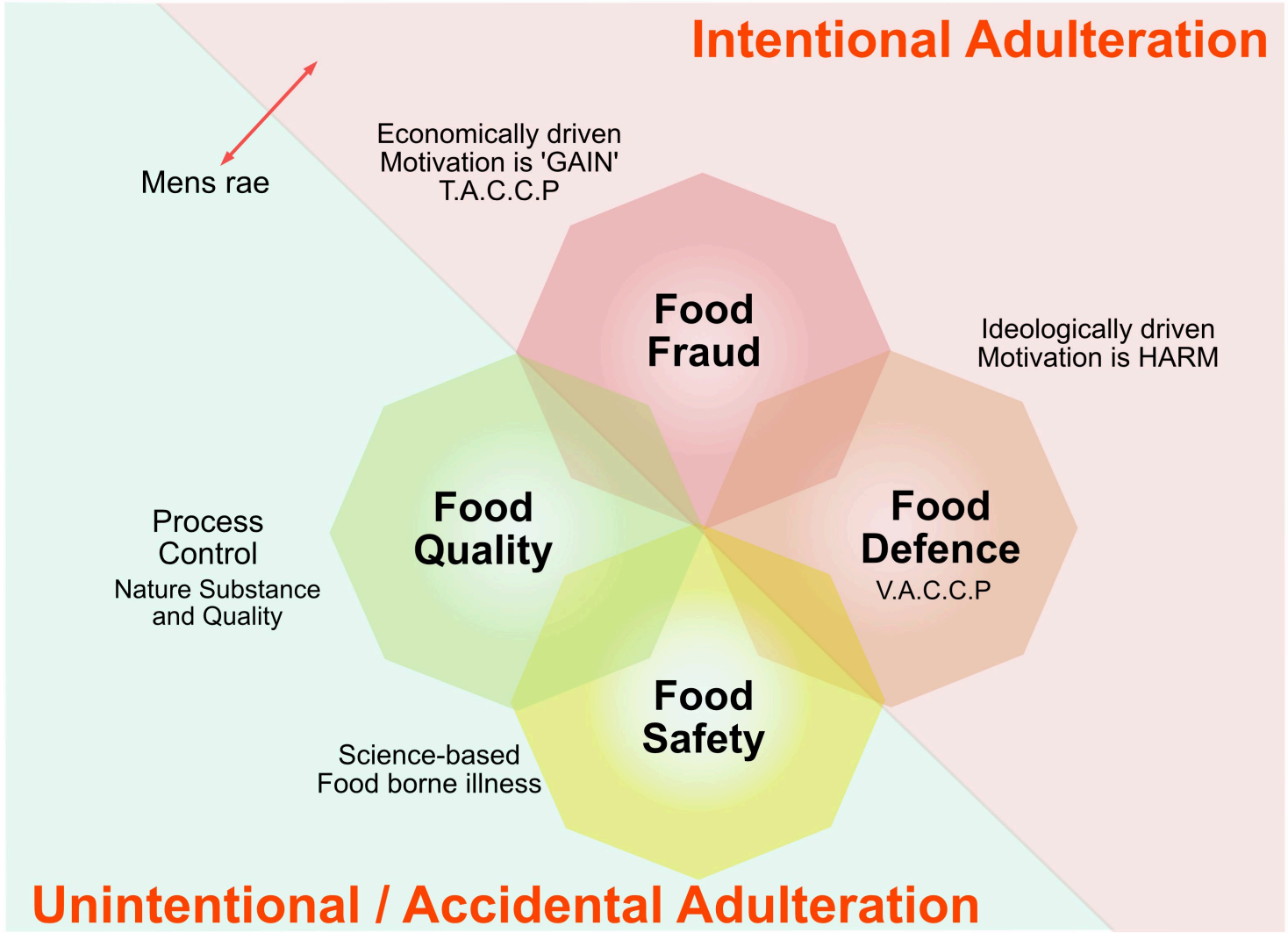
EMO = Effective Manufacturing Operations

QA - Quality Assurance

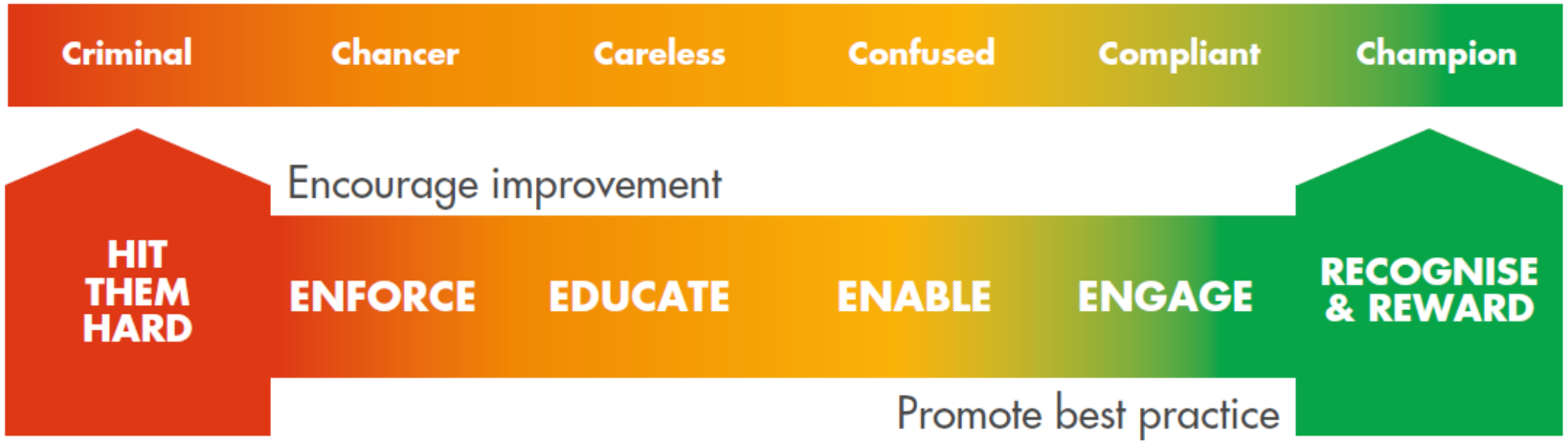
QC = Quality Control


Is there a vulnerability/threat relevant at this step/location/activity? – Apply to all questions
Usually only relevant at purchase/receipt (exception allergens)
Dilution?
Yes
Relevant vulnerability map
No
Subtraction?
Yes
Relevant vulnerability map
No
Concealment?
Yes
Relevant vulnerability map
No
Addition?
Yes
Relevant vulnerability map
No
Mis-labelling/mis-representation?
Yes
Relevant vulnerability map
No
Counter-fitting/diversion?
Yes
Relevant vulnerability map
No
Vulnerability not relevant at step/location/activity
Repeat for each step/location/activity

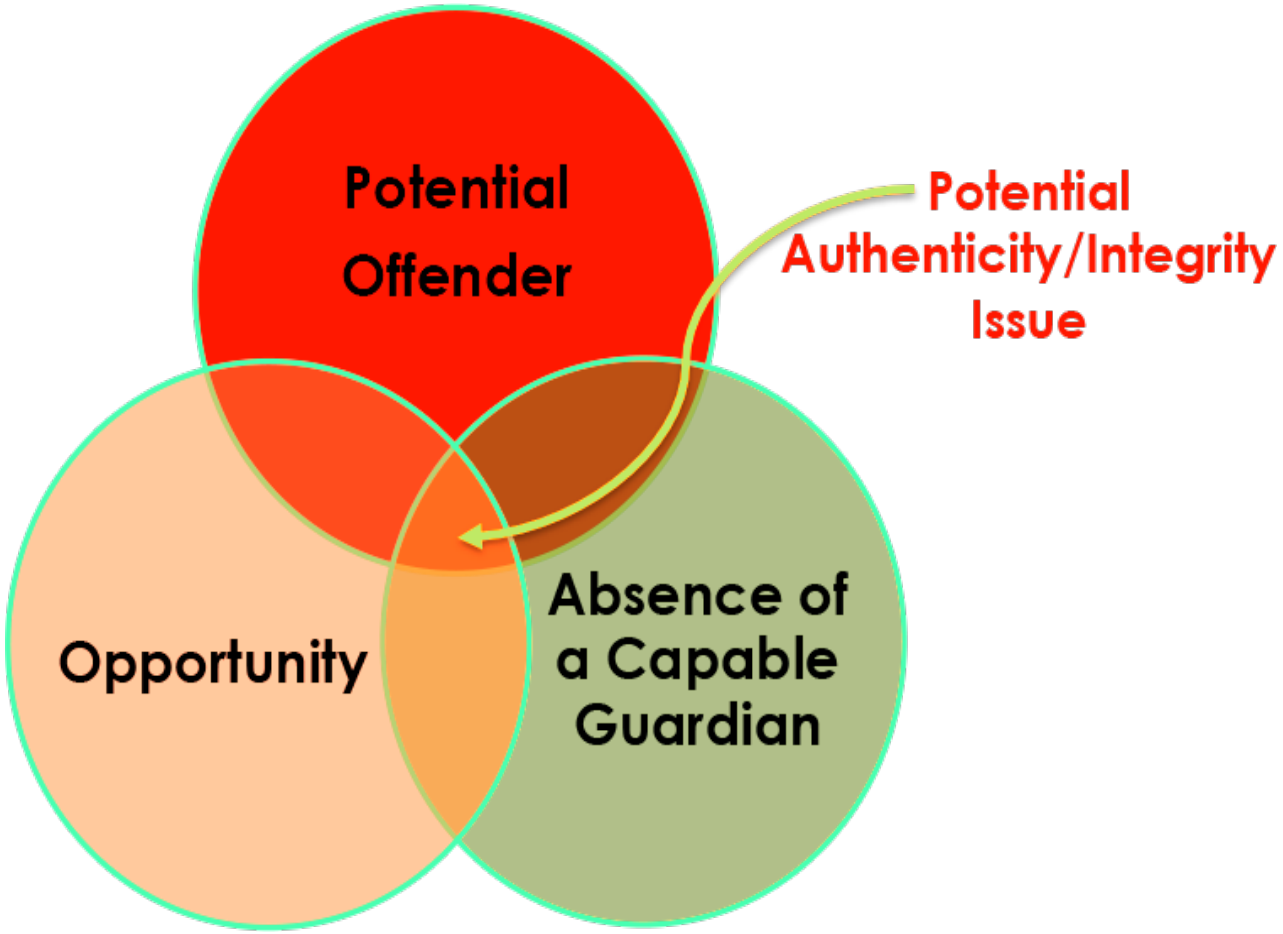
Food crime:-
Mens Rae and Malice aforethought

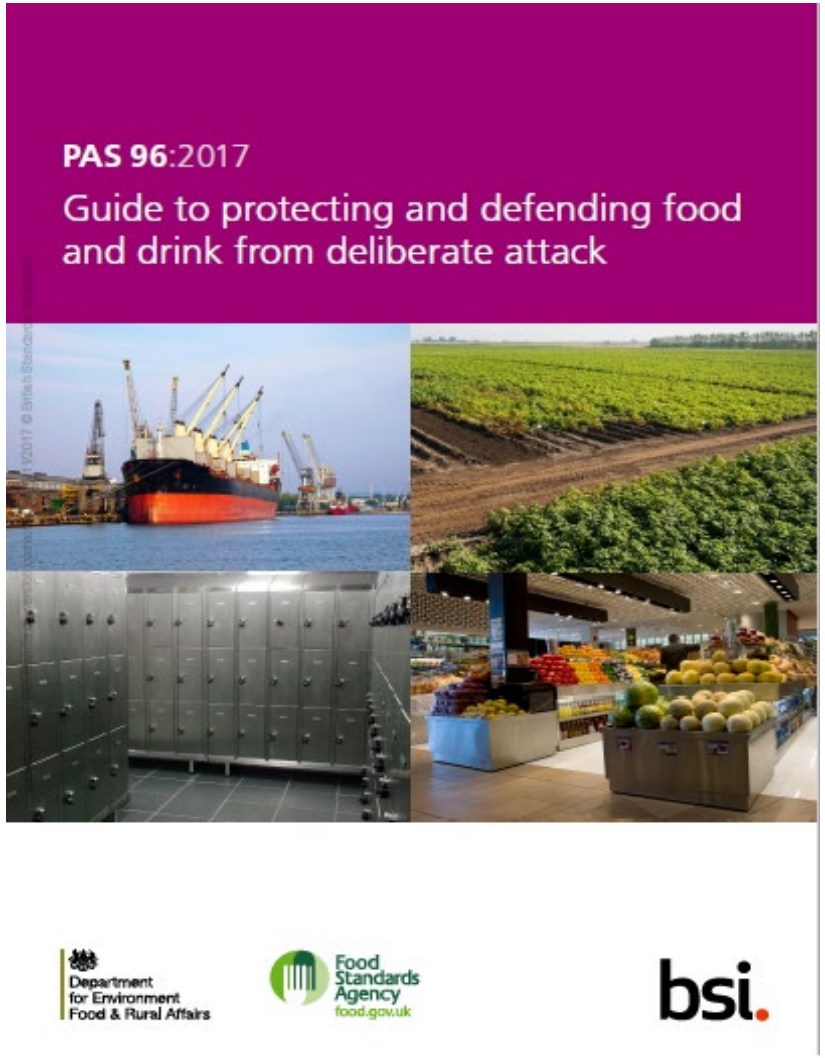

Intentional Adulteration
Mens rae
Economically driven
Motivation is 'GAIN'
T.A.C.C.P
Food Fraud
Ideologically driven
Motivation is HARM
Process Control
Nature Substance and Quality
Food Quality
Food Defence
V.A.C.C.P
Food Safety
Science-based
Food borne illness
Unintentional / Accidental Adulteration

An enforcement spectrum



Routine activity theory





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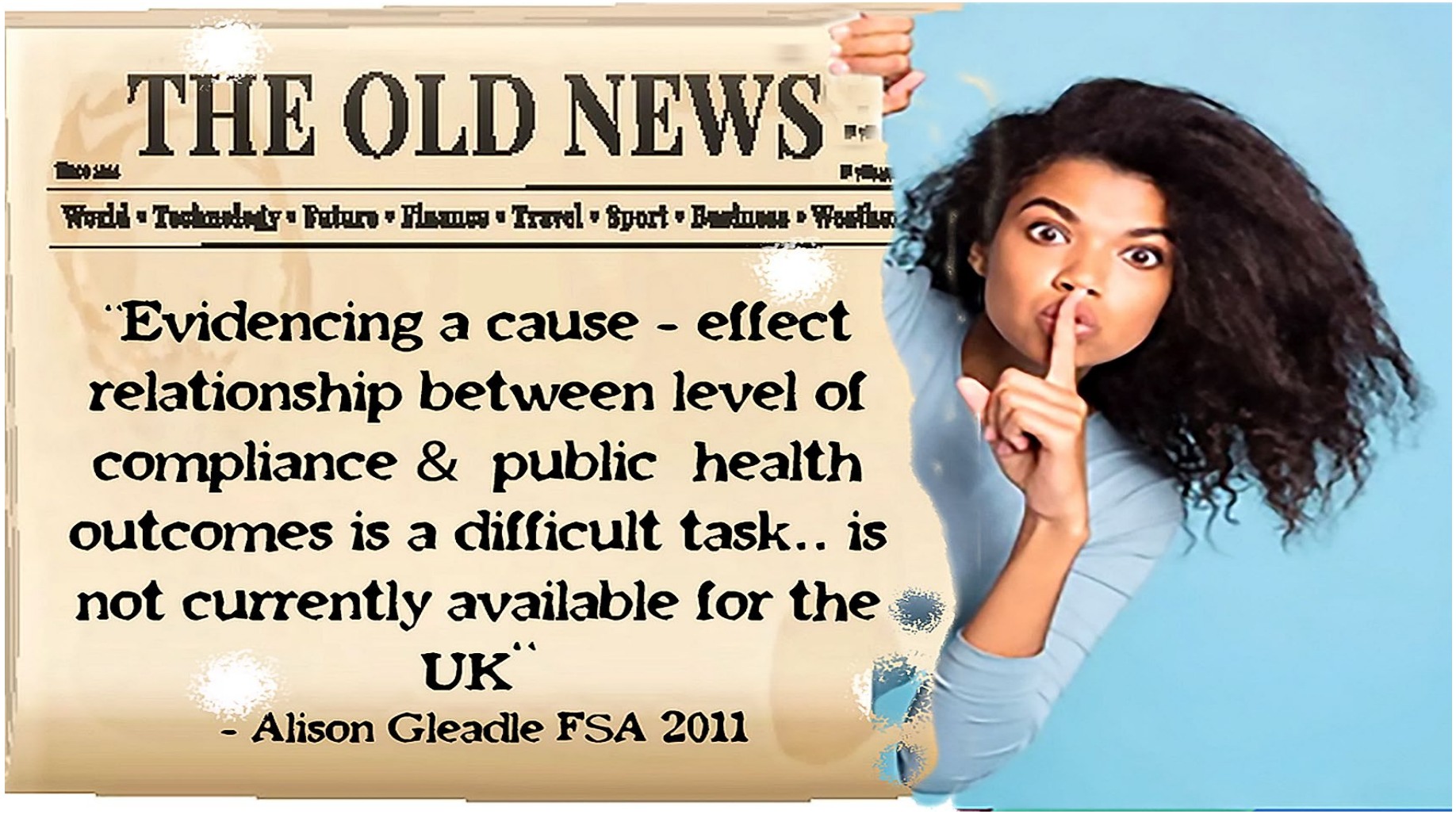
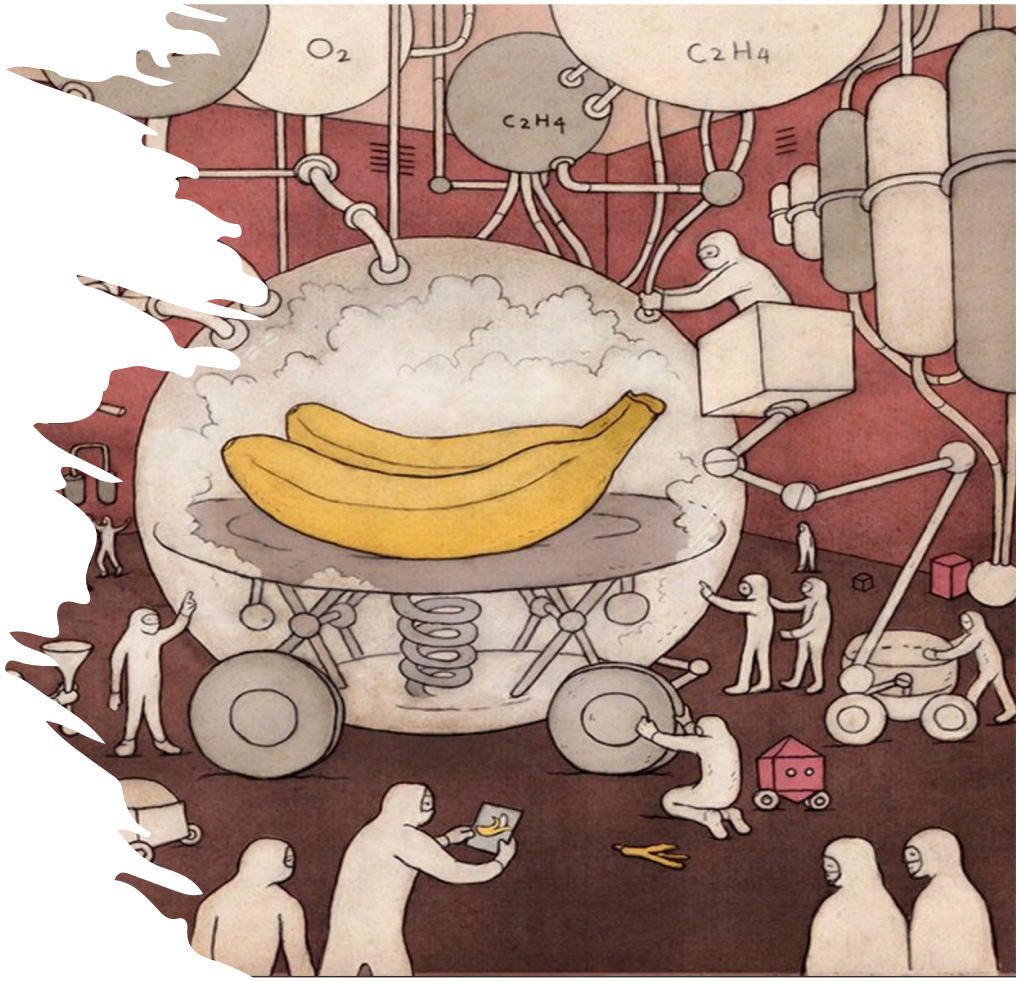

THE OLD NEWS
"Evidencing a cause - effect relationship between level of compliance & public health outcomes is a difficult task.. is not currently available for the UK"
- Alison Gleadle FSA 2011

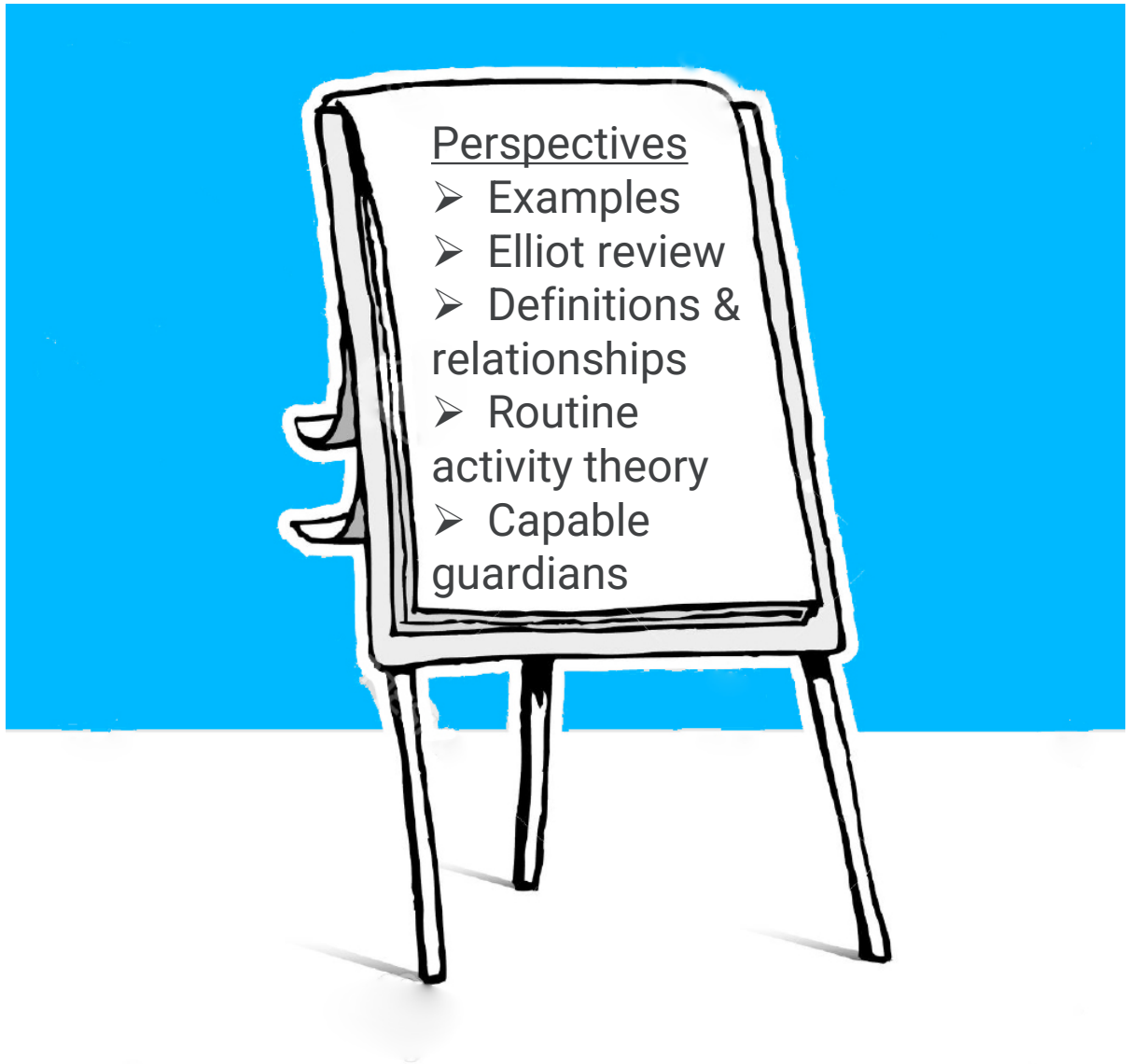
Complexity and simplification



Literature review

Capable guardians

Perspectives summary

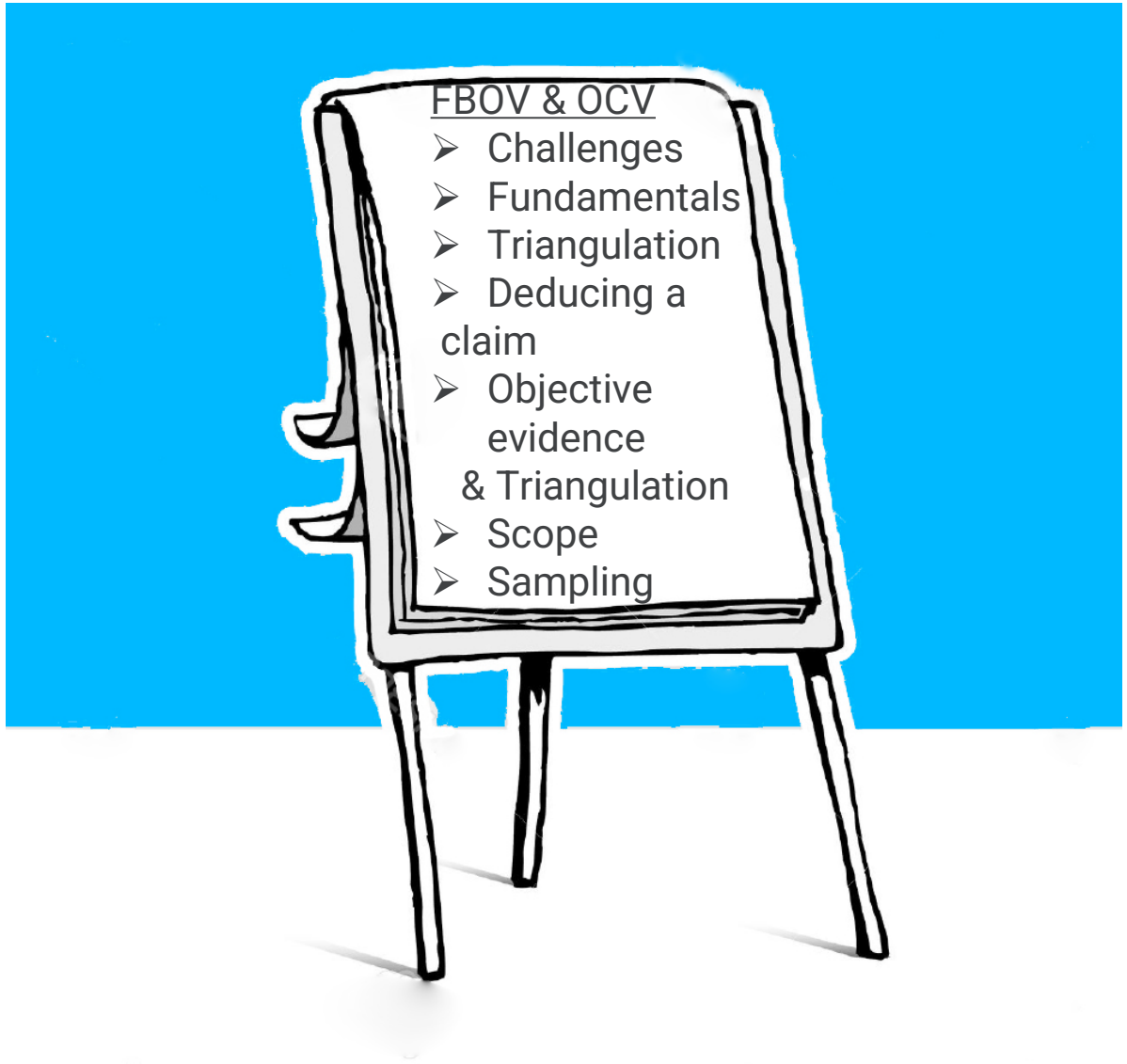


FBOV/OCV


FBOV
FBO STUDY
IMPLEMENTATION
(REALITY CHECK)
FCMS
GAP ANALYSIS


FBOV/OCV
Triangulation
FBO Culture
SPC
Mass-Balances
Traceability
Authentication
Verification
Objective Evidence
& Evidential
Triangulation
Sampling the FCMS
Elective &
Representative
Random

Verification FBOV and OCV overview



EFFECTIVENESS CHALLENGE

..FBOVS AND OCVS MUST BE 'EFFECTIVE' (FROM FOOD LAW)– AND THE PURPOSE OF FOOD LAW (AND THEREFORE FBOVS AND OCVS) IS TO ENSURE THE FBO PROTECTS THE CONSUMER IN FOOD AUTHENTICITY, INTEGRITY AND IN SAFETY TERMS...

SCIENCE CHALLENGES

REG 178 ESTABLISHED THE SCIENTIFIC BASIS OF FOOD LAW

THEREFORE -EMPIRICISM - OBJECTIVE EVIDENCE AND MEASUREMENT

PROPOSITIONS CHALLENGE

... BY PLACING FOOD ON THE MARKET – WE CAN DEDUCE THAT THE FBO PROPOSES THAT IT IS AUTHENTIC AND IT IS SAFE

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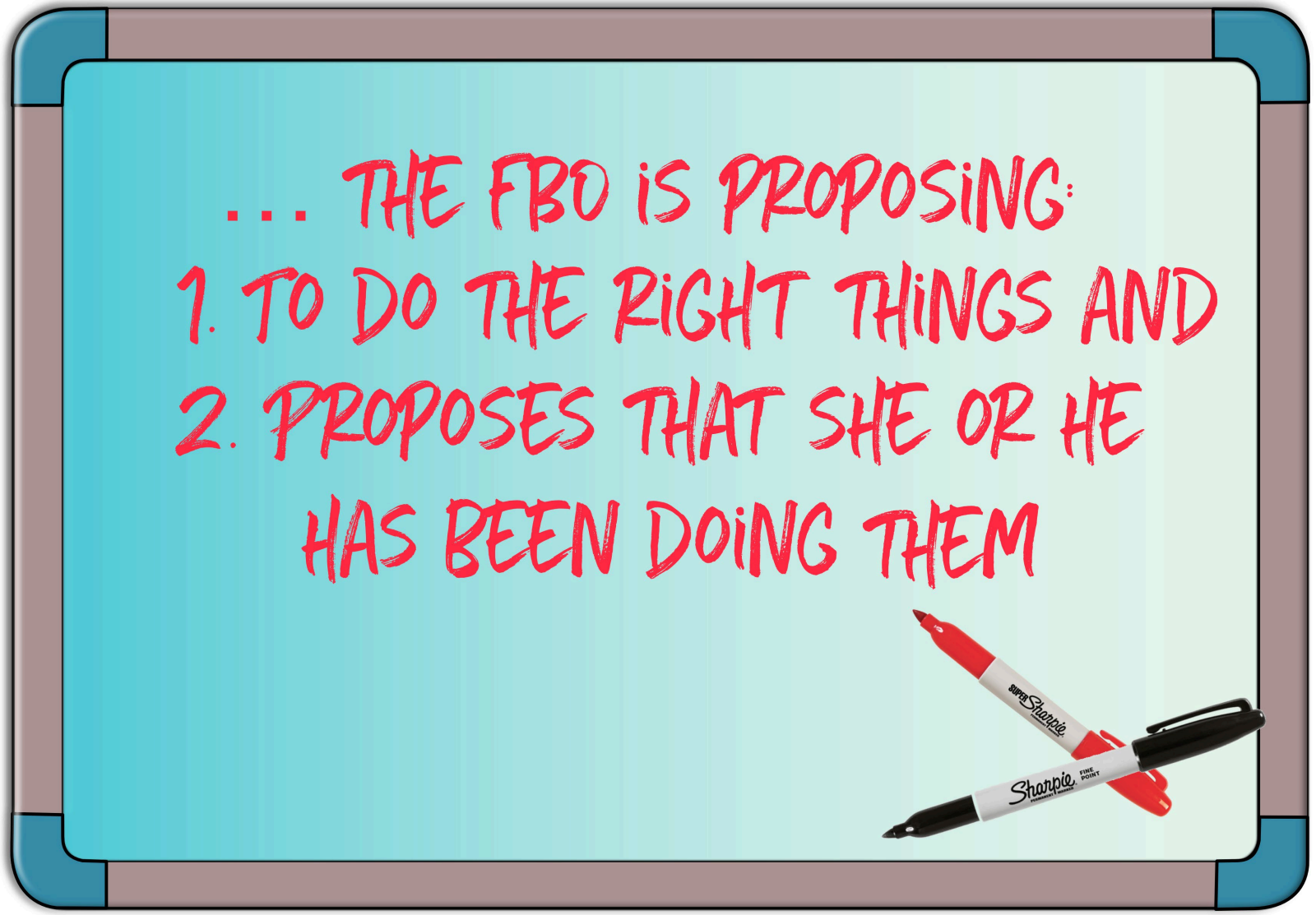
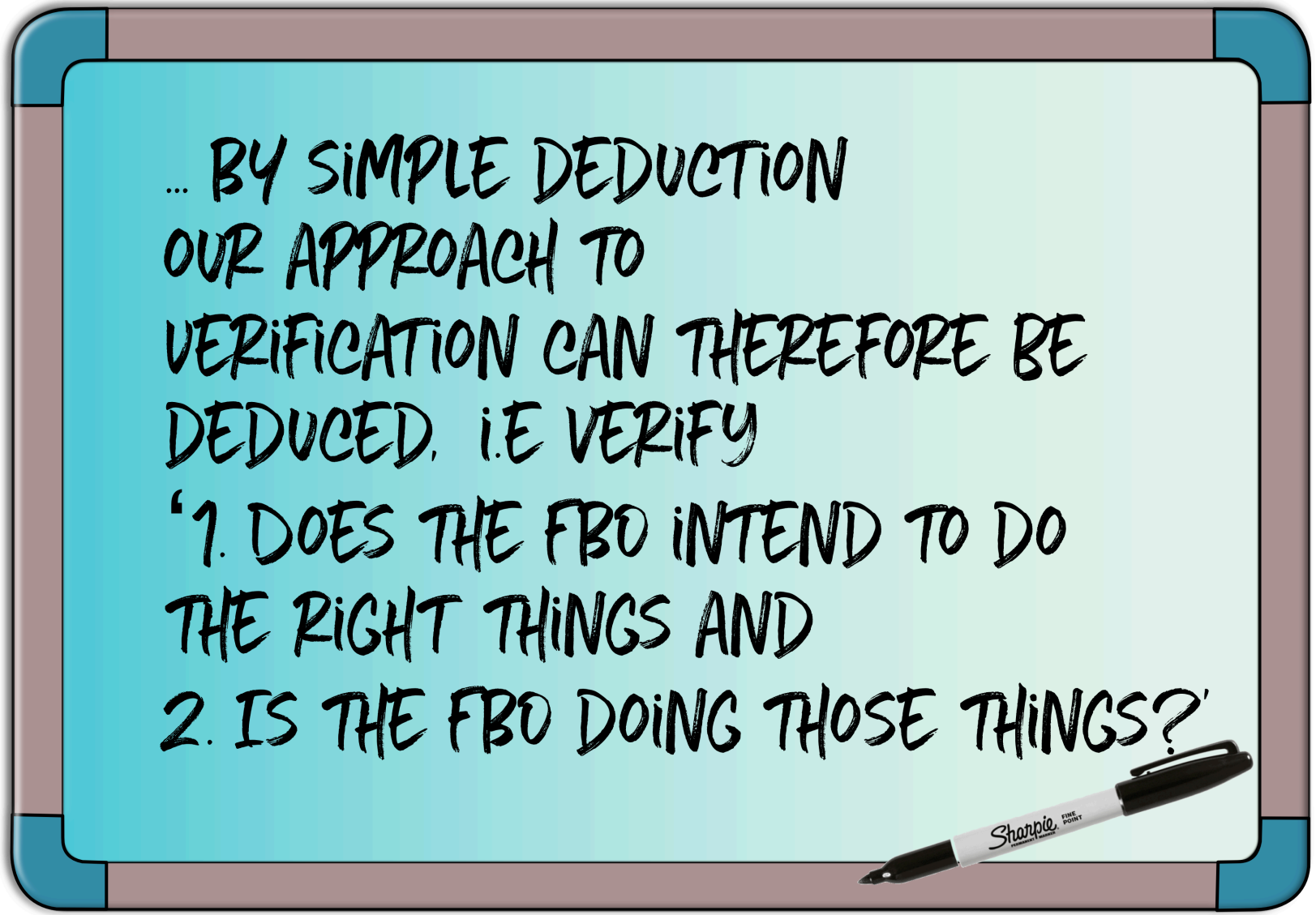
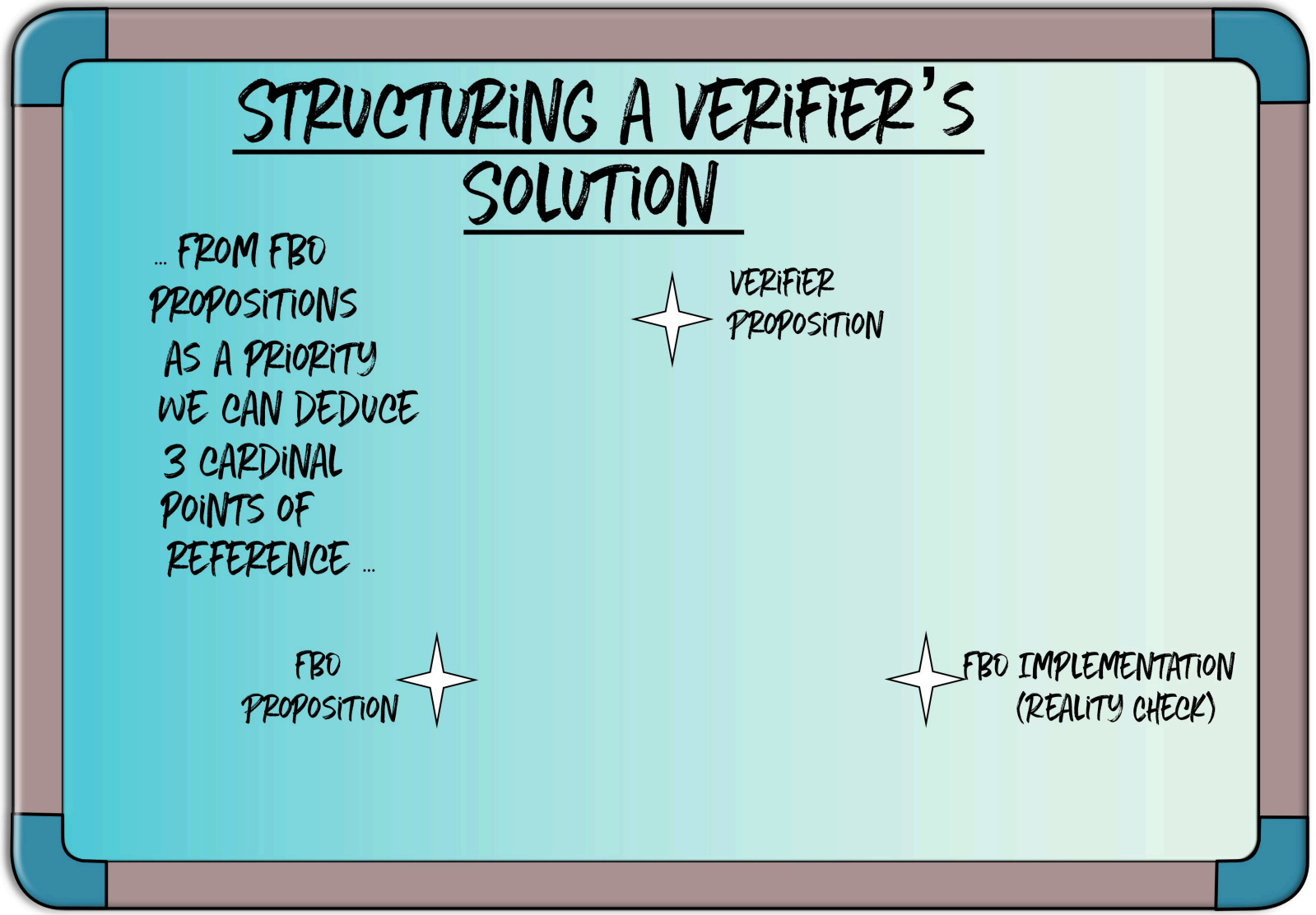
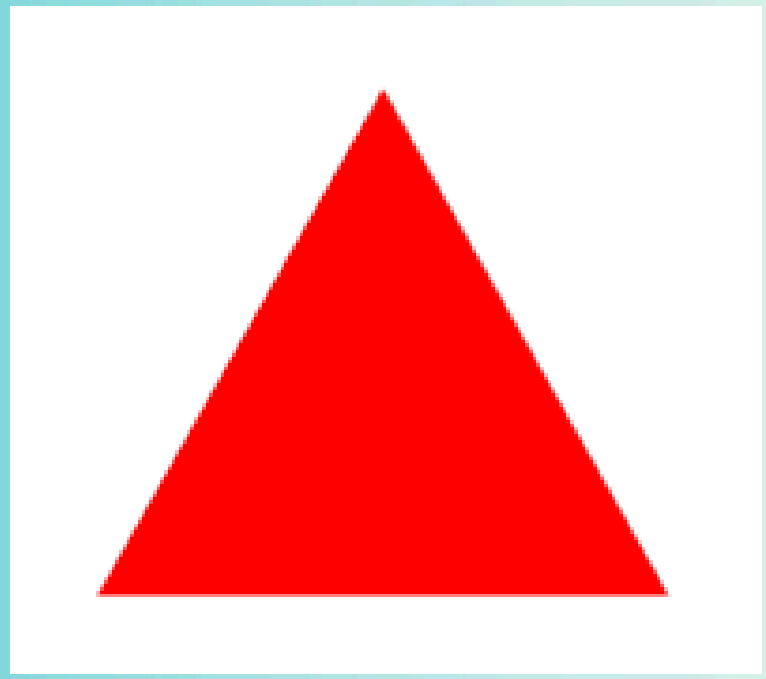

. . . THE FBO IS PROPOSING:
1. TO DO THE RIGHT THINGS AND
2. PROPOSES THAT SHE OR HE
HAS BEEN DOING THEM
SUPER Sharpie
Sharpie FINE POINT

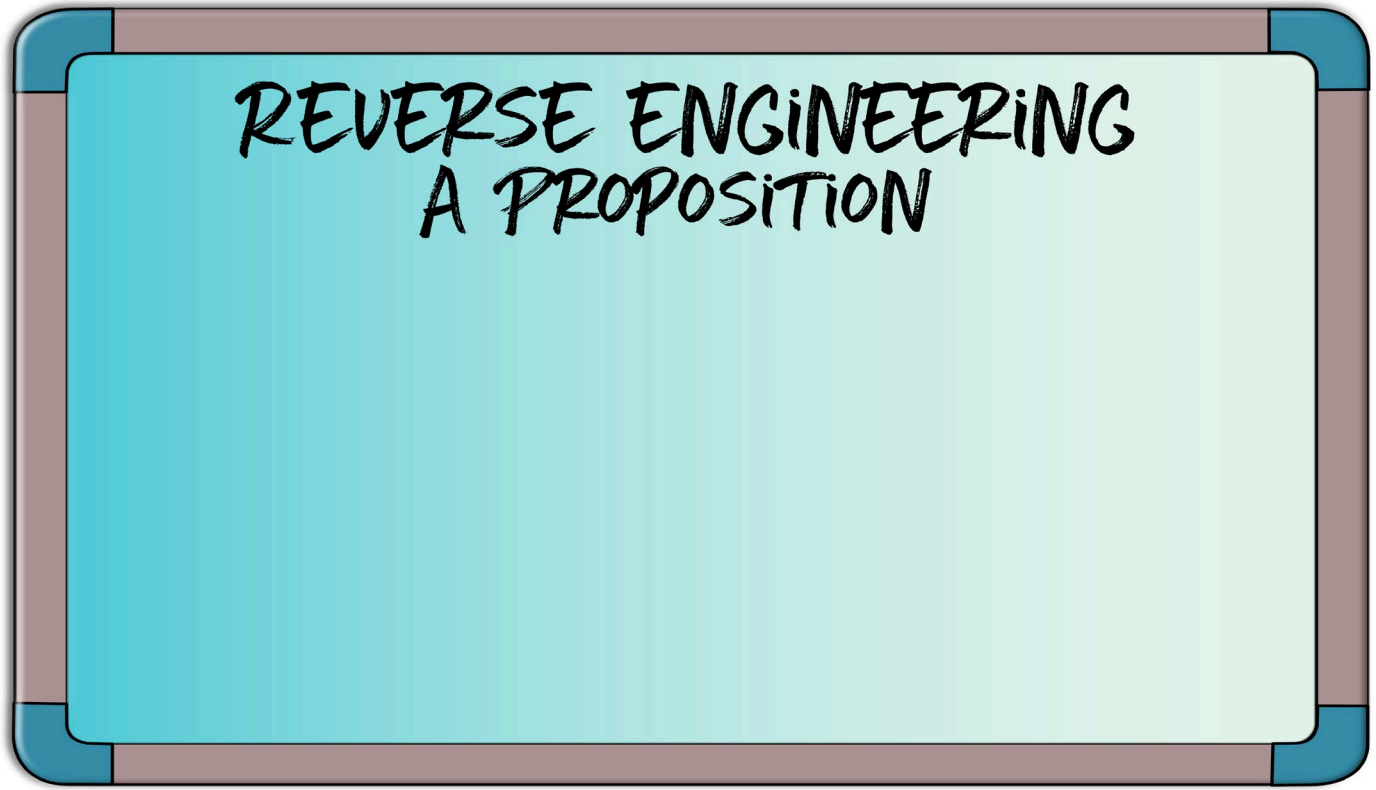

... BY SIMPLE DEDUCTION
OUR APPROACH TO
VERIFICATION CAN THEREFORE BE
DEDUCED. i.E VERIFY
'1. DOES THE FBO INTEND TO DO
THE RIGHT THINGS AND
2. IS THE FBO DOING THOSE THINGS?'
Sharpie
FINE POINT


STRUCTURING A VERIFIER'S SOLUTION
... FROM FBO PROPOSITIONS AS A PRIORITY WE CAN DEDUCE 3 CARDINAL POINTS OF REFERENCE ...
VERIFIER PROPOSITION
FBO PROPOSITION
FBO IMPLEMENTATION (REALITY CHECK)

REVERSE ENGINEERING
A PROPOSITION



Exercise – reverse engineering the FBO's proposition



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Objective evidence

- ***"Objective evidence and certitude are doubtless very fine ideals to play with, but where on this moonlit and dream-visited planet are they found?"***

- William James 1842 –1910 (considered to be one of the greatest philosophers of the pragmatic school)

- ***"Information that can be proved true, based upon facts obtained through observation, measurement test or other means"***

- First defined BS EN 8402/1995
- Referred Regulation (EC) 178/2004 - but not defined

Attributes of objective evidence

- Scientific — Can the data be evaluated by independent observers to reach the same conclusions?
- Scientific — Are the data documented in a manner to allow re-creation of the data or the events described?
- Scientific — Does the documented evidence provide sufficient data to prove what happened, when, by whom, how, and why?
- Legal — Was the documentation completed concurrent with the tasks?
- Legal — Is the documentation attributable?

Denise Dion
USA FDA Office of Regulatory Affairs, Primary editor of the FDA Investigations Operations manual

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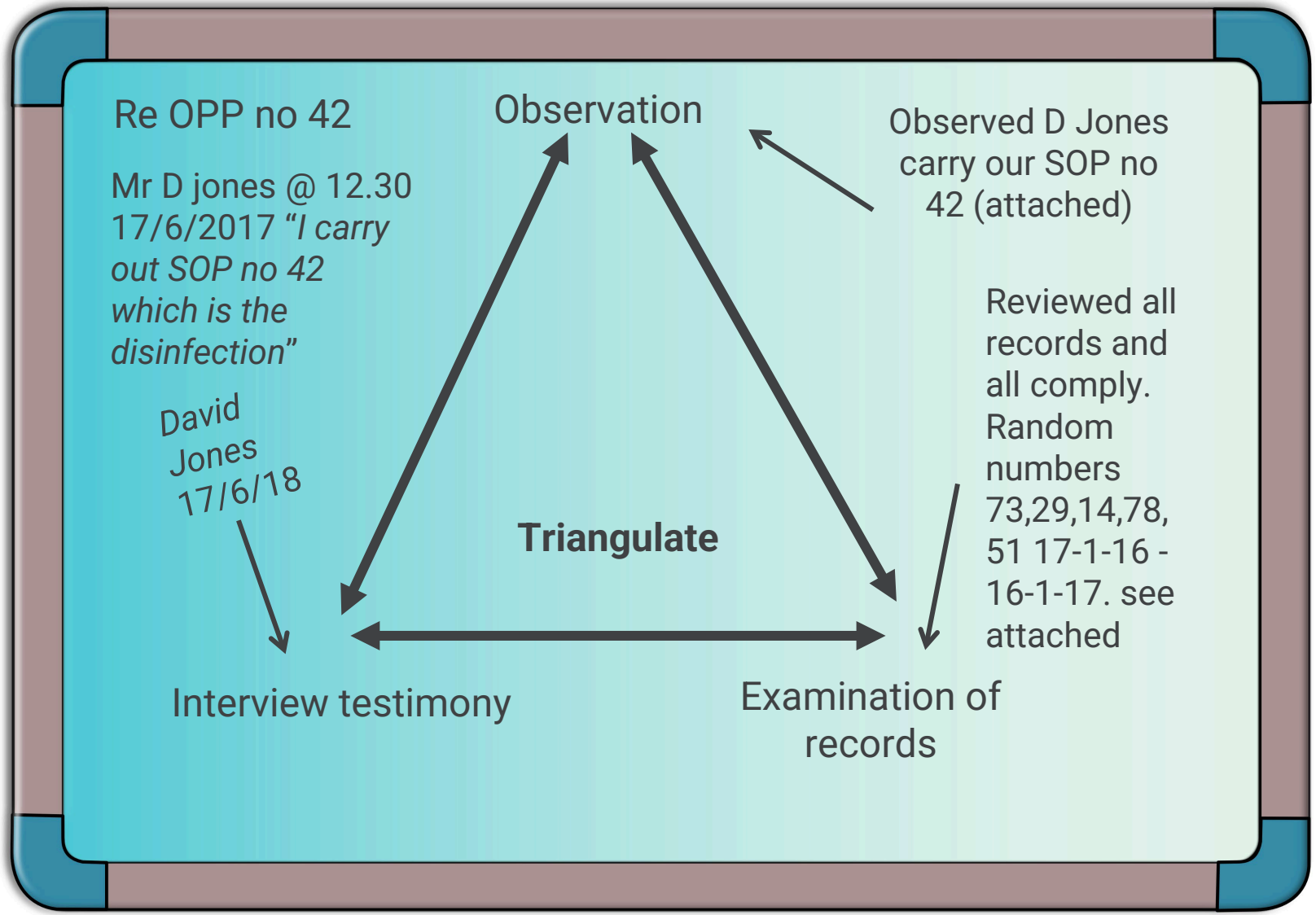
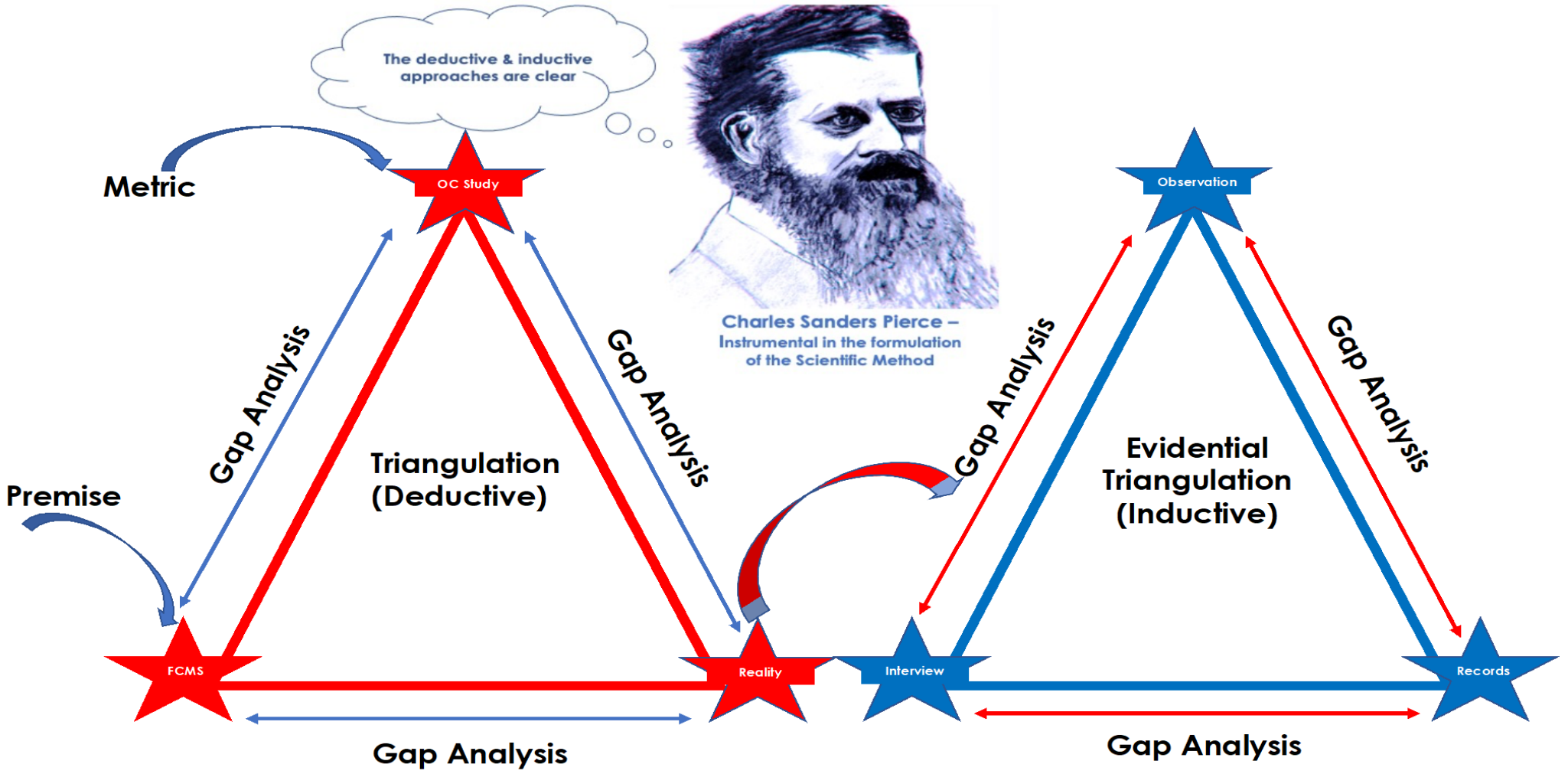
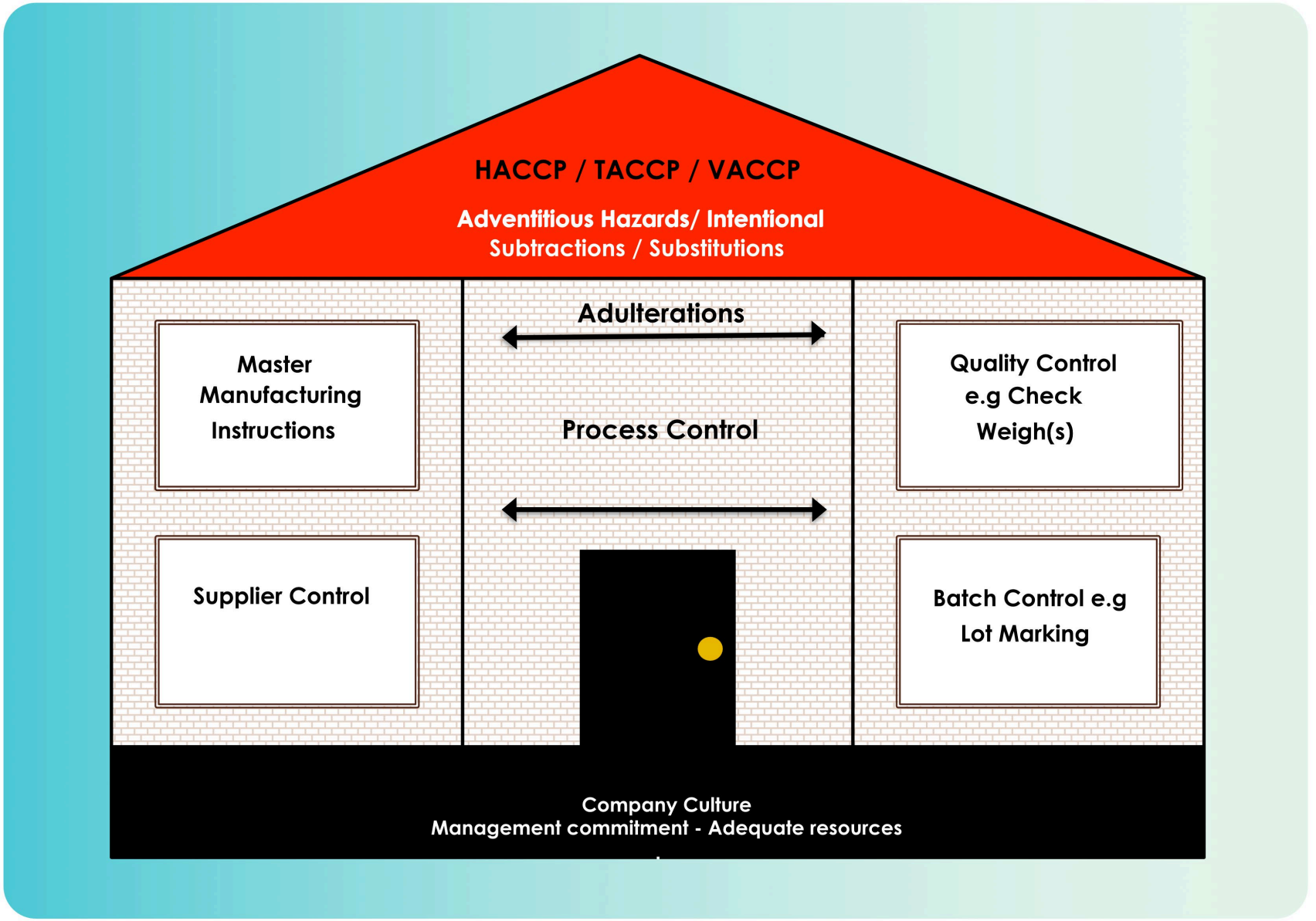

Re OPP no 42
Mr D jones @ 12.30 17/6/2017 "I carry out SOP no 42 which is the disinfection"
David Jones 17/6/18
Observation
Observed D Jones carry our SOP no 42 (attached)
Reviewed all records and all comply. Random numbers 73,29,14,78, 51 17-1-16 - 16-1-17. see attached
Triangulate
Interview testimony
Examination of records

Relationship to science




HACCP / TACCP / VACCP
Adventitious Hazards/ Intentional
Subtractions / Substitutions
Adulterations
Master Manufacturing Instructions
Process Control
Quality Control e.g Check Weigh(s)
Supplier Control
Batch Control e.g Lot Marking
Company Culture
Management commitment - Adequate resources

Week	
1	88 22 87 58 39 82 13 51 4 29 36 92 85 17 69 37 11 70 55 02
2	52 49 94 07 83 16 15 80 75 93 81 61 62 41 28 77 35 63 19 48
3	07 26 93 35 54 51 05 60 28 94 12 23 24 62 36 64 69 88 40 10
4	46 73 97 80 32 71 01 09 48 87 67 65 99 95 08 85 04 06 55 37
5	94 53 43 96 16 49 88 61 93 71 34 48 50 59 62 40 55 01 23 67
6	98 25 68 75 57 52 28 54 73 58 19 81 37 56 09 92 07 90 84 42
7	29 78 14 89 60 97 77 87 85 70 30 27 22 18 10 32 69 21 51 44
8	71 39 03 66 80 47 05 13 72 20 31 02 91 35 95 46 15 36 33 04
9	63 41 86 83 65 17 79 99 64 08 24 76 45 38 74 26 82 11 12 06
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15	19 17 34 41 29 92 12 22 89 05 18 71 93 47 99 85 69 20 57 87
16	67 08 72 73 91 60 49 13 06 58 15 87 16 54 78 11 66 33 46 39
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18	27 98 43 74 21 23 70 86 79 56 09 65 96 26 61 28 68 42 02 92
19	95 77 25 35 45 62 76 86 39 50 55 90 31 63 10 81 94 82 53 87
20	64 20 95 17 49 97 50 58 55 14 56 54 29 69 71 74 33 12 42 82
21	80 08 39 79 24 75 19 57 02 94 28 18 67 81 91 84 31 30 86 49
22	77 35 82 48 13 72 34 52 92 65 96 90 06 38 63 85 51 32 27 13
23	41 04 45 66 46 68 15 83 10 61 01 03 21 99 47 88 09 05 60 32
24	62 93 76 07 98 73 70 44 26 23 16 97 40 25 11 36 59 37 87 48
25	19 51 43 46 68 40 88 33 26 27 21 58 60 90 34 30 52 07 65 73
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27	94 16 23 73 32 83 71 17 76 63 49 10 61 06 98 47 70 22 82 18
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29	78 93 39 99 97 81 85 86 37 62 14 02 20 24 45 54 35 04 03 36
30	36 38 52 79 15 73 71 66 01 67 03 53 70 99 07 57 29 75 27 45
31	96 84 92 81 61 89 43 35 11 24 91 63 26 55 74 23 46 68 54 98
32	64 95 04 06 94 17 78 42 56 80 25 16 69 83 09 33 34 12 87 77
33	72 28 62 86 31 22 65 40 10 90 85 13 41 47 97 60 37 51 59 14
34	19 05 02 30 21 76 44 29 49 93 32 58 08 82 18 39 20 88 50 48
35	09 86 11 65 92 32 23 19 20 61 33 75 69 82 35 84 14 59 17 58
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38	85 21 81 51 57 01 13 16 34 08 73 18 72 26 76 95 87 74 64 55
39	39 56 04 48 70 67 05 53 03 78 41 38 77 83 12 50 88 15 89 46
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41	27 28 78 23 03 02 73 30 42 95 29 77 65 88 94 90 53 63 97 81
42	61 70 67 17 93 45 59 24 35 79 16 14 21 26 64 46 19 69 86 20
43	66 50 92 51 96 08 84 12 36 62 55 01 68 58 56 47 40 31 71 60
44	99 41 54 37 83 89 43 15 34 57 18 11 49 87 09 74 98 33 85 48
45	68 58 23 32 73 75 40 91 29 20 27 63 05 13 72 98 59 03 71 66
46	87 33 44 37 80 61 86 45 11 47 48 15 60 88 55 76 09 34 67 17
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48	21 81 49 35 57 84 08 89 77 53 83 16 97 99 04 18 06 54 14 19
49	52 22 96 56 07 24 85 10 36 10 64 95 78 31 25 79 02 30 50 46
50	41 17 25 81 18 45 83 96 15 92 58 84 75 12 29 59 56 91 98 49
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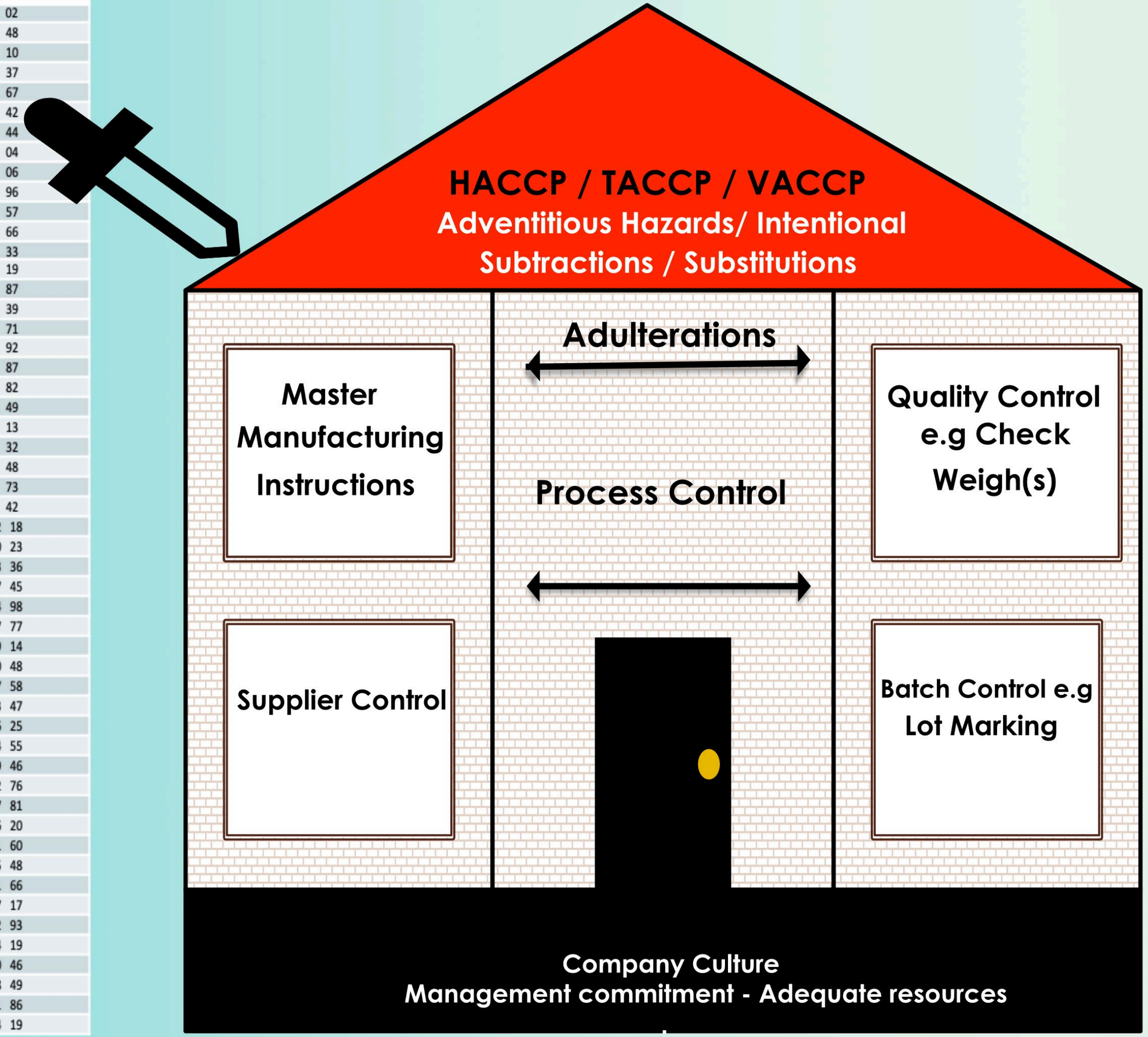
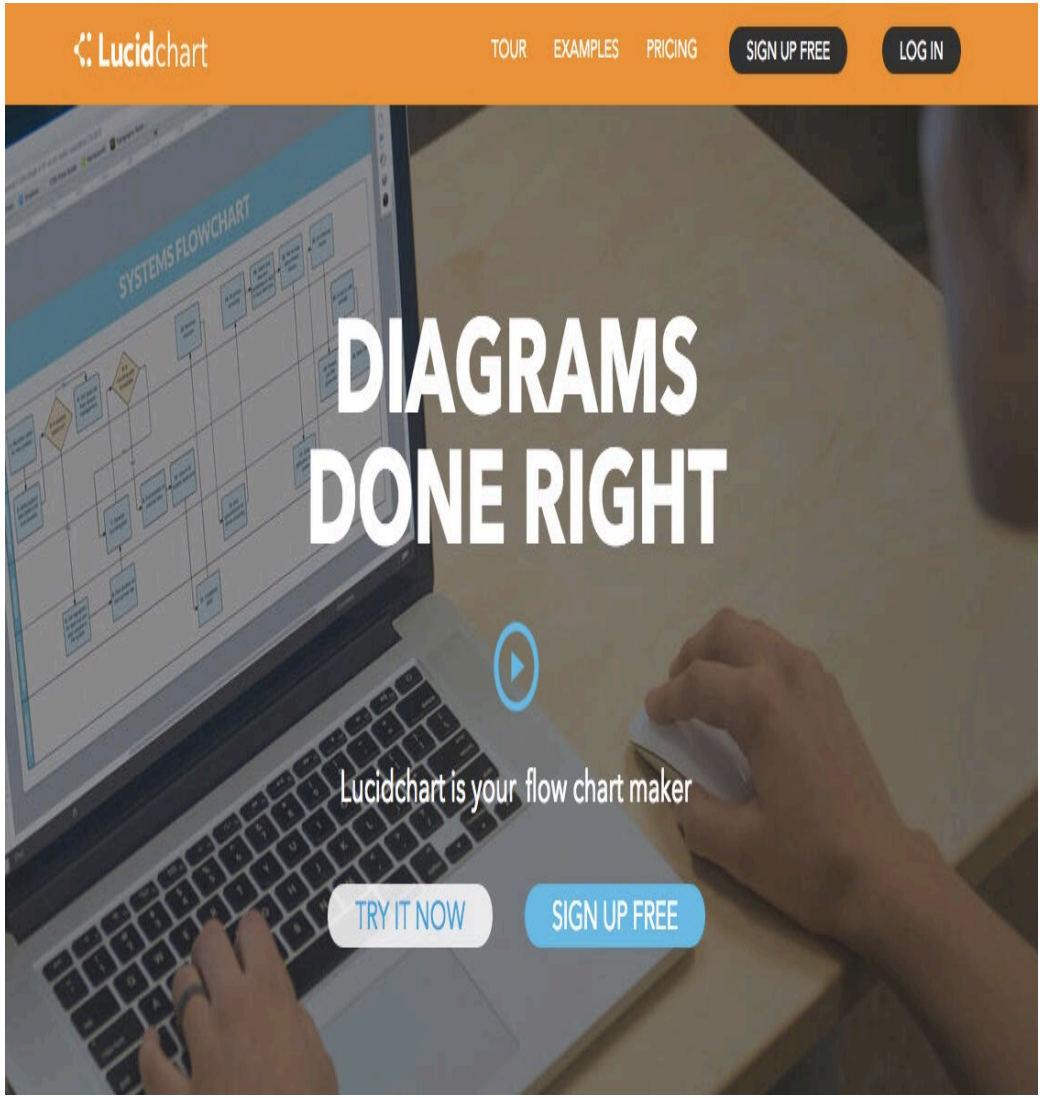
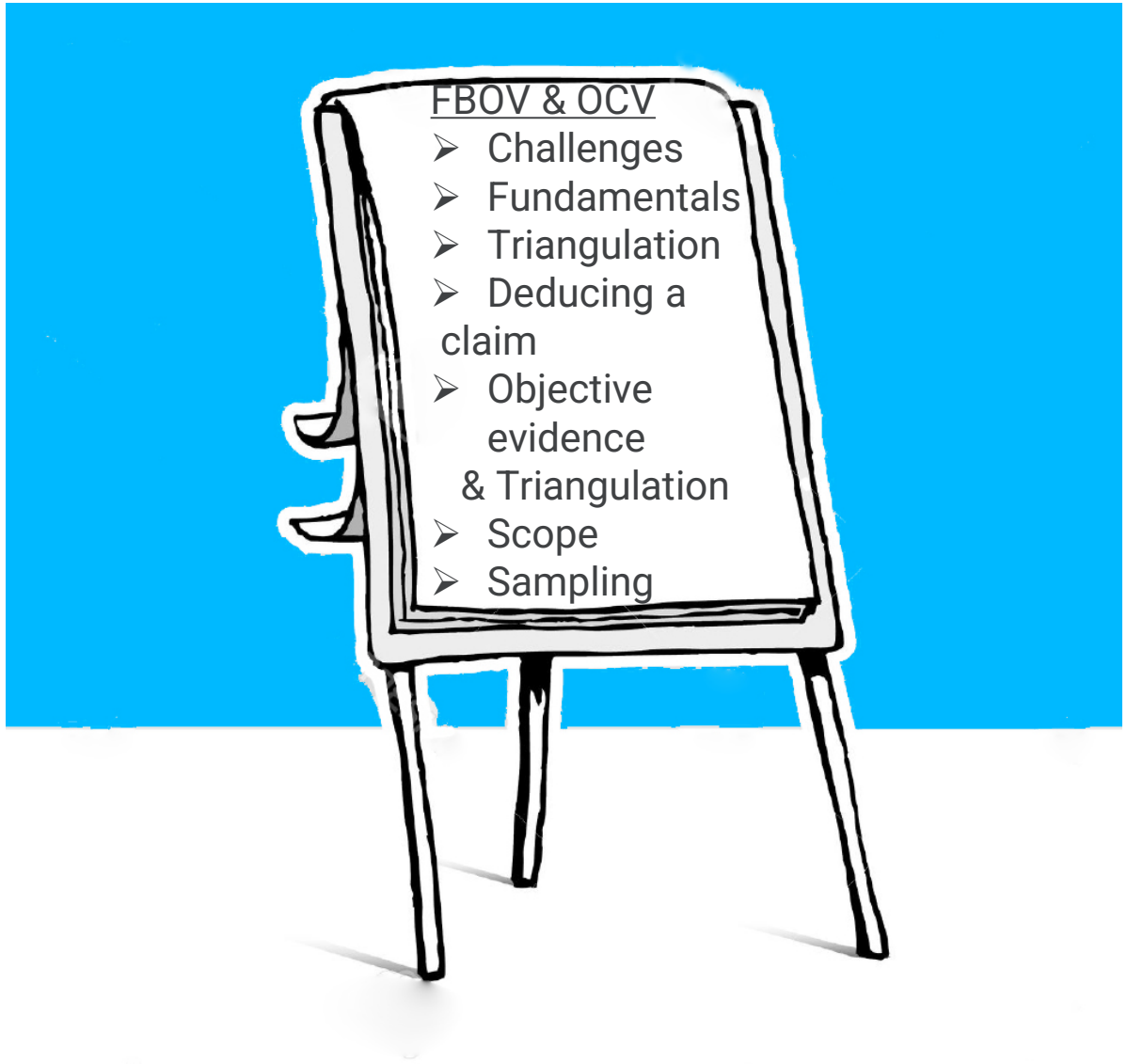



Ploys and hacks

Lucid chart


Lucidchart
TOUR
EXAMPLES
PRICING
SIGN UP FREE
LOG IN
SYSTEMS FLOWCHART
DIAGRAMS
DONE RIGHT
Lucidchart is your flow chart maker
TRY IT NOW
SIGN UP FREE

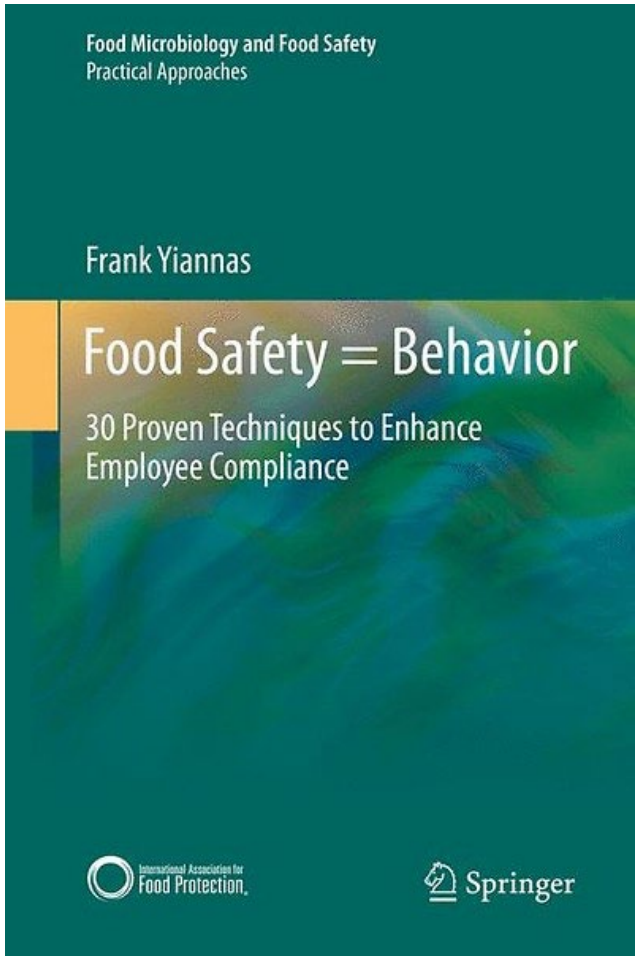
Verification FBOV and OCV summary

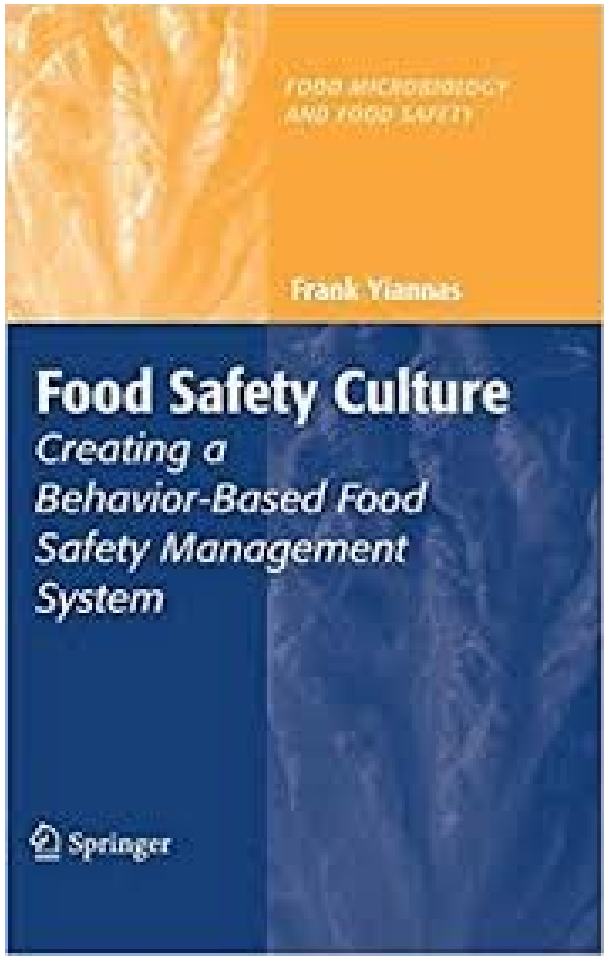


Company Culture

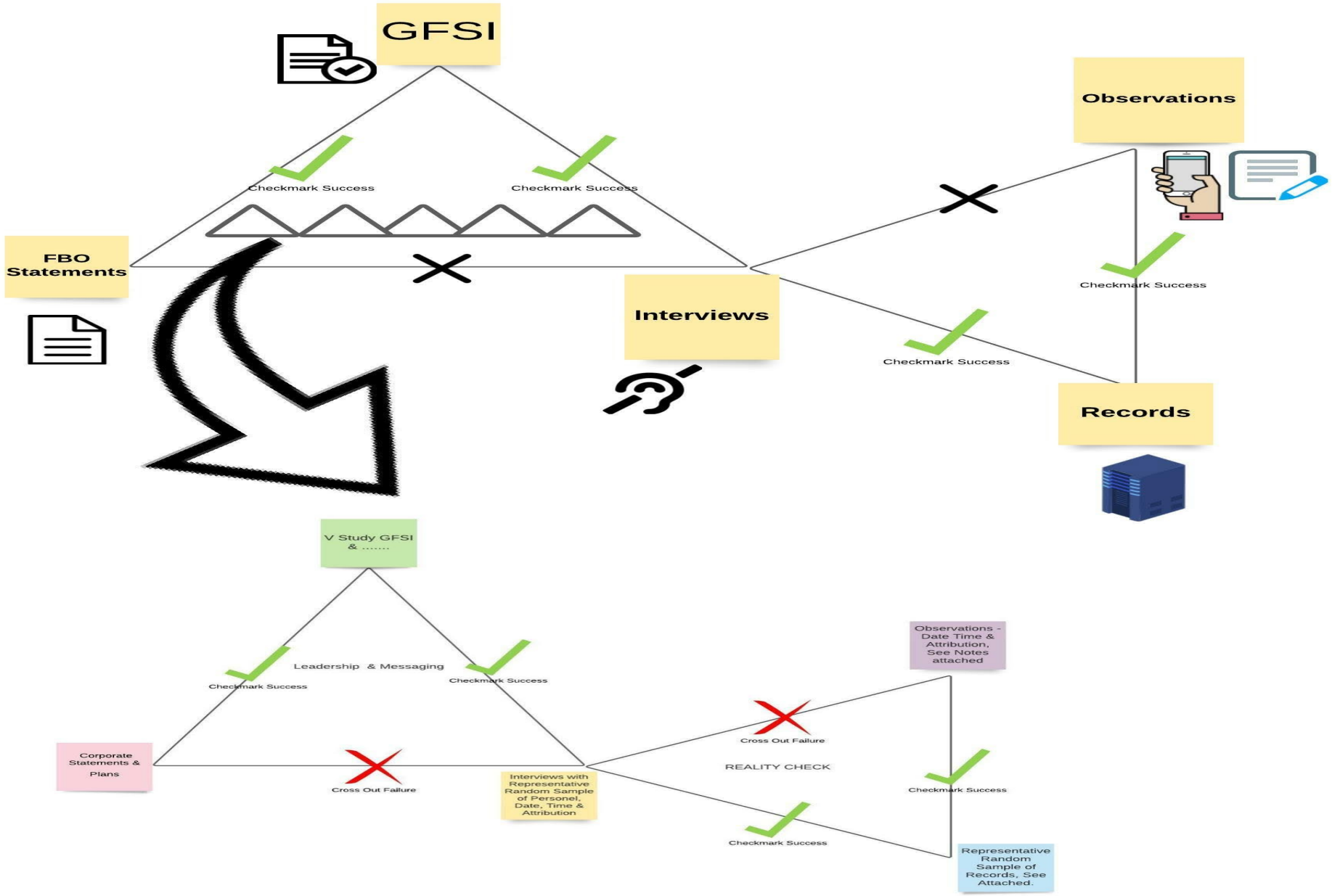
Company culture overview

Sources

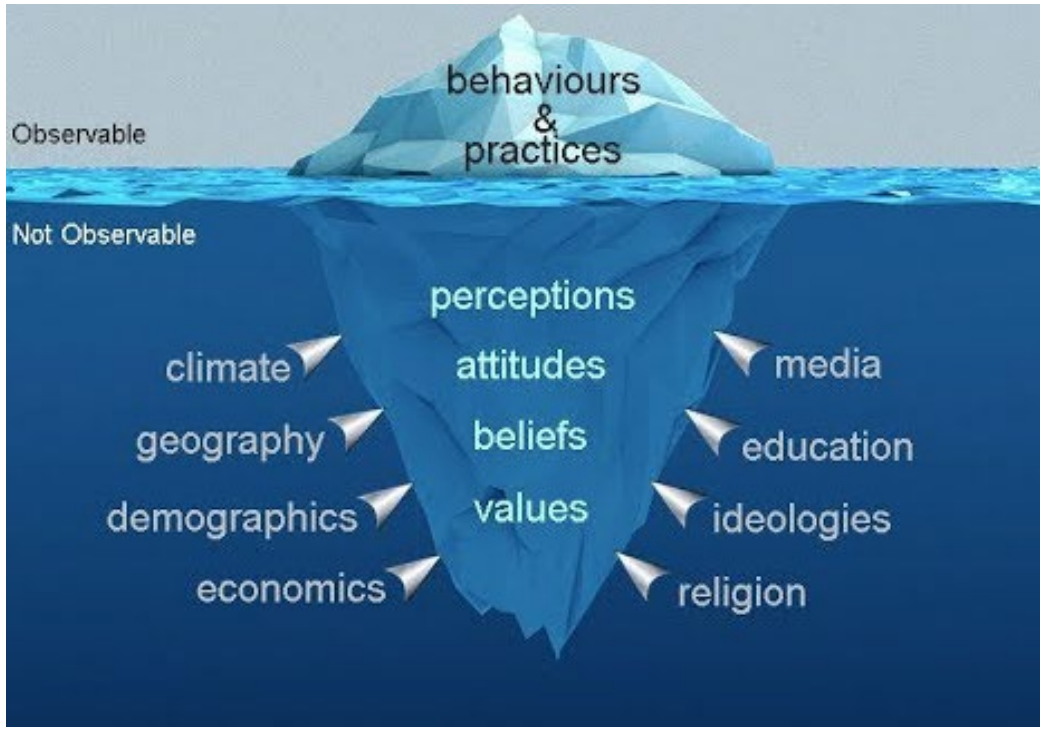




seafish


GFSI
Checkmark Success
Checkmark Success
FBO Statements
Interviews
Observations
Checkmark Success
Checkmark Success
Records
V Study GFSI & .....
Leadership & Messaging
Checkmark Success
Checkmark Success
Corporate Statements & Plans
Cross Out Failure
Interviews with Representative Random Sample of Personel, Date, Time & Attribution
Observations - Date Time & Attribution, See Notes attached
Cross Out Failure
REALITY CHECK
Checkmark Success
Checkmark Success
Representative Random Sample of Records, See Attached.

The Iceberg Model

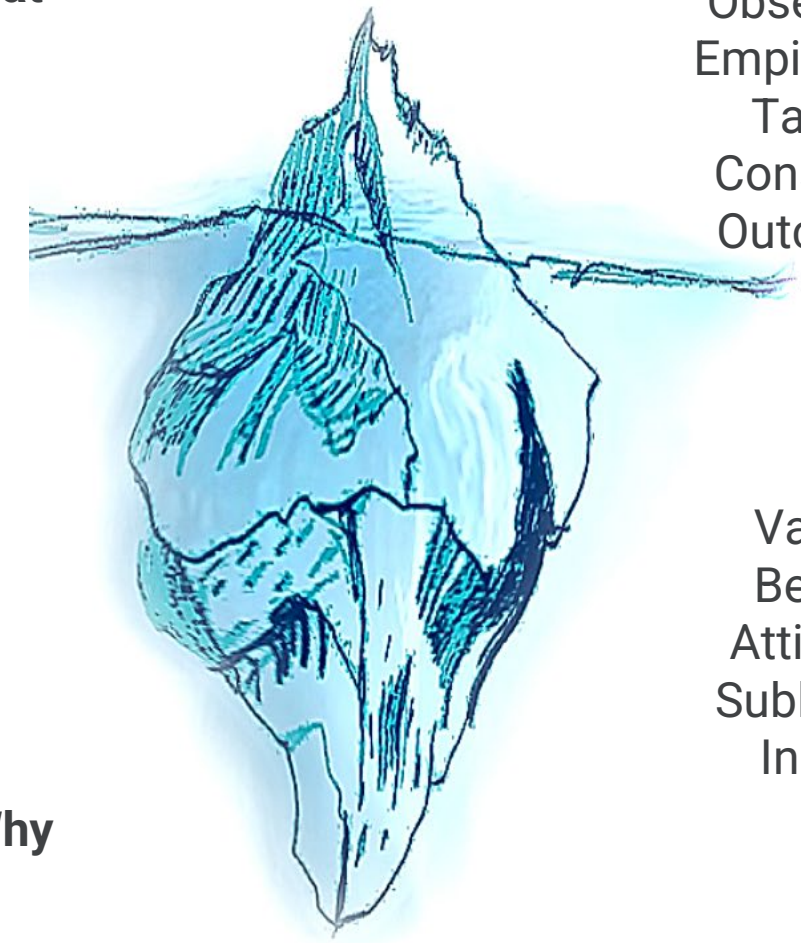


- *"Shared values, beliefs and norms that effect mind-set and behaviour toward Food Safety in, across and throughout an organization." GFSI 2018*

The What

Behaviors
Observable
Empirical (?)
Taught
Conscious
Outcomes

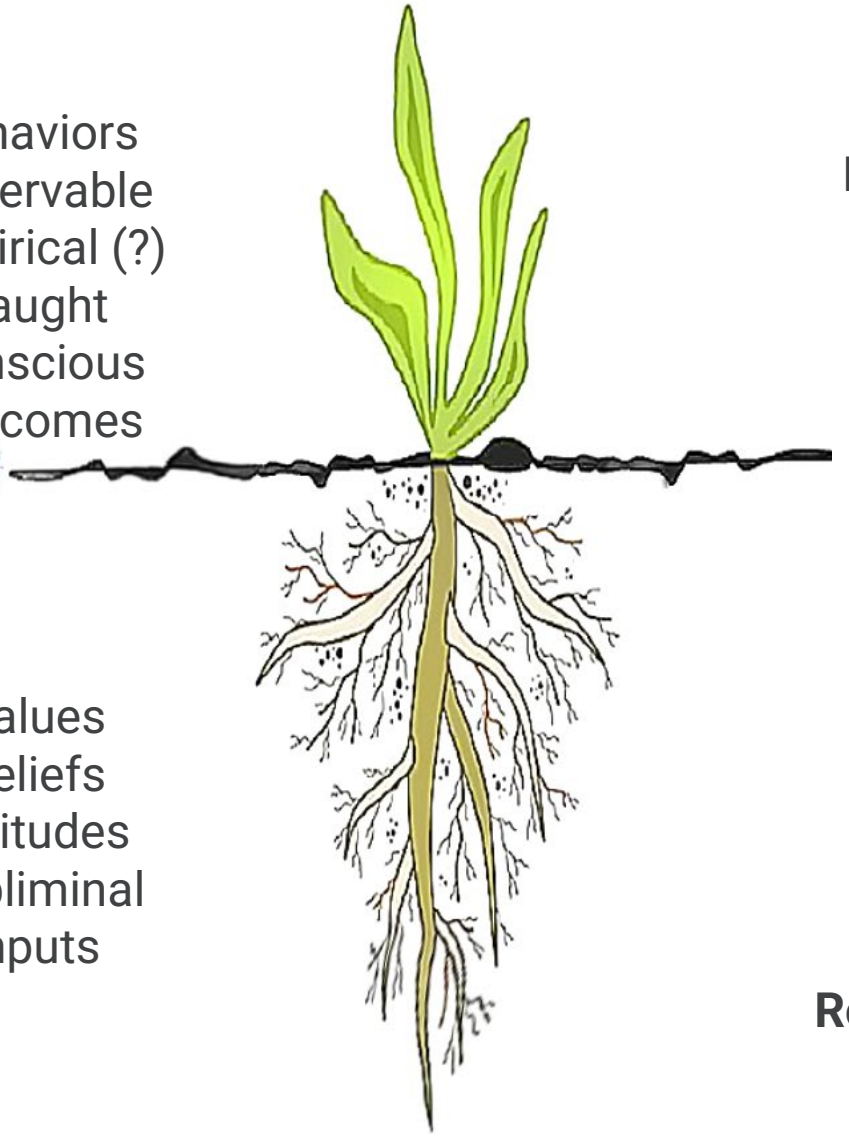
Effects



Edward T Hall 1976

Values
Beliefs
Attitudes
Subliminal
Inputs

The Why



Root Causes

Ishikawa Kaoru 1982

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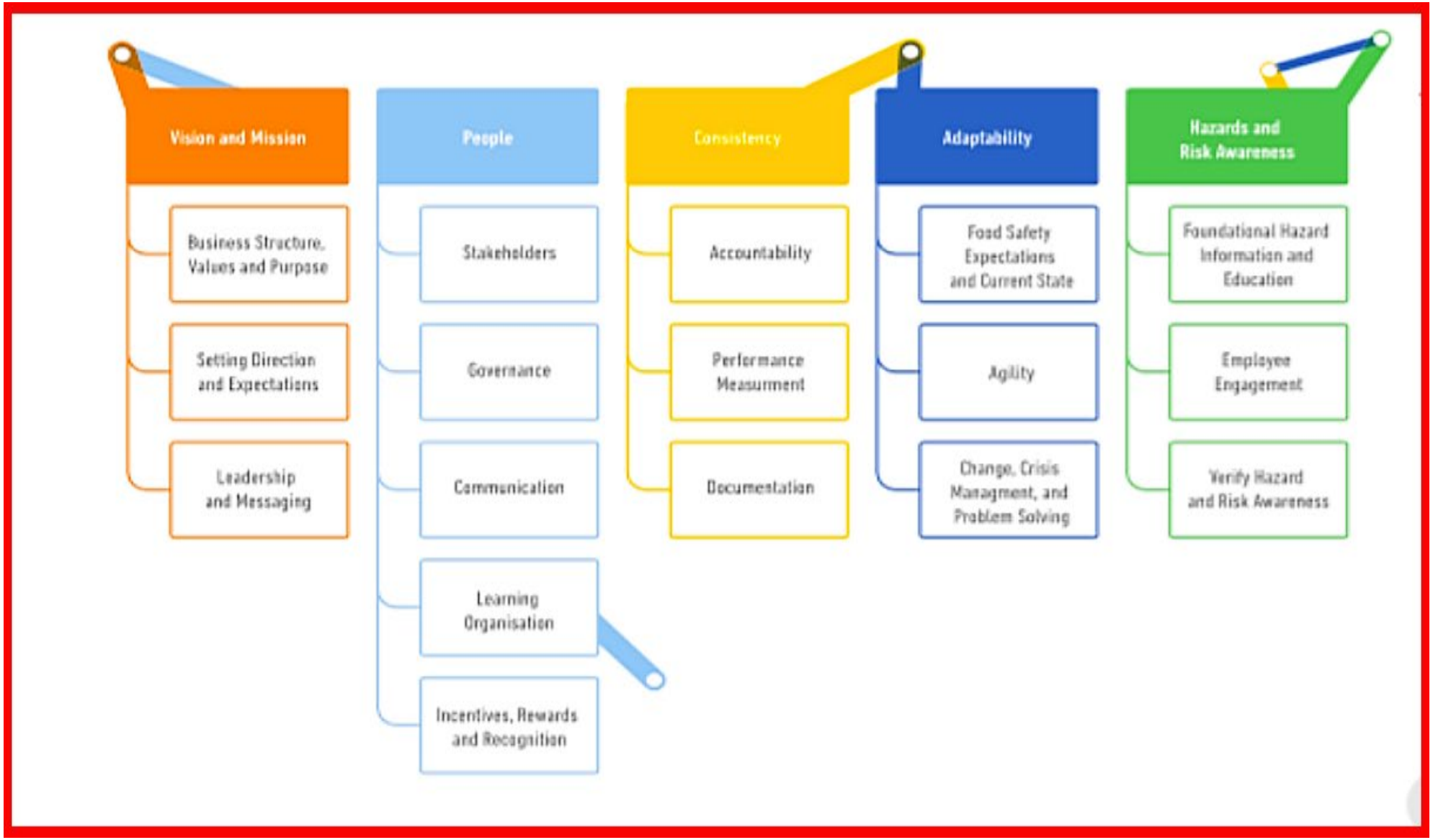
FBO culture

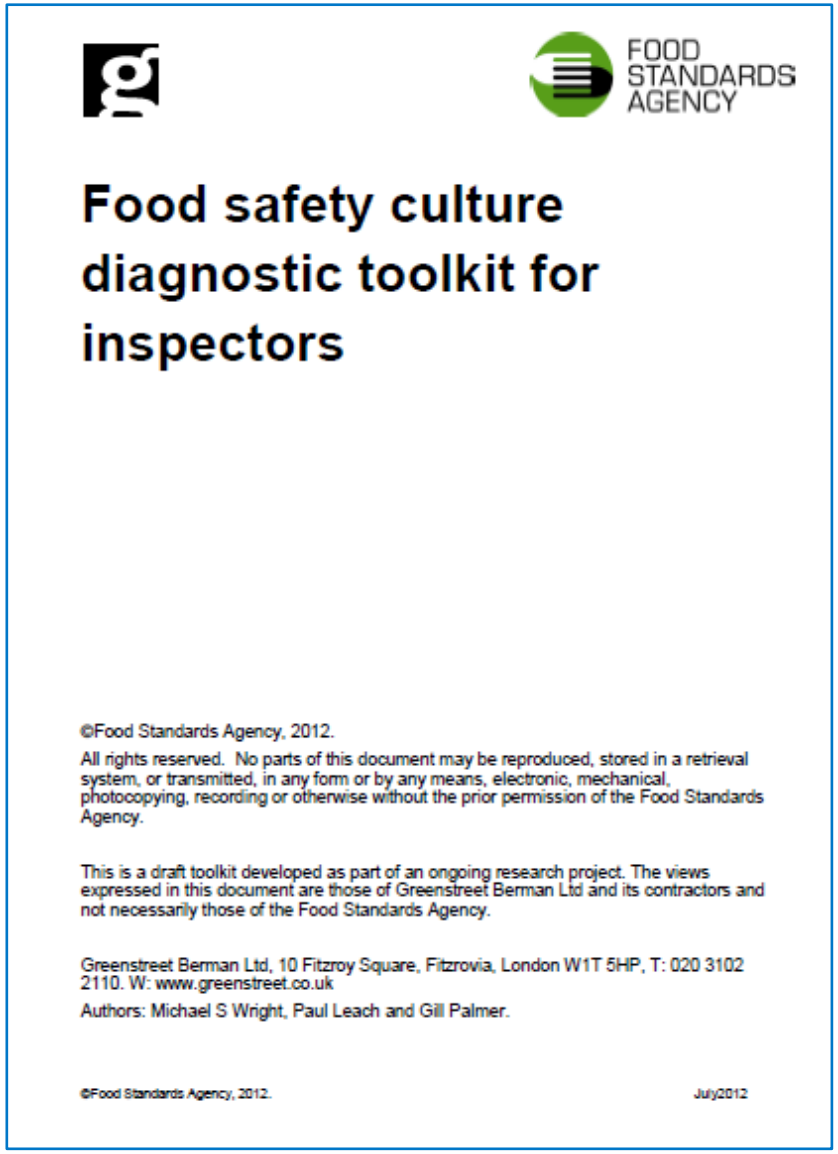
“Creating a culture in which all staff are both able and confident to report suspicions of wrongdoing is vital. Businesses can do this by ensuring they provide an environment in which staff are able to see the moral as well as the commercial benefits of identifying wrongdoing, whether within or outside of their business. Working with the National Food Crime Unit, whether by sharing fraud concerns or by finding new ways to design out fraud, will make the UK food sector both a safer and a more economically prosperous place, benefitting both businesses and consumers alike”

Andy Morling Head of FSA Food Crime Unit
2016

Five dimensions of food culture



Verifying FBO culture



Food safety culture diagnostic toolkit for inspectors

This is a draft toolkit developed as part of an ongoing research project. The views expressed in this document are those of Greenstreet Berman Ltd and its contractors and not necessarily those of the Food Standards Agency.

Greenstreet Berman Ltd, 10 Fitzroy Square, Fitzrovia, London W1T 5HP, T: 020 3102 2110. W: www.greenstreet.co.uk

Authors: Michael S Wright, Paul Leach and Gill Palmer.

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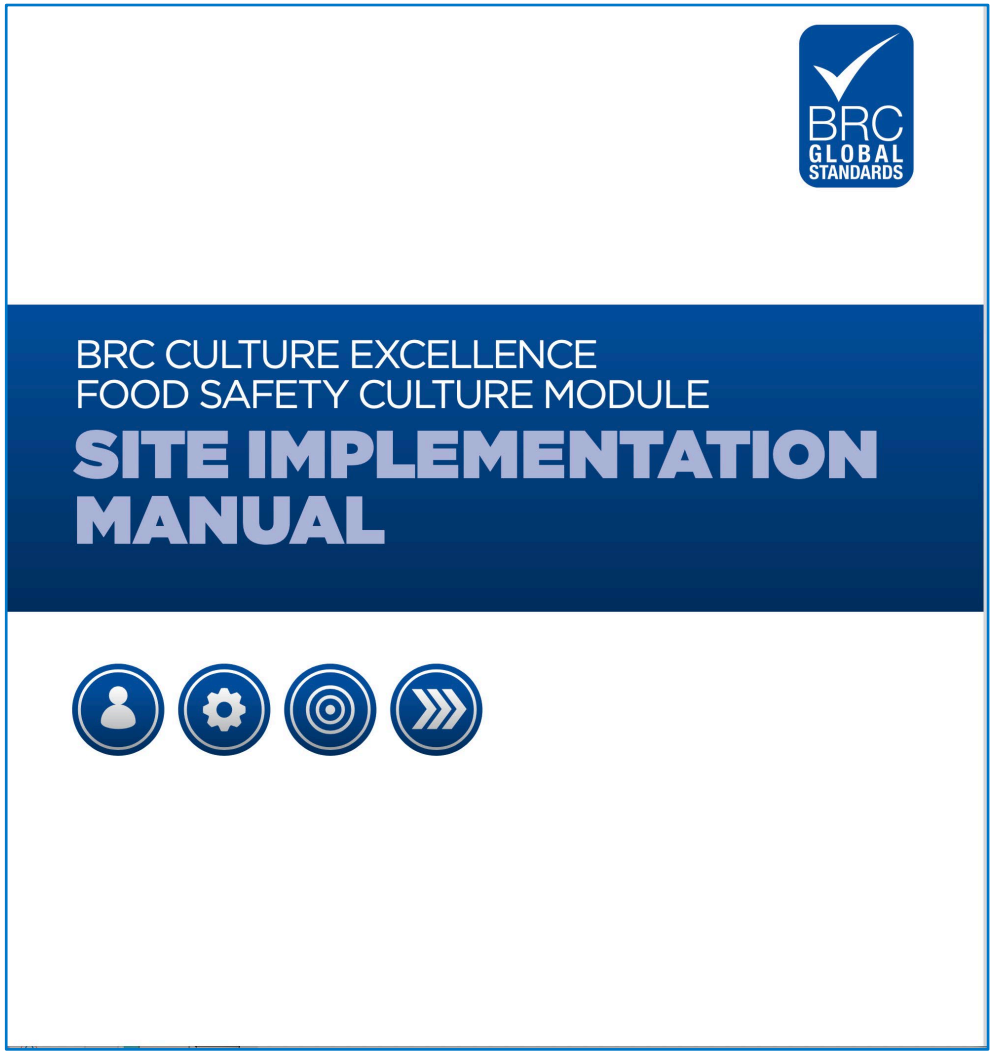
July2012

Verifying FBO culture



Discussion – promoting & verifying FBO food culture

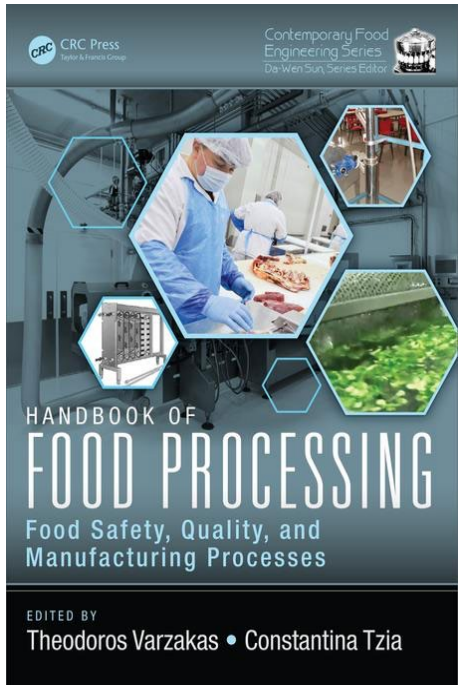
Company culture summary

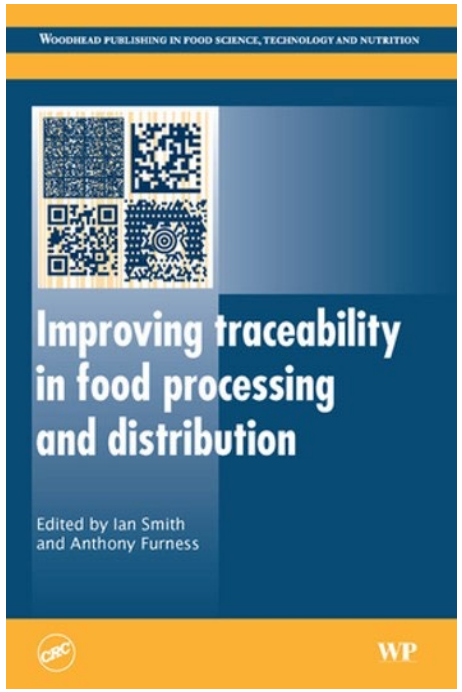
Traceability and Provenance

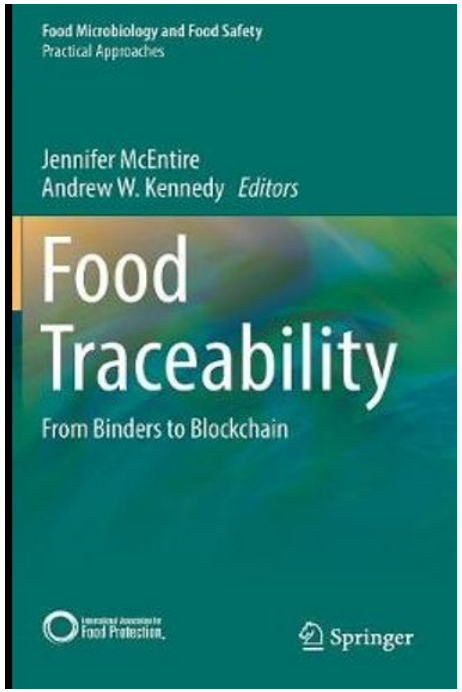
Traceability & provenance overview

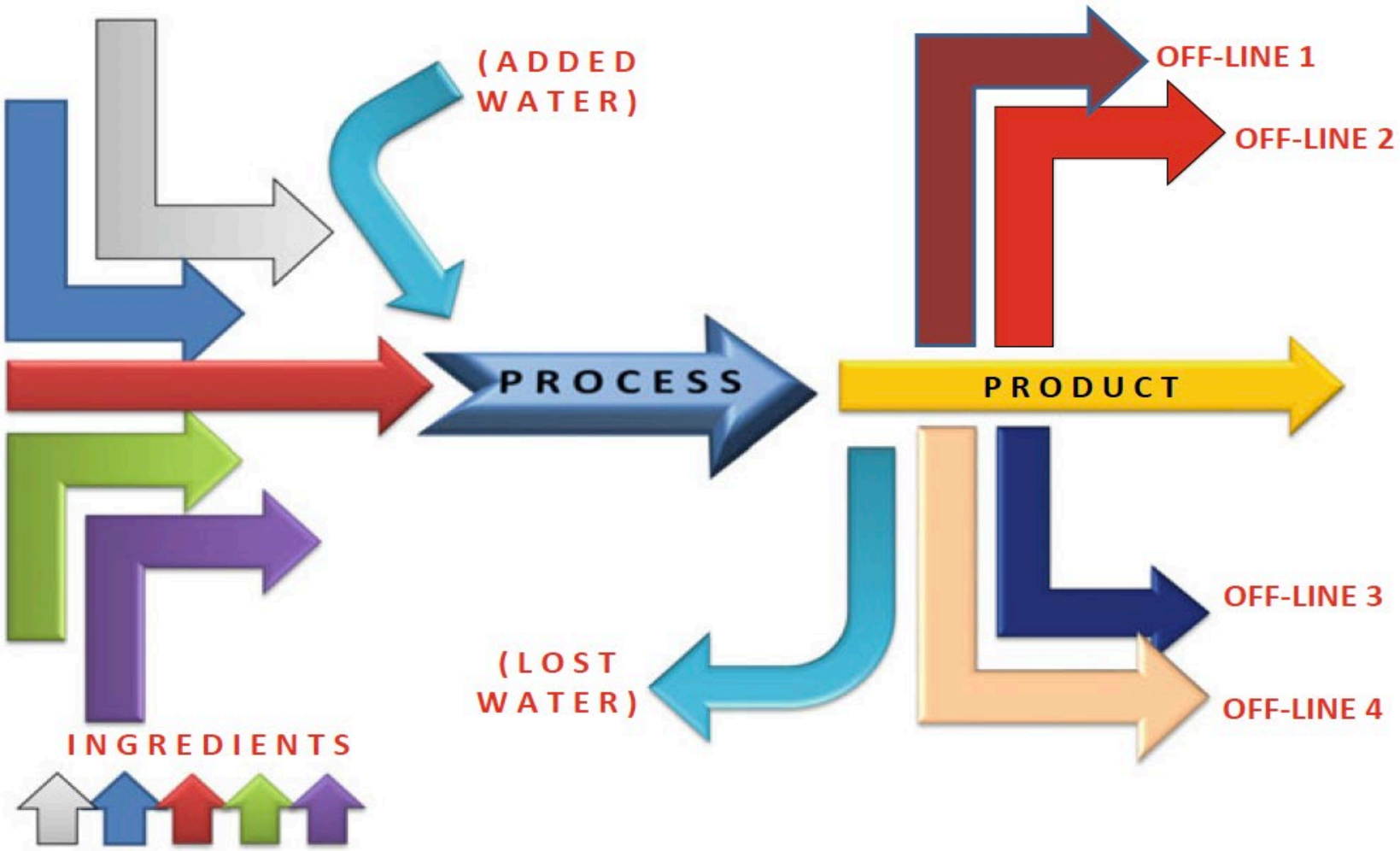
Sources


Food & Drink
7TH EDITION
Good Manufacturing Practice
A GUIDE TO ITS RESPONSIBLE MANAGEMENT
ifst
WILEY


CRC Press
Contemporary Food Engineering Series
HANDBOOK OF
FOOD PROCESSING
Food Safety, Quality, and Manufacturing Processes
EDITED BY
Theodoros Varzakas • Constantina Tzia

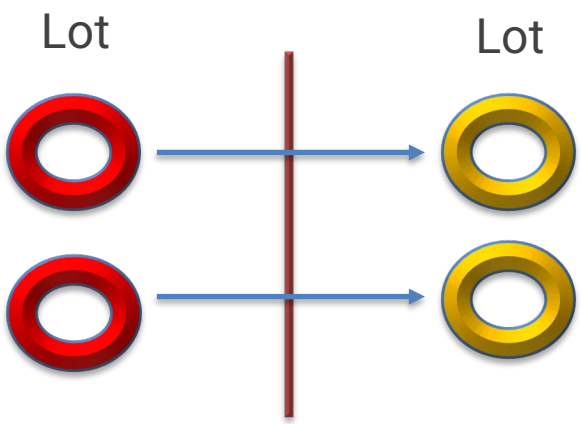

Woodhead Publishing in Food Science, Technology and Nutrition
Improving traceability in food processing and distribution
Edited by Ian Smith and Anthony Furness
WP


Food Microbiology and Food Safety
Practical Approaches
Jennifer McEntire
Andrew W. Kennedy Editors
Food Traceability
From Binders to Blockchain
Springer


(ADDED WATER)
OFF-LINE 1
OFF-LINE 2
PROCESS
PRODUCT
OFF-LINE 3
(LOST WATER)
OFF-LINE 4
INGREDIENTS

Transactions

(a) Receiving lots



- Verify the incoming shipment and its information (labels/invoice etc.)
- Cross ref to supplier date and time
- Record info
- Where one step back FBO has not implemented traceability verify ID on incoming lot – follow G (see below)

(b) In establishment movement where there is no processing

- Cross ref the lot with label and invoice
- Record date and time

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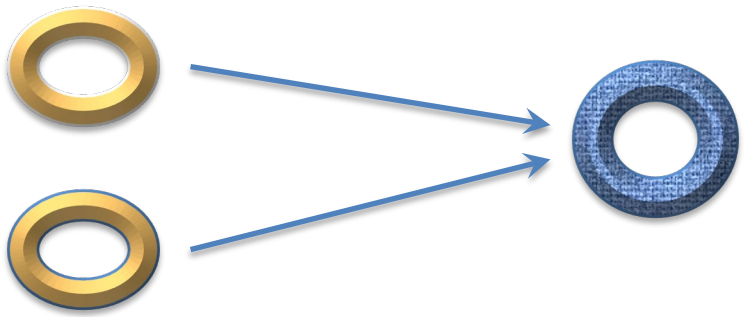
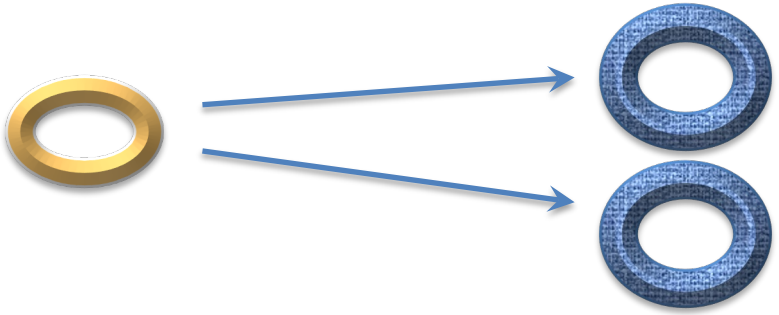
Transactions

(c) Combination of a lot



- Verify data re pre-combined lots, refer SOP and record
- Assign new ID to combined lot
- Link data before and after combination and record.
- Record info re combination work needed for ID if any (e.g.. date, quantity before and after combination)
- Prepare label and invoice with the new ID and attach

(d) Division of a lot



- Verify pre-divided lot data and record
- Assign new lot ID to divided lots
- Record the ID linkages
- Record division data, e.g.. quantities before and after division, date and time
- Prepare label and invoice with the new ID and attach

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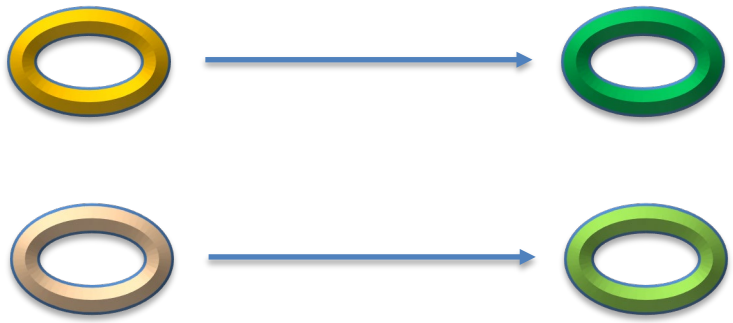
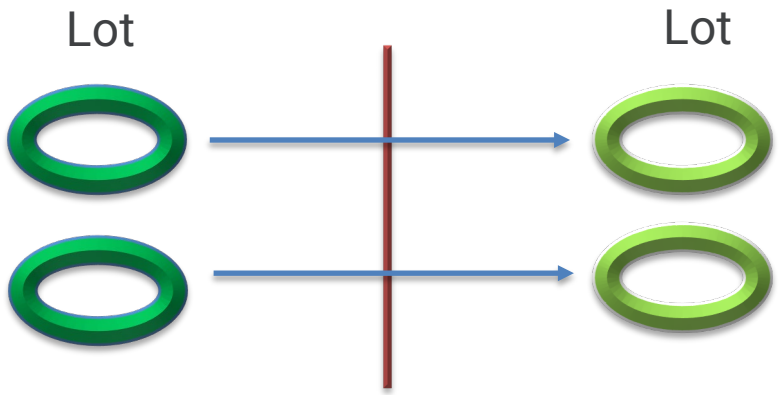
Transactions

(e) Processing not involving Combination of lots e.g.., heating, freezing drying etc.



- Verify pre-processing lots data and record
- Record info re processing work required for ID - If any e.g.., date and time of processing, quantities before & after processing
- Prepare label and invoice with ID of processed lot and attach

(f) Shipment of a lot



- Verify lot to be shipped and its data. Record
- Cross reference and link ID of shipped lot to buyer date and time. Record

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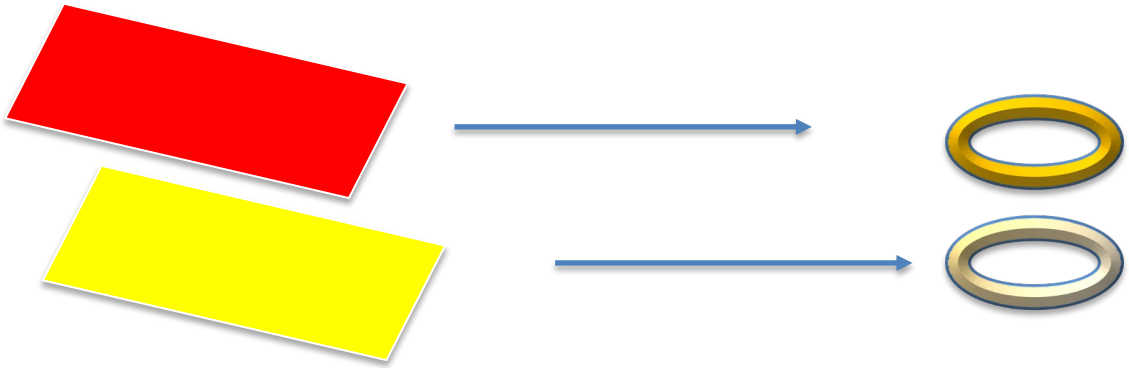
Transactions

(g) Formation of a lot (e.g.., obtaining from the farm (livestock and marine products) or when receiving no ID products not covered by the FCMS



- Decide on the product lot and assign ID
- For each lot record data required for ID e.g.., (producer, farm date and time)

(h) Disposal of a lot

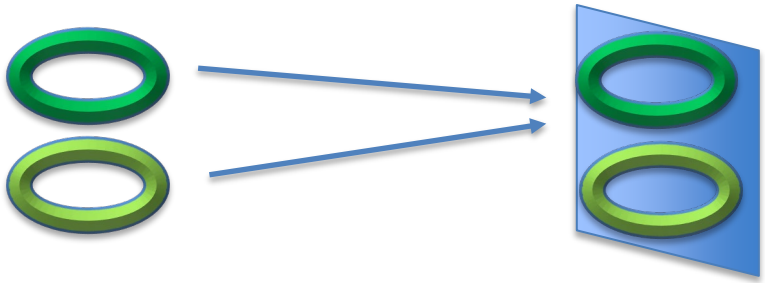
- Verify the product lot and its data prior to disposition. Record
- For each lot record the disposal date, time and place

Transactions

(i) Requirements for in-house IDs

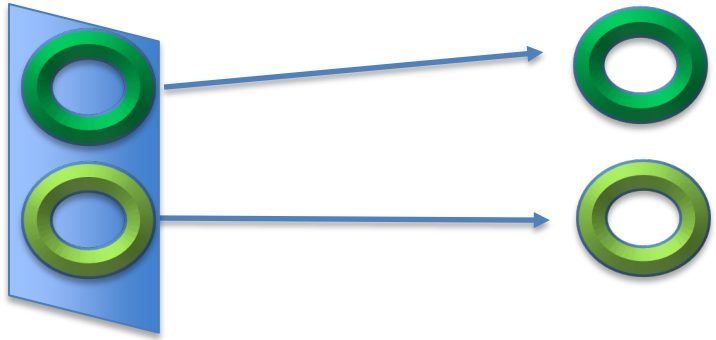
- FBO to set a rule re in-house ID, linked to incoming and out-going lot IDs

(j) Grouping (forming) lots



- Assign a new ID to grouped lot
- Link to product ID before the grouping to after. Record
- Record info re grouping work if any e.g.., date, time place

(k) Dividing Lots (e.g. a traceable unit)



- Link to product ID before the division to after. Record
- Record info re division work if any e.g.., date, time, place

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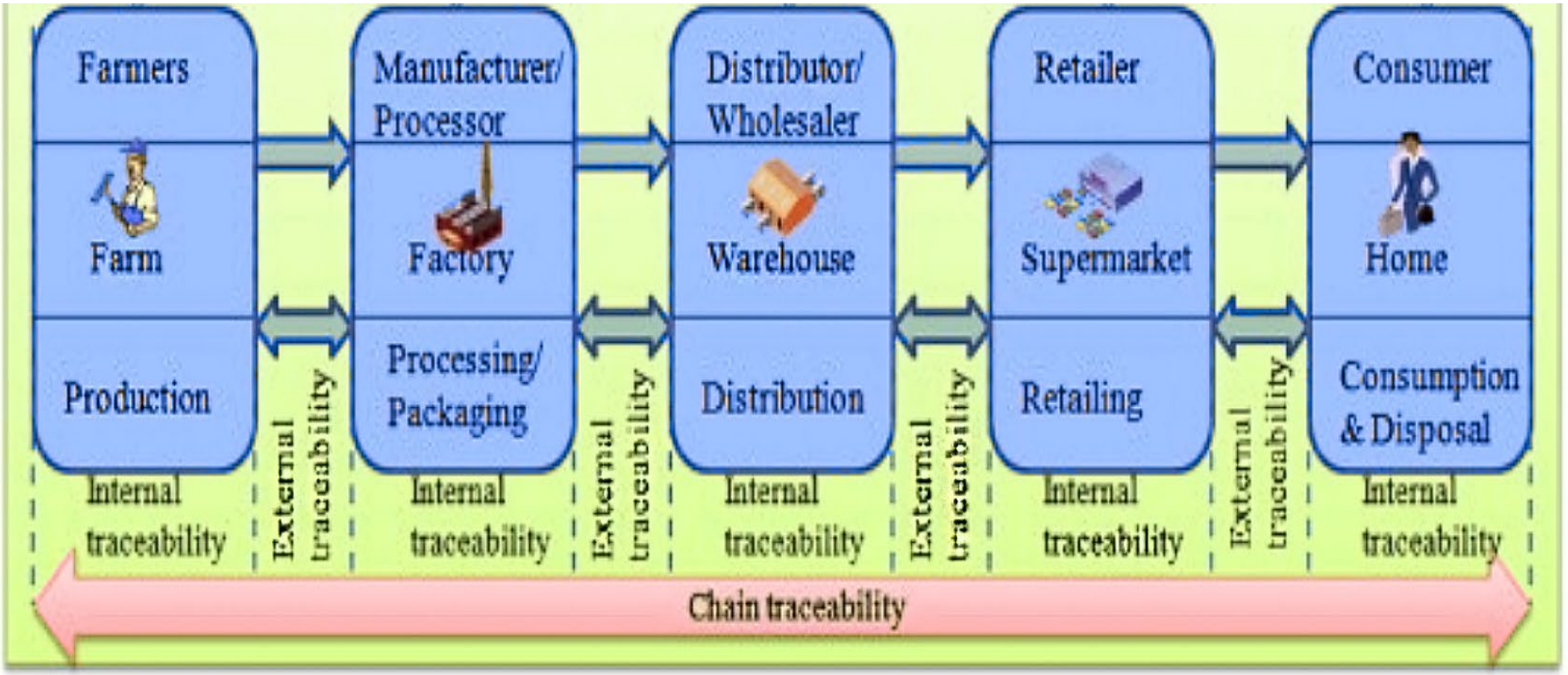
Traceability



Traditional vs forensics

	Traditional	Forensics
Speed	*X* Can be slow relies on checking data & each point in the supply chain	✓ Fast 1 to 5 days
Accuracy	*X* Reliant on packaging - Fails when packaging lost or counterfeit	✓ Traces product not packaging ✓ Science & algorithmic methods Can't be counterfeited without detection
Farm to Fork	*X* Reliant on packaging – Does not reach critical point of consumption	✓ Actual product assayed Trace from consumer to farm
Scientific	*X* Paper based – Prone to error	✓ Peer reviewed scientific literature ✓ Accepted as evidence in court

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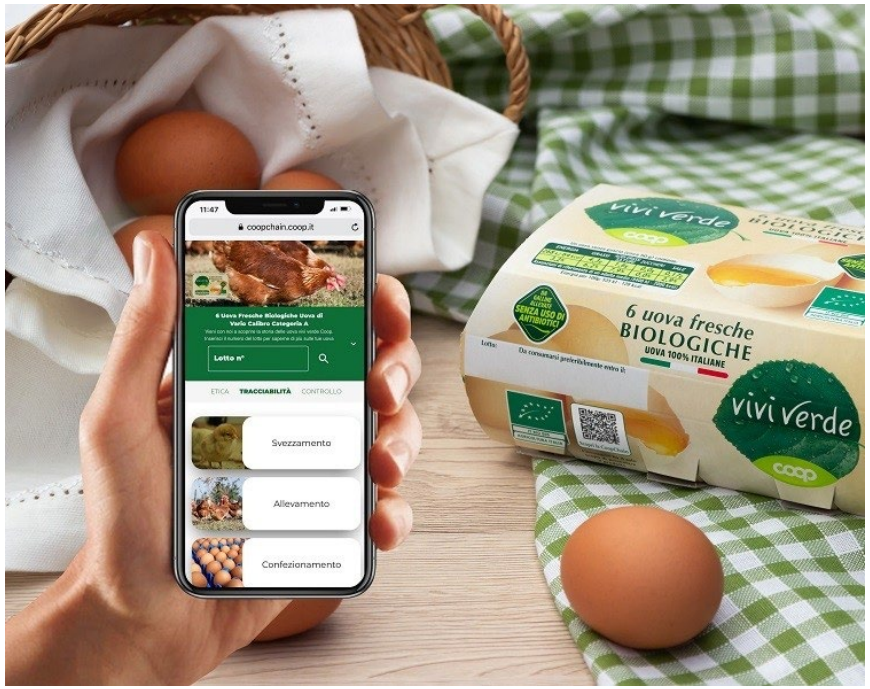
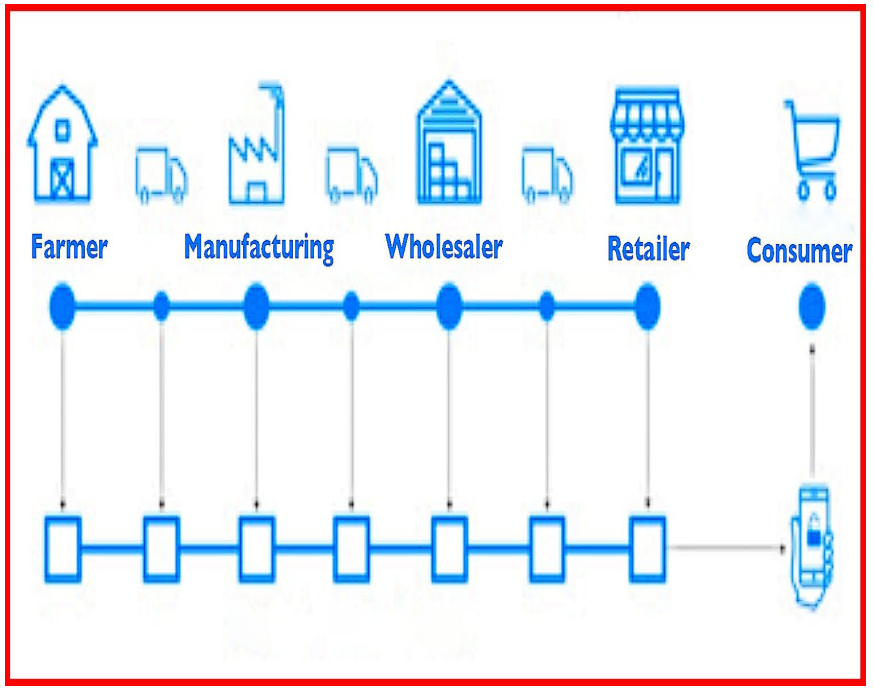
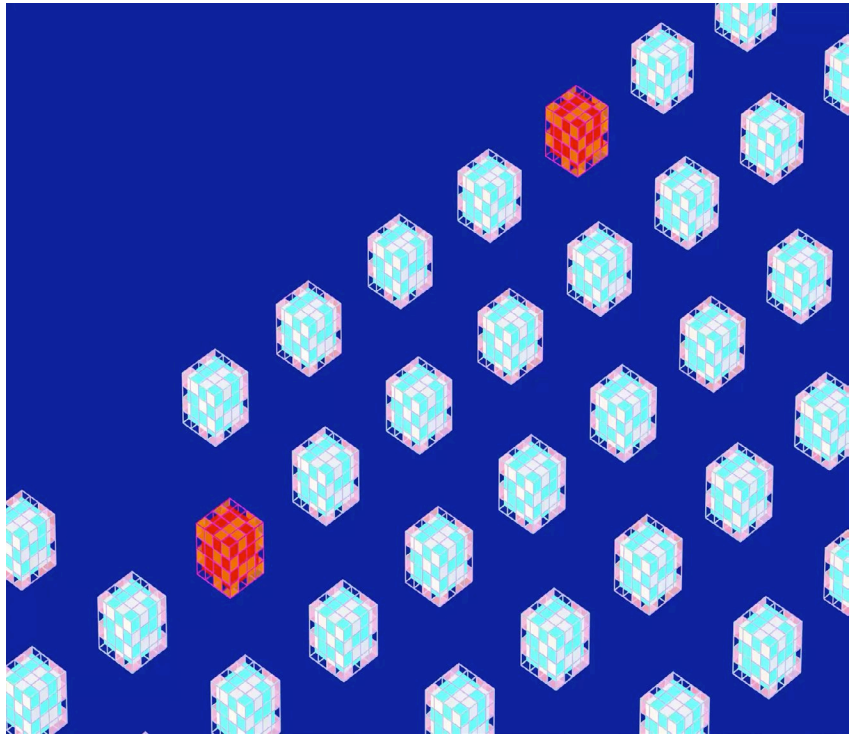
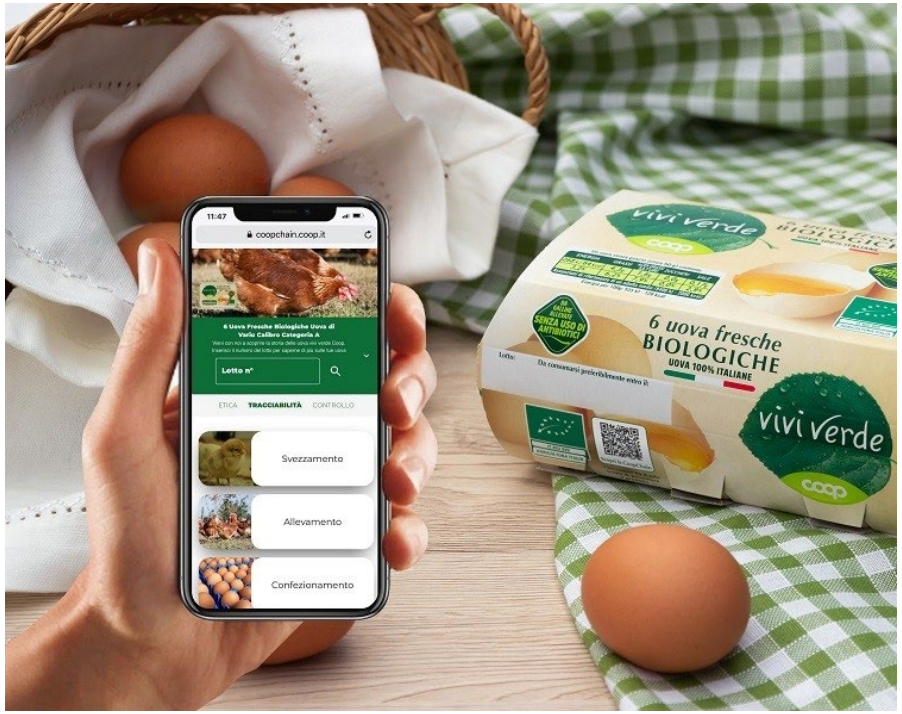
Blockchain


coopchain.coop.it
Lotto n°
ETICA
TRACCIABILITÀ
CONTROLLO
Svezzamento
Allevamento
Confezionamento
vivi verde
6 uova fresche
BIOLOGICHE
UOVA 100% ITALIANE


Farmer
Manufacturing
Wholesaler
Retailer
Consumer

Blockchain




coopchain.coop.it
Lotto n°
ETICA
TRACCIABILITÀ
CONTROLLO
Svezzamento
Allevamento
Confezionamento
vivi verde
6 uova fresche
BIOLOGICHE
UOVA 100% ITALIANE

Discussion - traceability

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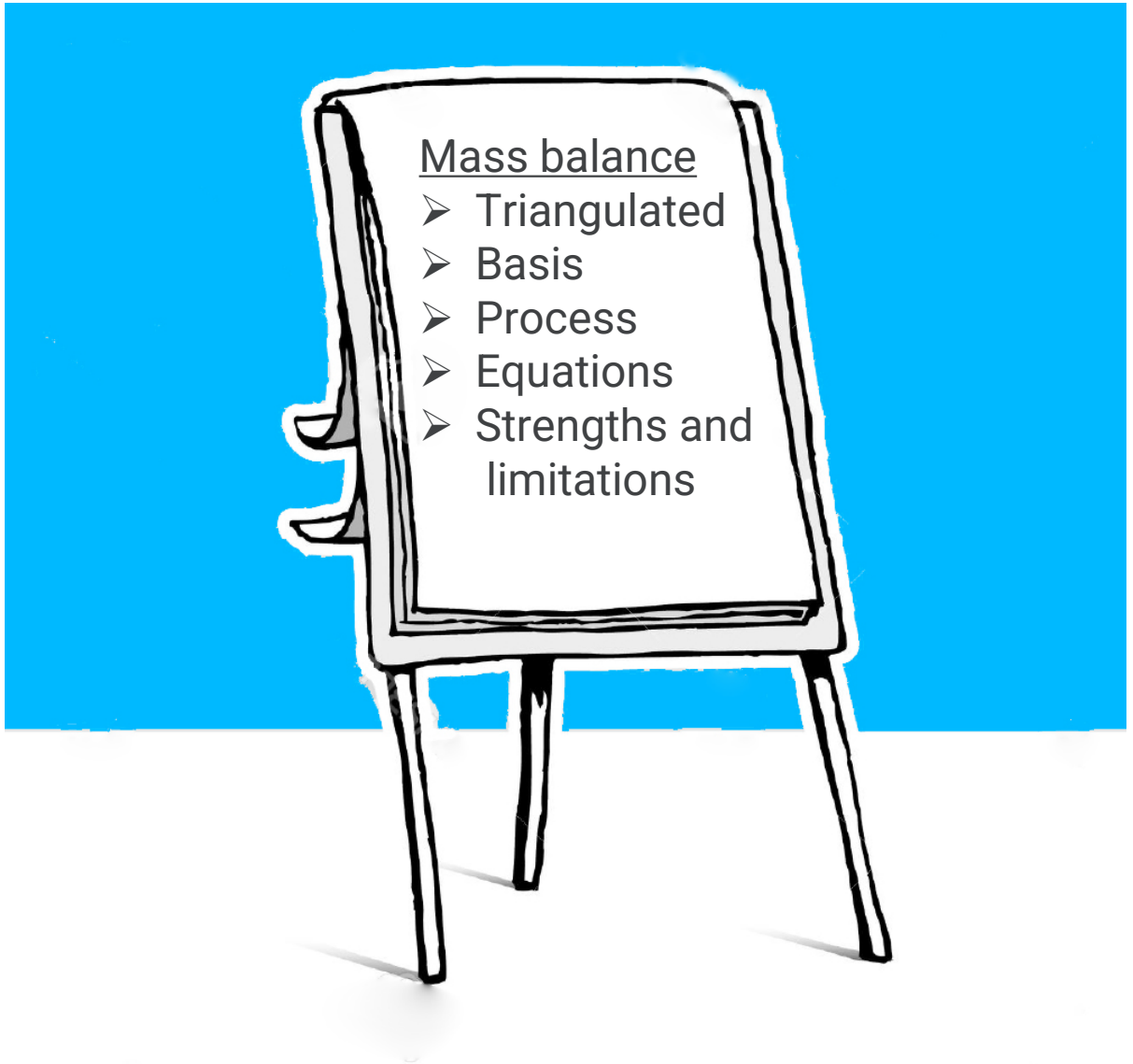
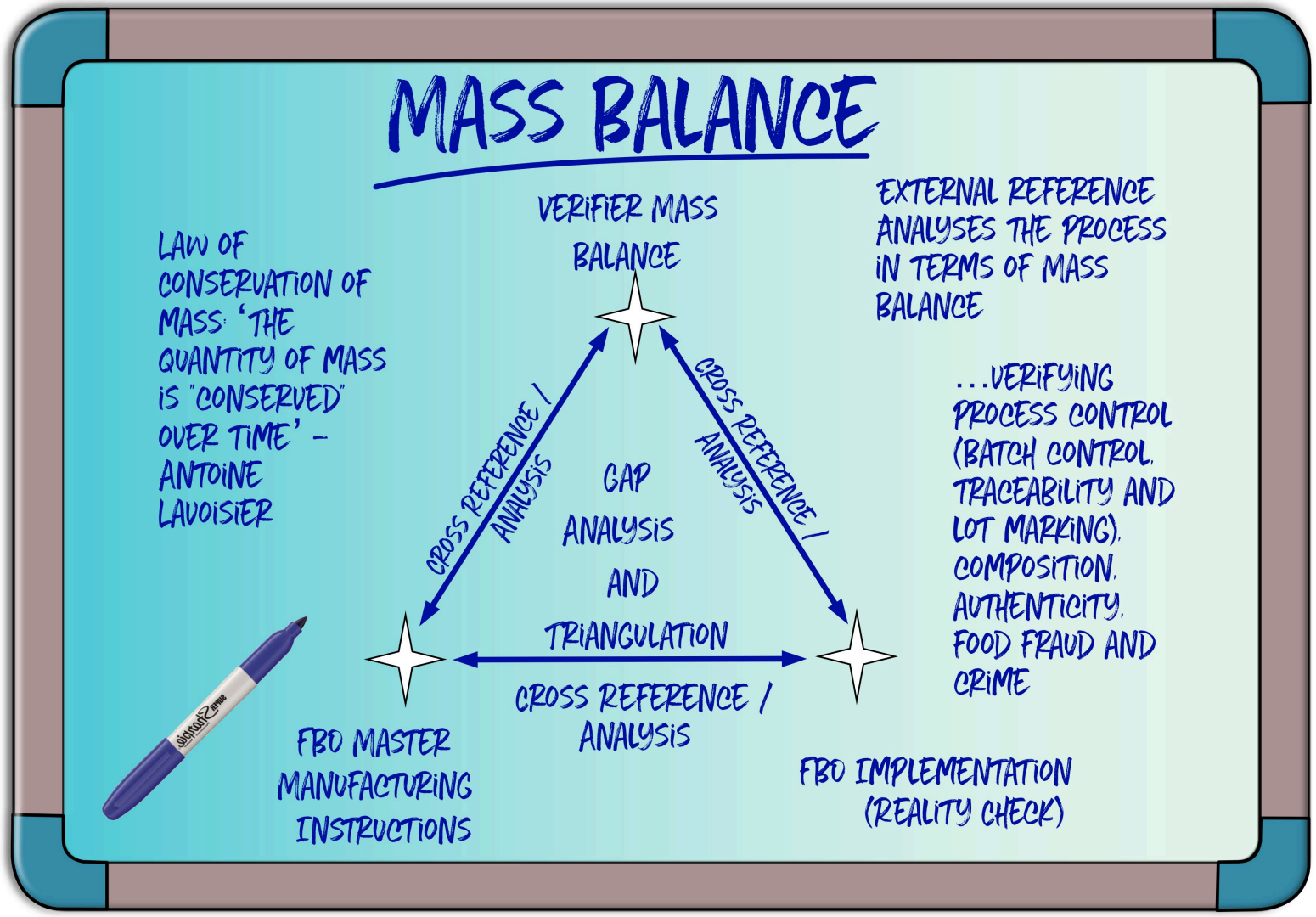
Traceability & provenance summary

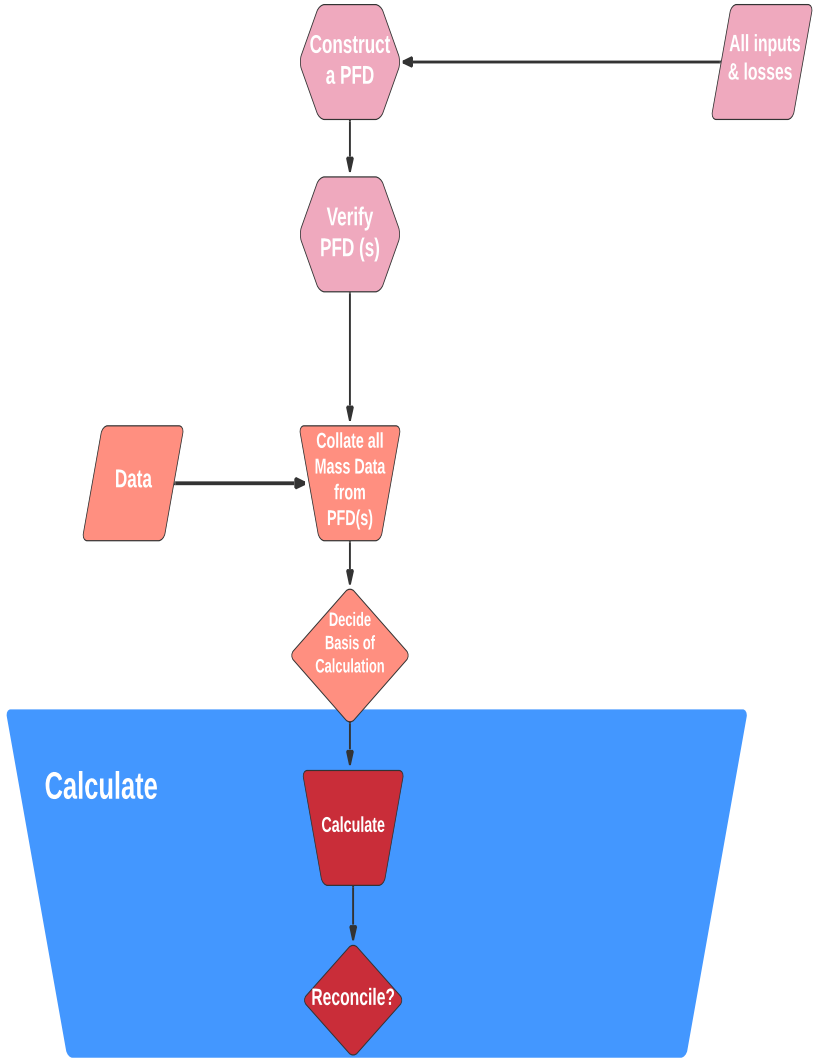
Mass balance

Mass balance overview




MASS BALANCE
LAW OF CONSERVATION OF MASS: 'THE QUANTITY OF MASS IS "CONSERVED" OVER TIME' – ANTOINE LAVOISIER
VERIFIER MASS BALANCE
EXTERNAL REFERENCE ANALYSES THE PROCESS IN TERMS OF MASS BALANCE
CROSS REFERENCE / ANALYSIS
CROSS REFERENCE / ANALYSIS
GAP ANALYSIS AND TRIANGULATION
...VERIFYING PROCESS CONTROL (BATCH CONTROL, TRACEABILITY AND LOT MARKING), COMPOSITION, AUTHENTICITY, FOOD FRAUD AND CRIME
CROSS REFERENCE / ANALYSIS
FBO MASTER MANUFACTURING INSTRUCTIONS
FBO IMPLEMENTATION (REALITY CHECK)

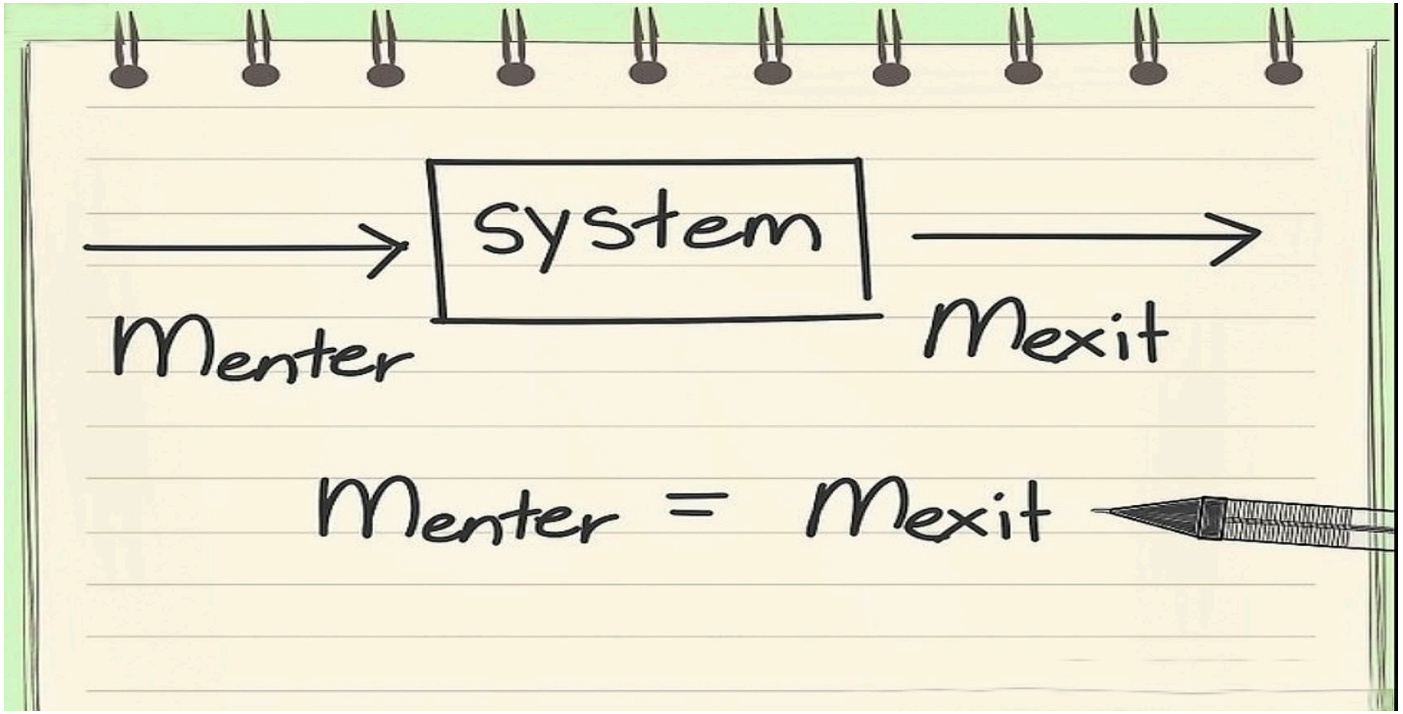
Mass balance process



EQUATIONS OF MASS BALANCE

$m_{in} = m_{out}$	*Steady State Situation'* – The most common situation e.g. batch process Where M_{in} and M_{out} are the total mass flow rates entering and leaving the system respectively
$\dot{m}_{in} - \dot{m}_{out} = \frac{dm_{sys}}{dt}$	*Continuous Flow Situation'* e.g. Milk pasteurisation with '*Just in Time'* Distribution. Where dm_{sys}/dt is the rate of mass accumulation (or mass depletion) within a system at a specific point in Kg/s.
$\sum_{i=1}^{K} \dot{m}_{i\ in} = \sum_{j=1}^{n} \dot{m}_{j\ out}$	Multi Stream Situation. Where $M_{\ i\ in}$ and $M_{\ j\ out}$ are the flow rates of streams 'i' and 'j' entering and leaving the system respectively.
$\sum_{i=1}^{K} X_i \dot{m}_{i\ in} = \sum_{j=1}^{n} X_j \dot{m}_{j\ out}$	Chemical Reaction Situation:- Where X_i is the mass fraction of a specific component in the 'entering stream' 'i', and X_j is the mass fraction of the same component in the 'exiting stream' 'j'.

Steady state is most common



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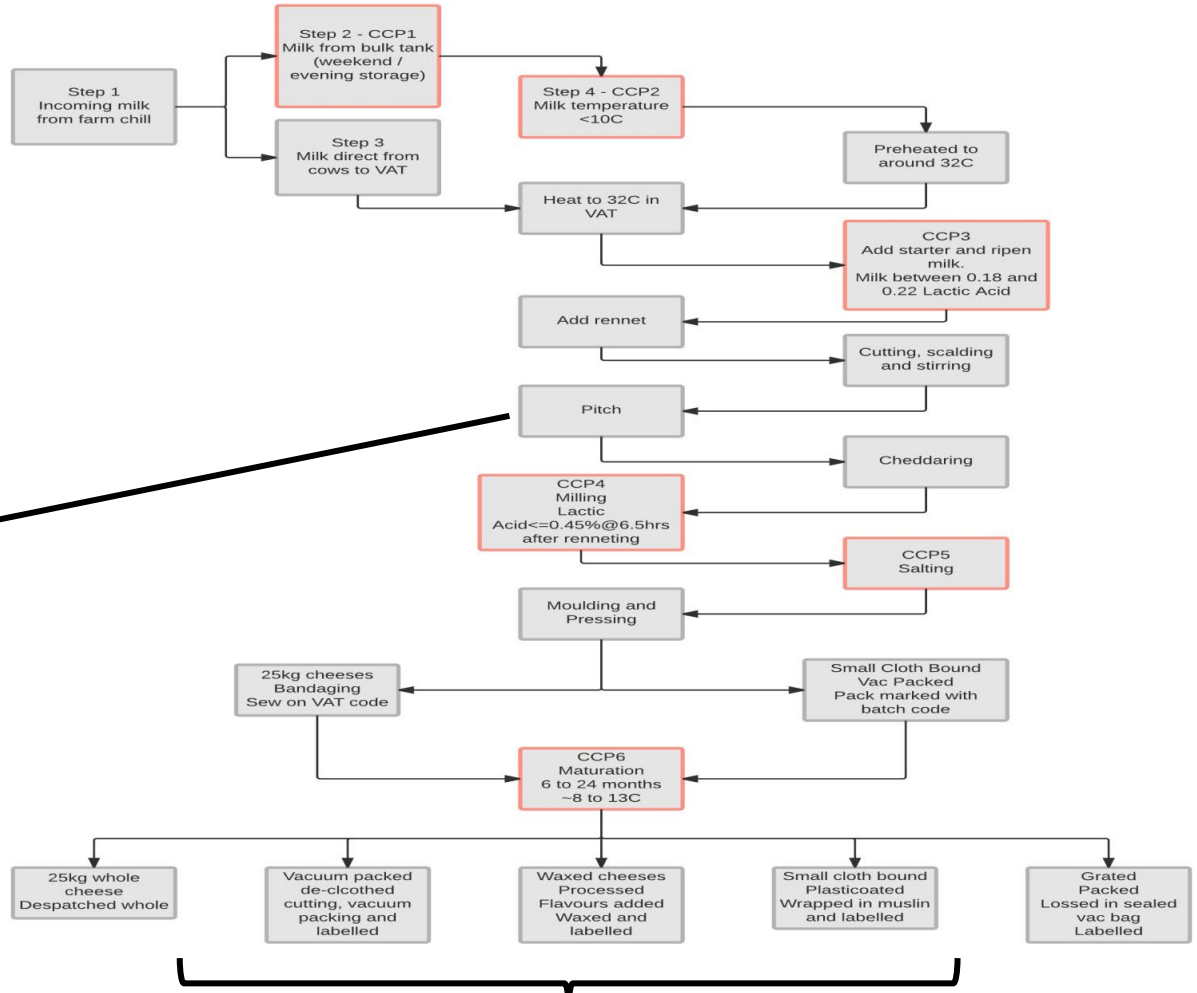
M_{in} = M_{out} ∴ $Milk_{in}$ = cheese out + whey out

M_{in} = Incoming Milk =

455L



248kg weigh

220kg

1 gallon milk makes 11lb cheese. Weight loss “approx 52%)

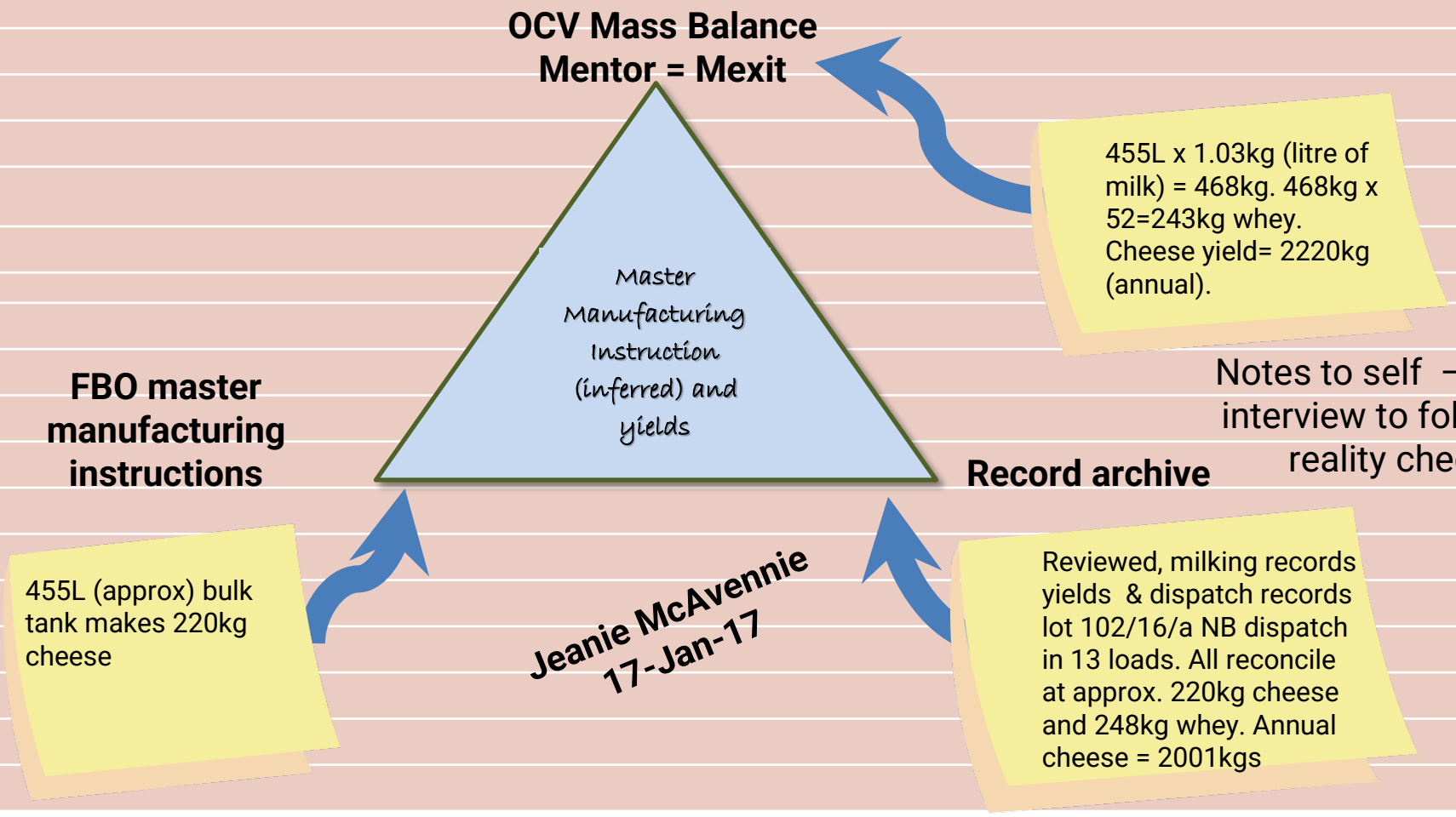
Jeanie McAvennie
17-Jan-17

∴ 4.55L makes 2.2kg cheese
∴ 445L = makes 220kg cheese ∴ weight loss should be 248 approx

seafish

Notes :- Triangulating FBO proposition re process control and composition.

Random number = 201 ∴ production day 201. Lot mark = 102/16/a (Sample size is 13 @ 95% confidence)



Notes to self – obs & interview to follow @ reality check

Strengths	Limitations / Points to Consider
• **If input/output data exists, this method can be relatively cost-effective; otherwise it can be costly** • **Can obtain estimates of FLW where no direct data exists (e.g.., estimate FLW from food supply and consumption)** • **Depending on how data are collected, may help identify waste hotspots (e.g.., food categories)**	• Can have large inaccuracies depending on the type of data available • Difficult to estimate uncertainties • Requires quantification of all major flows of food (e.g.., food going to feed animals) • Difficult to apply if there is substantial addition or removal of water (e.g.., evaporation of water during cooking) • May be difficult to determine root causes

seafish

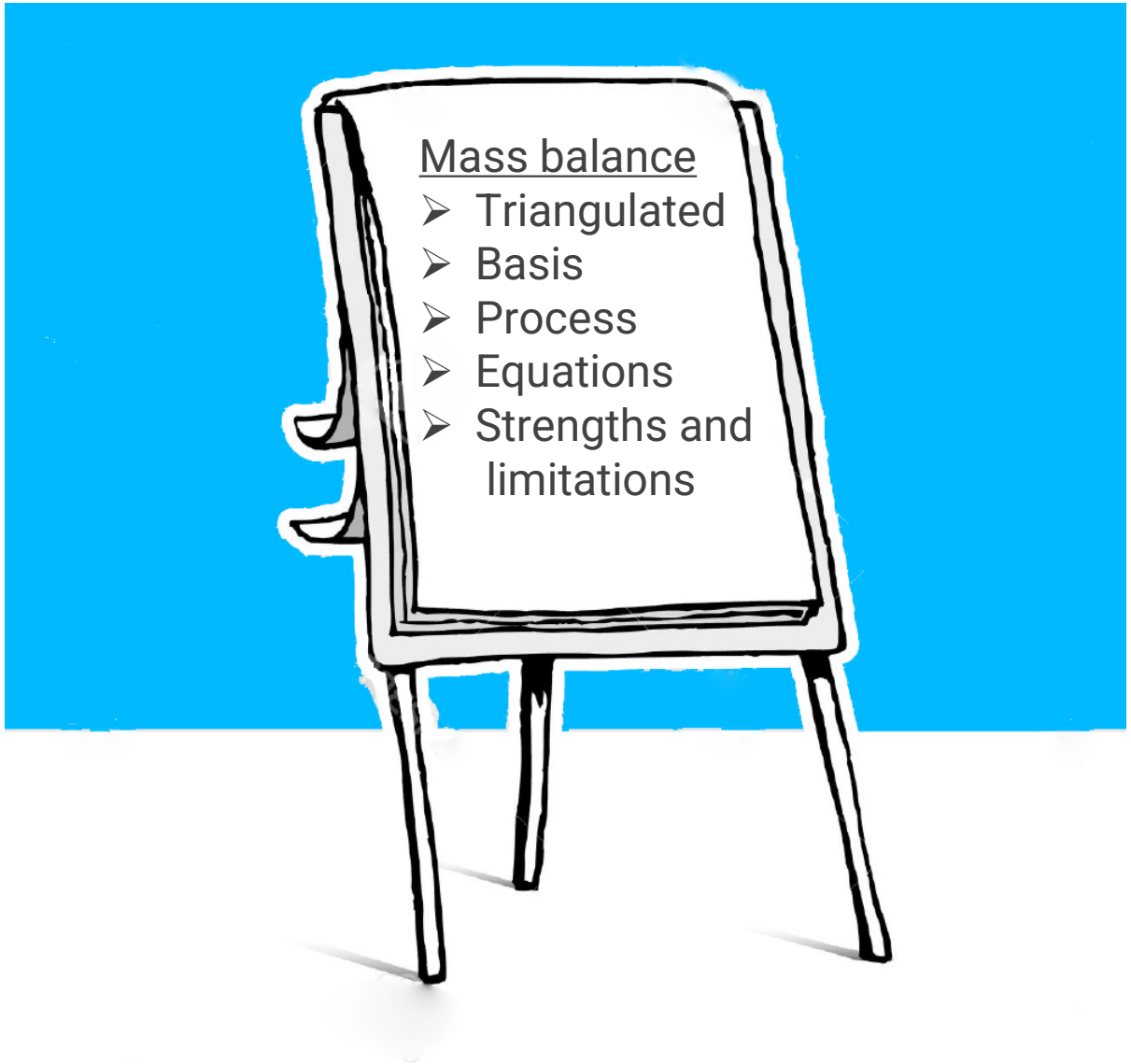
Exercise – a mass balance


Ploys and hacks

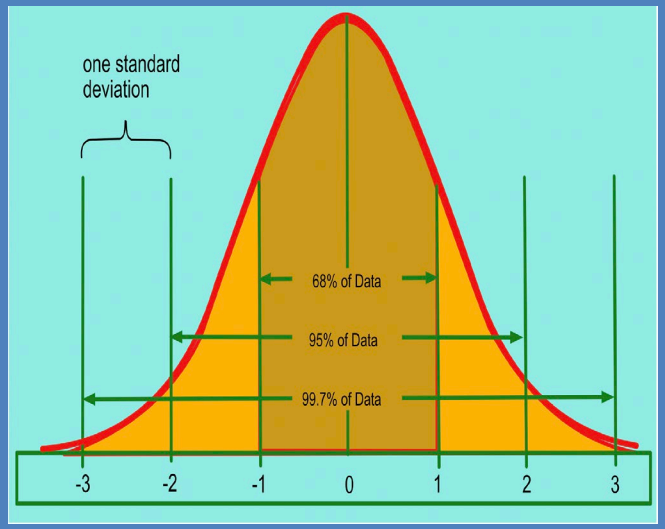
Overlaps

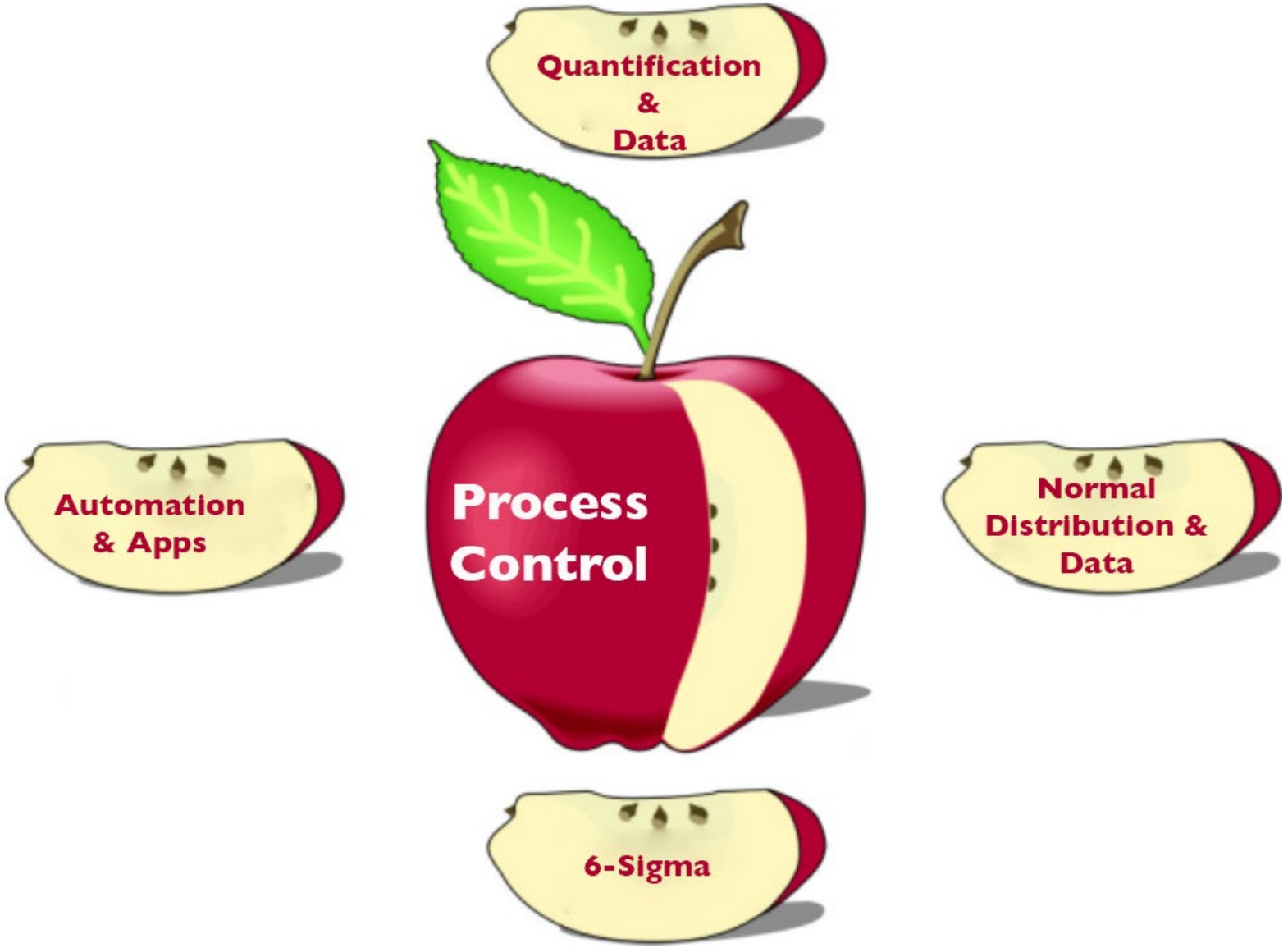
- Yields – mass balances, traceability – product recall

Mass balance summary



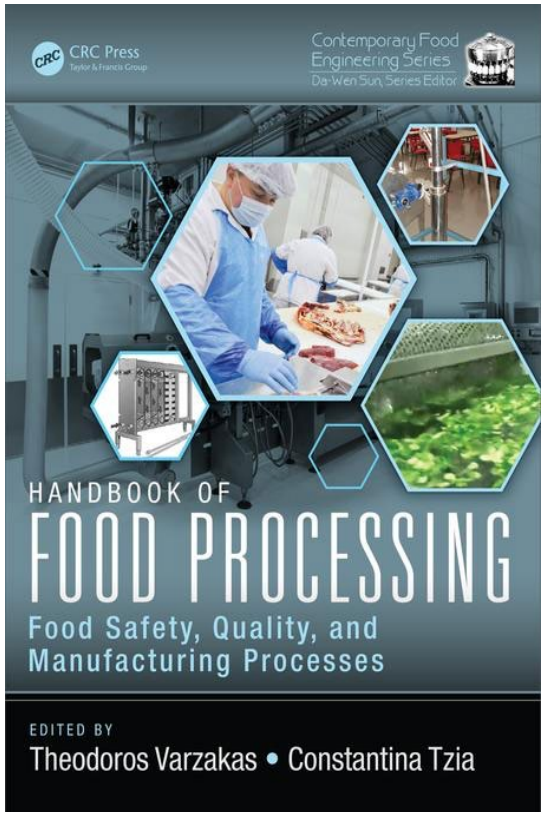
EMOs and process control

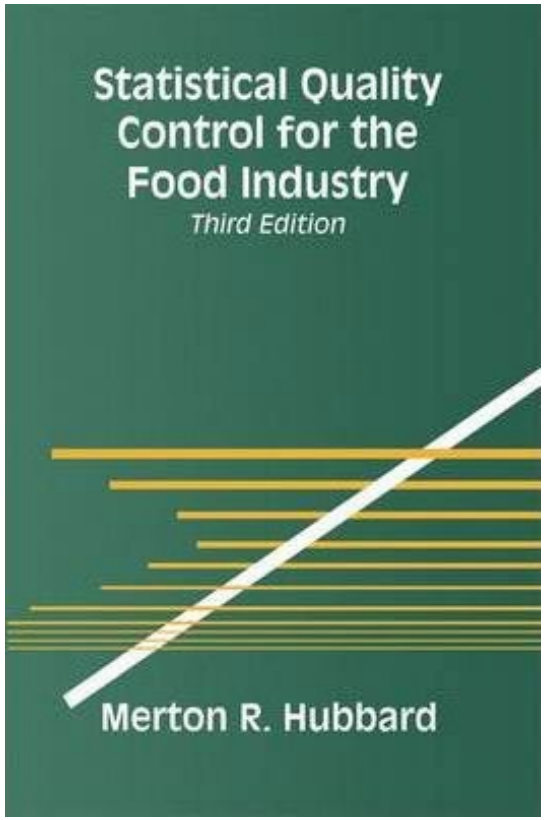


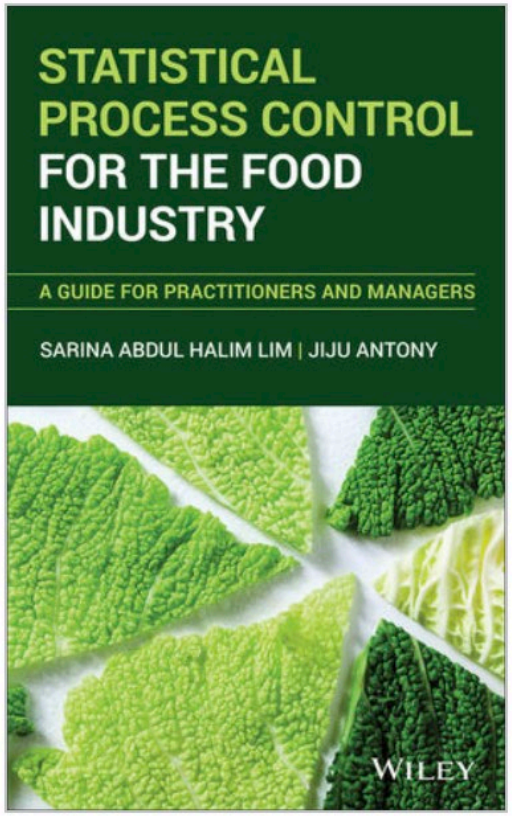

Quantification
&
Data
Automation
& Apps
Process
Control
Normal
Distribution &
Data
6-Sigma

Process control overview

Sources







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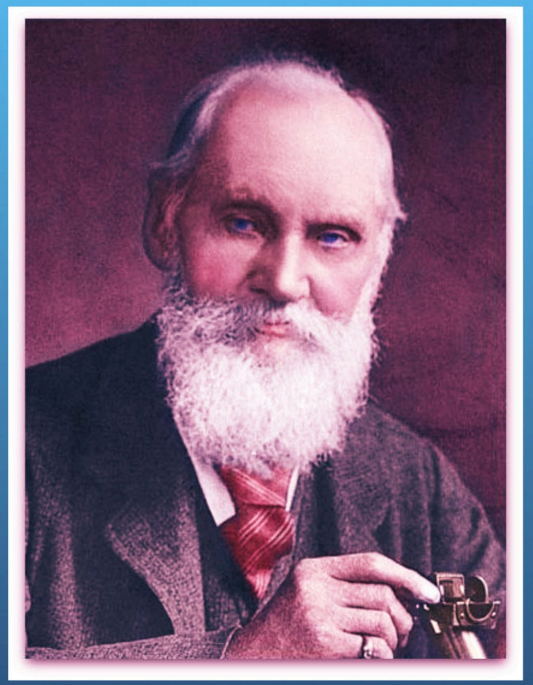
Quantification

Lord Kelvin on quantification and scientific knowledge



I often say when you can measure what you are speaking about, and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

Lecture on "Electrical Units of Measurement" (3rd May 1883) published in Popular Lectures

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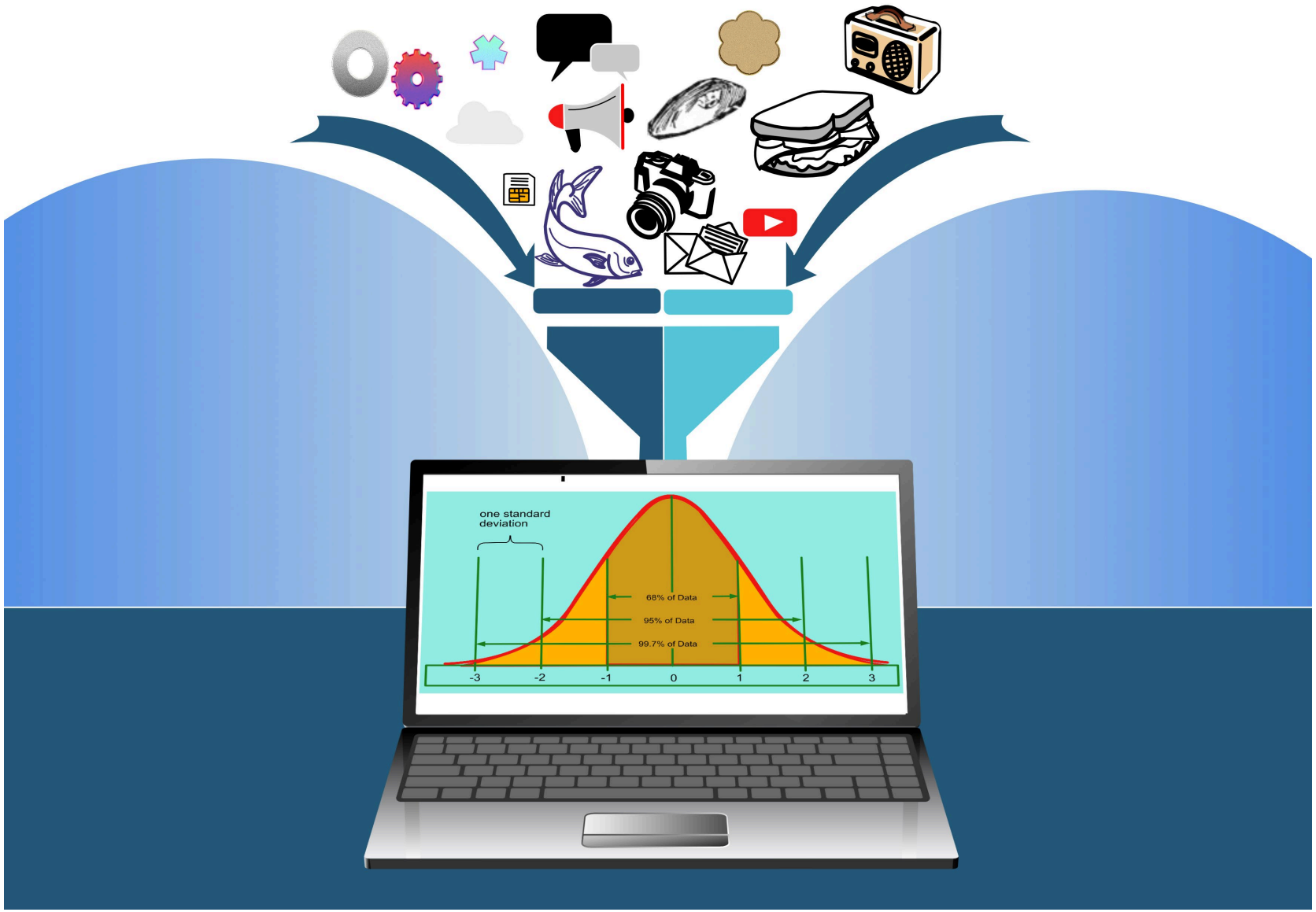
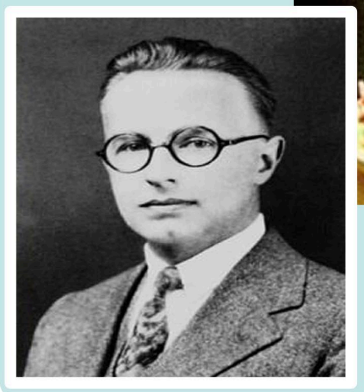
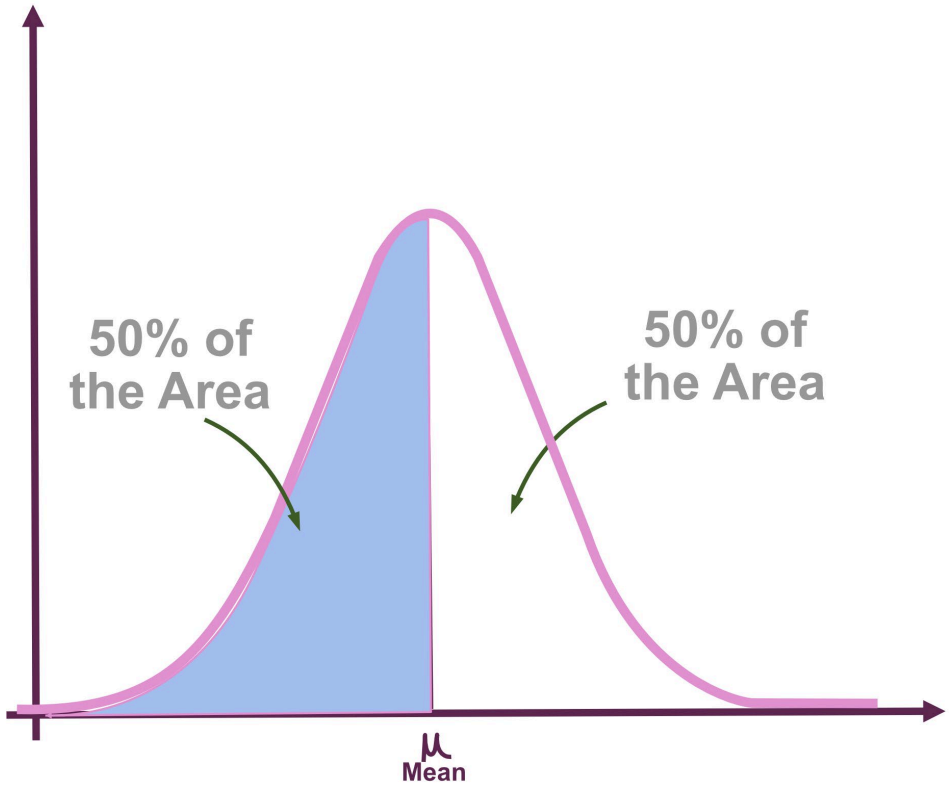

one standard deviation
68% of Data
95% of Data
99.7% of Data
-3
-2
-1
0
1
2
3

Statistical Process Control

改善

Kai =Change **Zen = Good**





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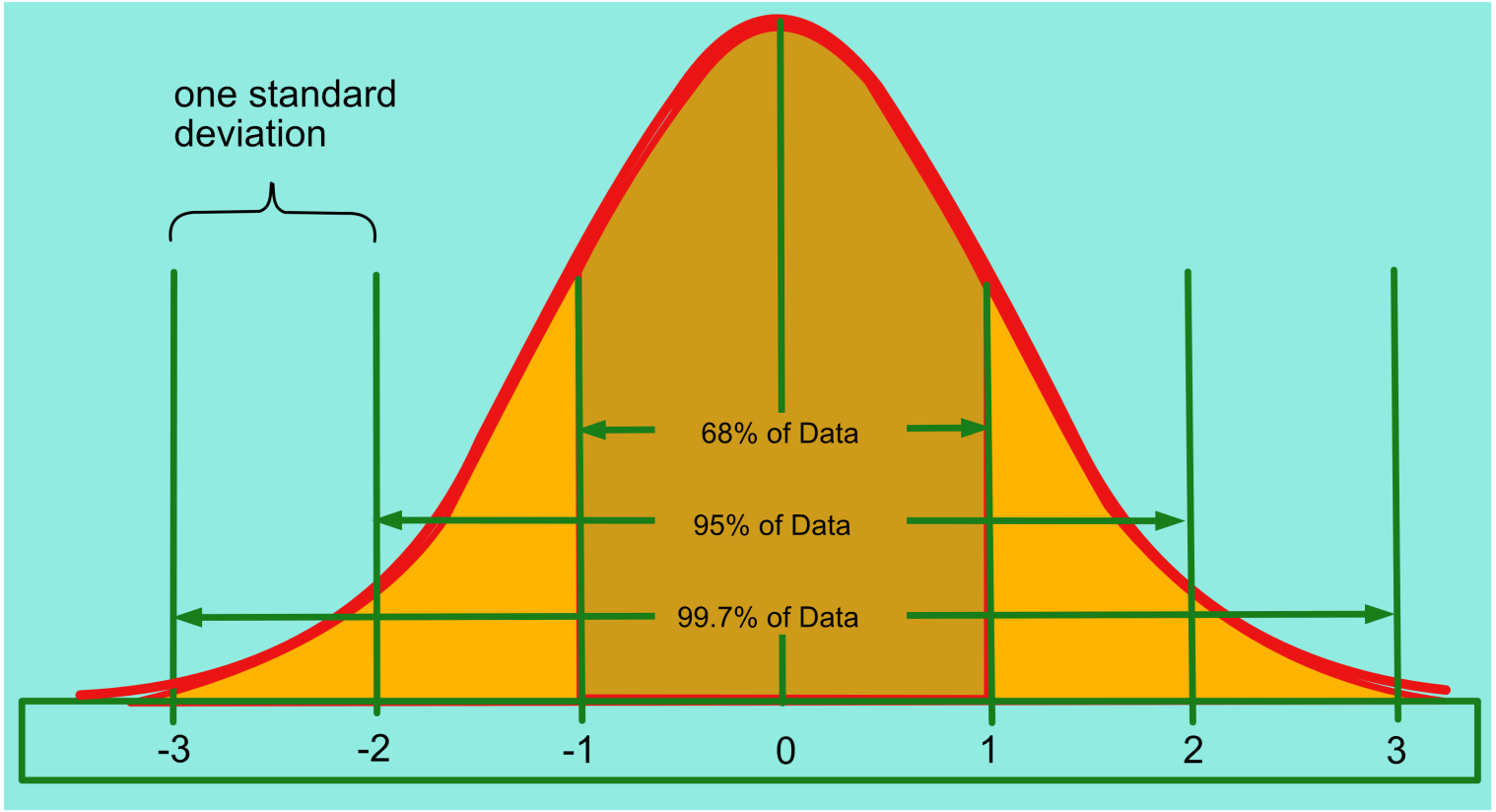
The Empirical Rule



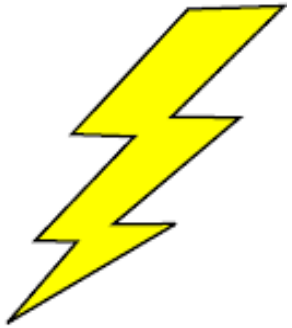
Common cause and special cause variation

Common cause variation

- A source of **variation caused** by unknown factors that result in a steady but random distribution of output around the mean/average of the data. **Common cause variation** is a measure of the process's potential, or how well the process can perform when **special cause variation** is removed.

Special cause variation

- **Special cause variability** is a shift in output caused by a specific known factors such as environmental conditions or processing errors. It is insidious but can be accounted for directly and potentially removed. It is a **measure of process control.** Also referred to as “**exceptional**” or “**assignable**” variation.



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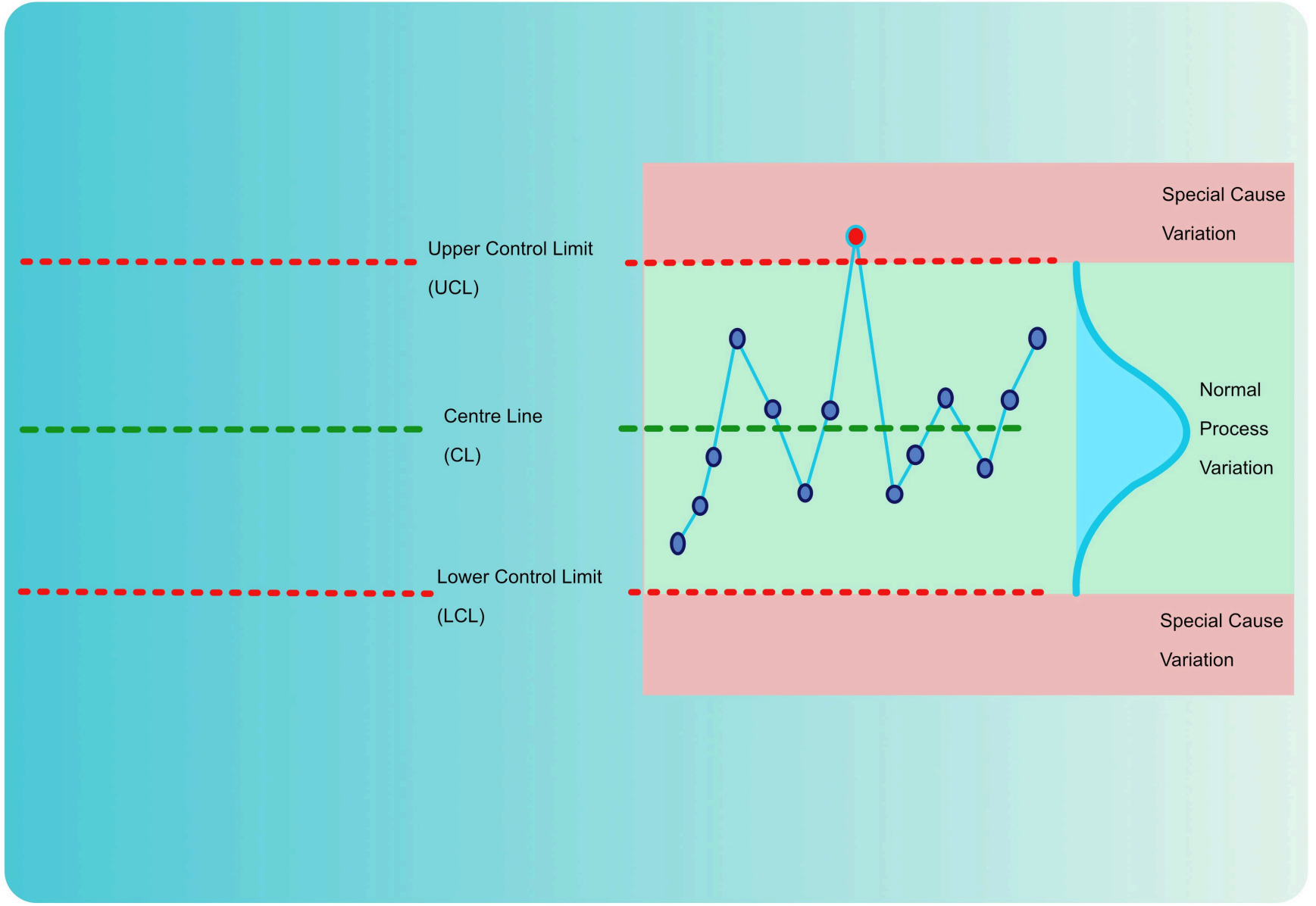
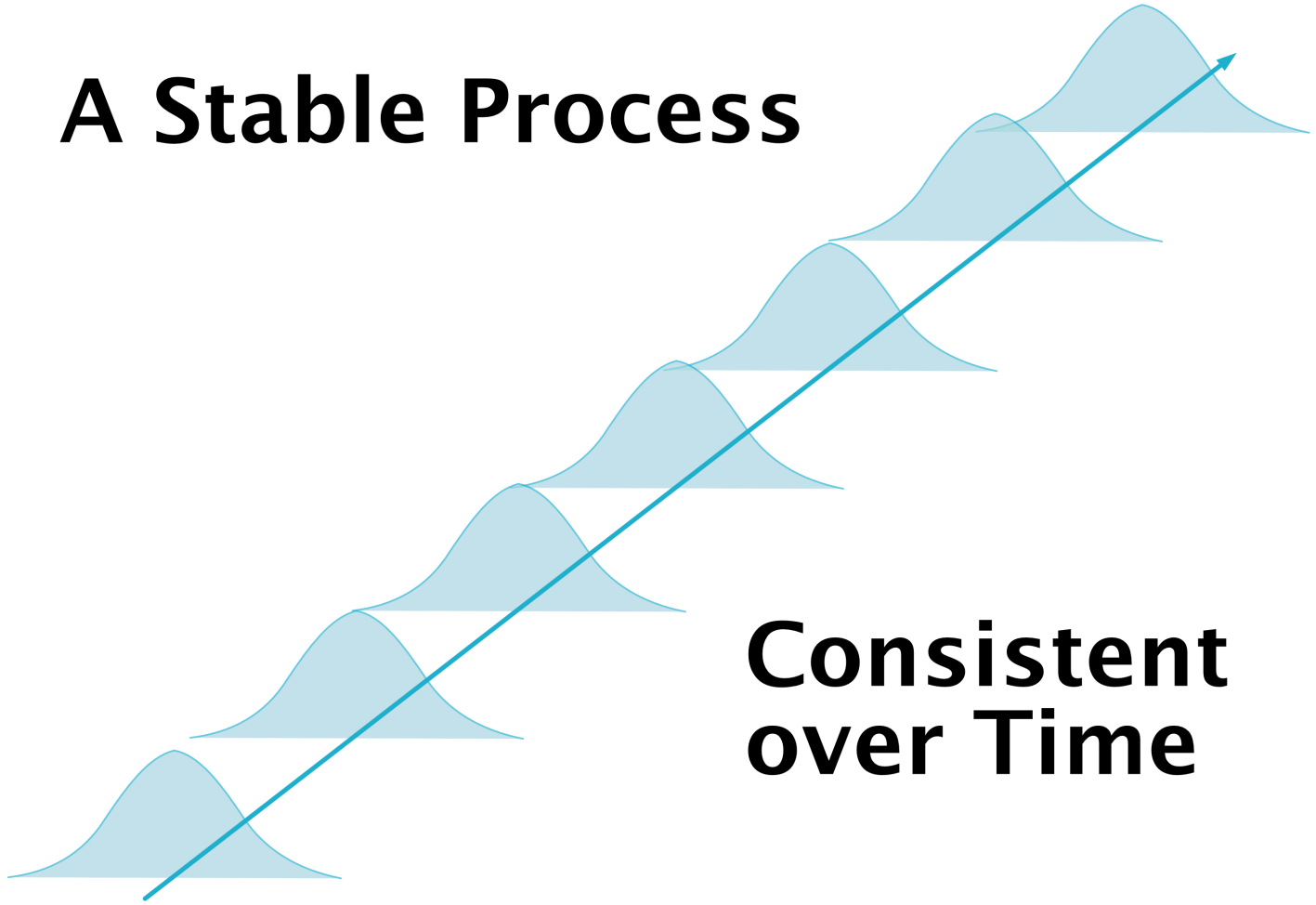

Special Cause
Variation
Upper Control Limit
(UCL)
Centre Line
(CL)
Normal
Process
Variation
Lower Control Limit
(LCL)
Special Cause
Variation

A Stable Process



Consistent
over Time

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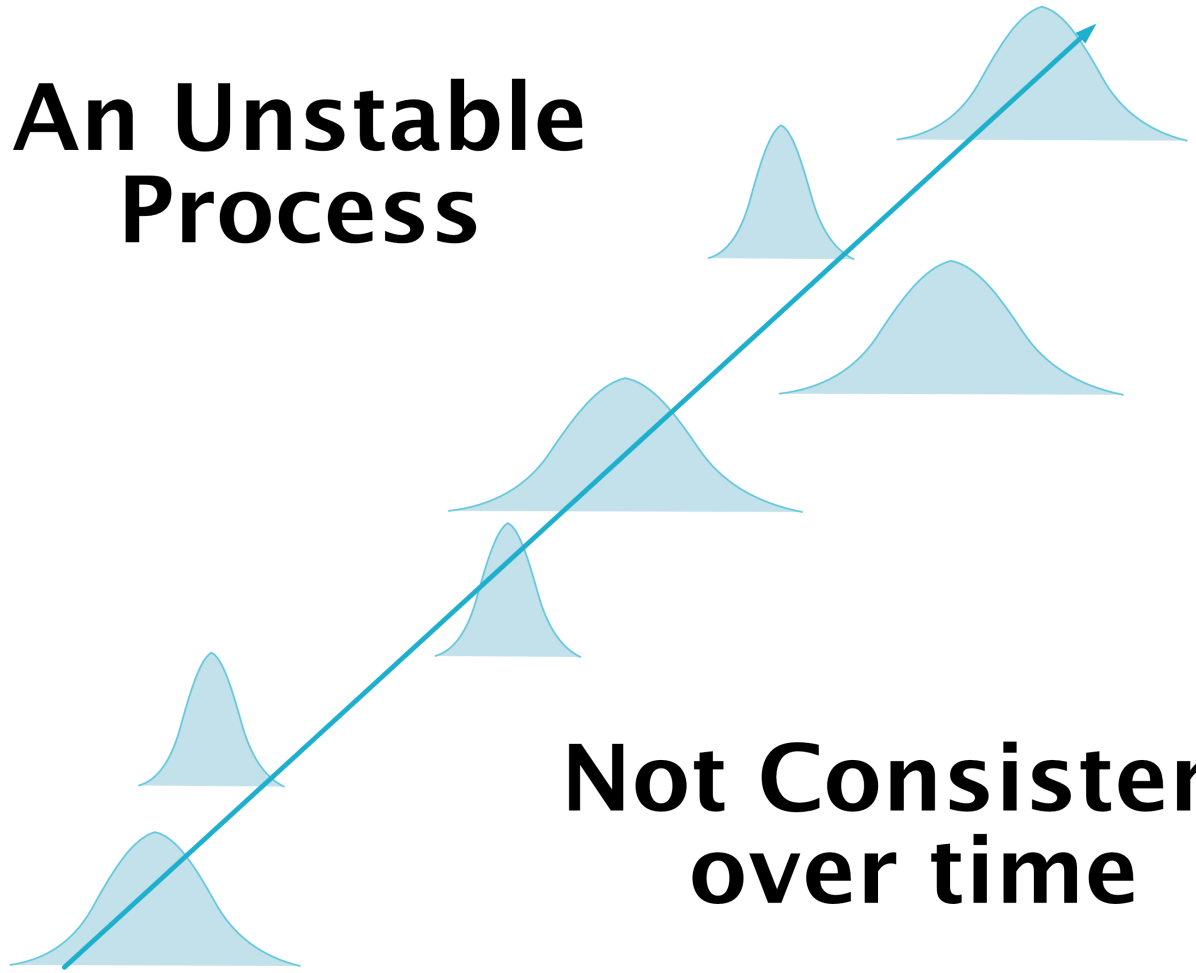
An Unstable Process



Not Consistent over time

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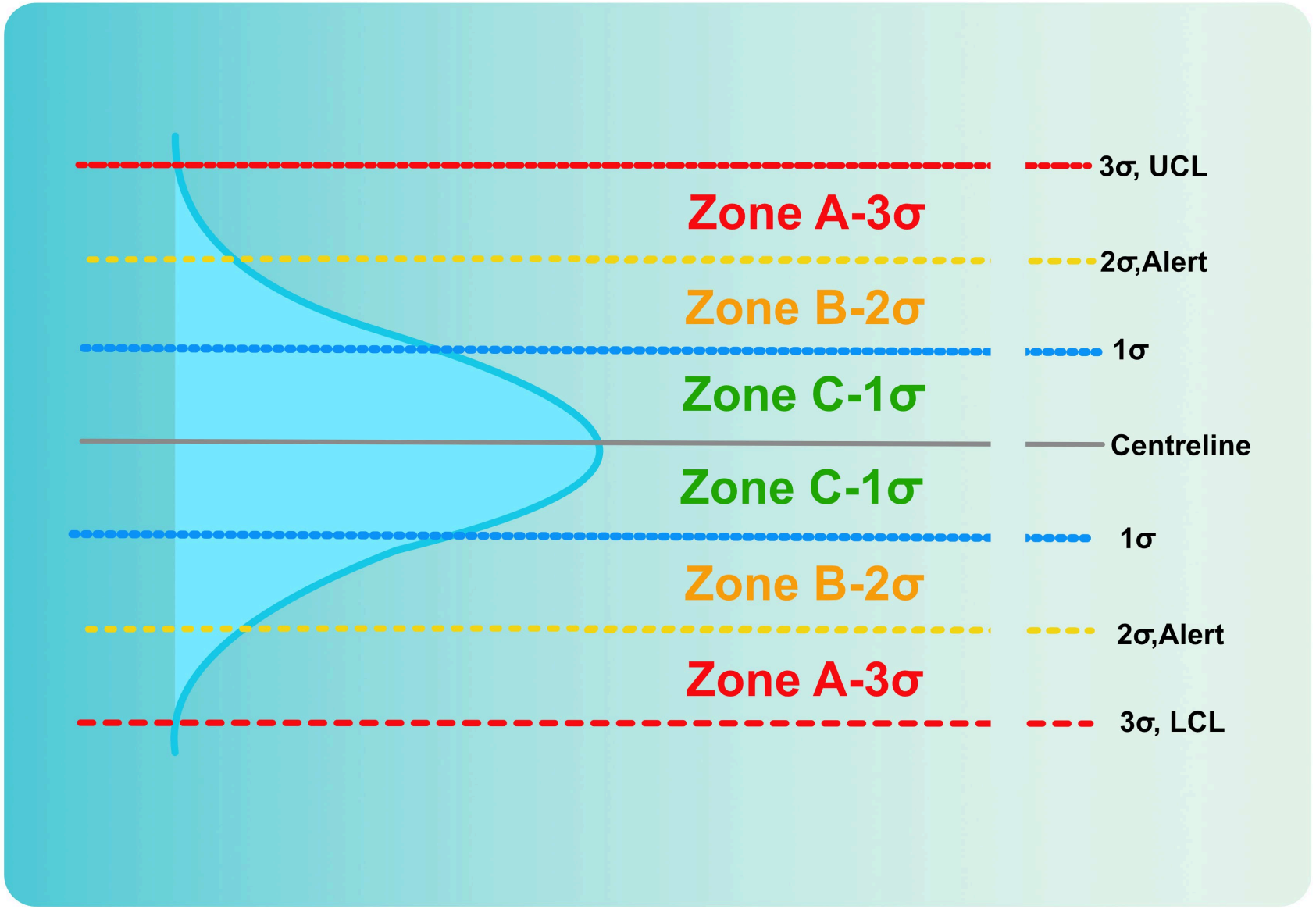
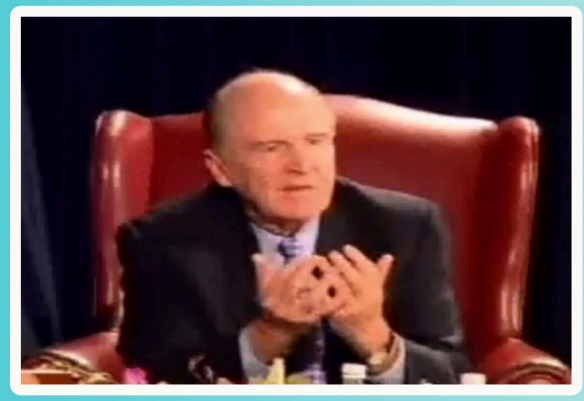

3σ, UCL
Zone A-3σ
2σ,Alert
Zone B-2σ
1σ
Zone C-1σ
Centreline
Zone C-1σ
1σ
Zone B-2σ
2σ,Alert
Zone A-3σ
3σ, LCL

Bill Smith



Jack Welch

6σ SIX SIGMA

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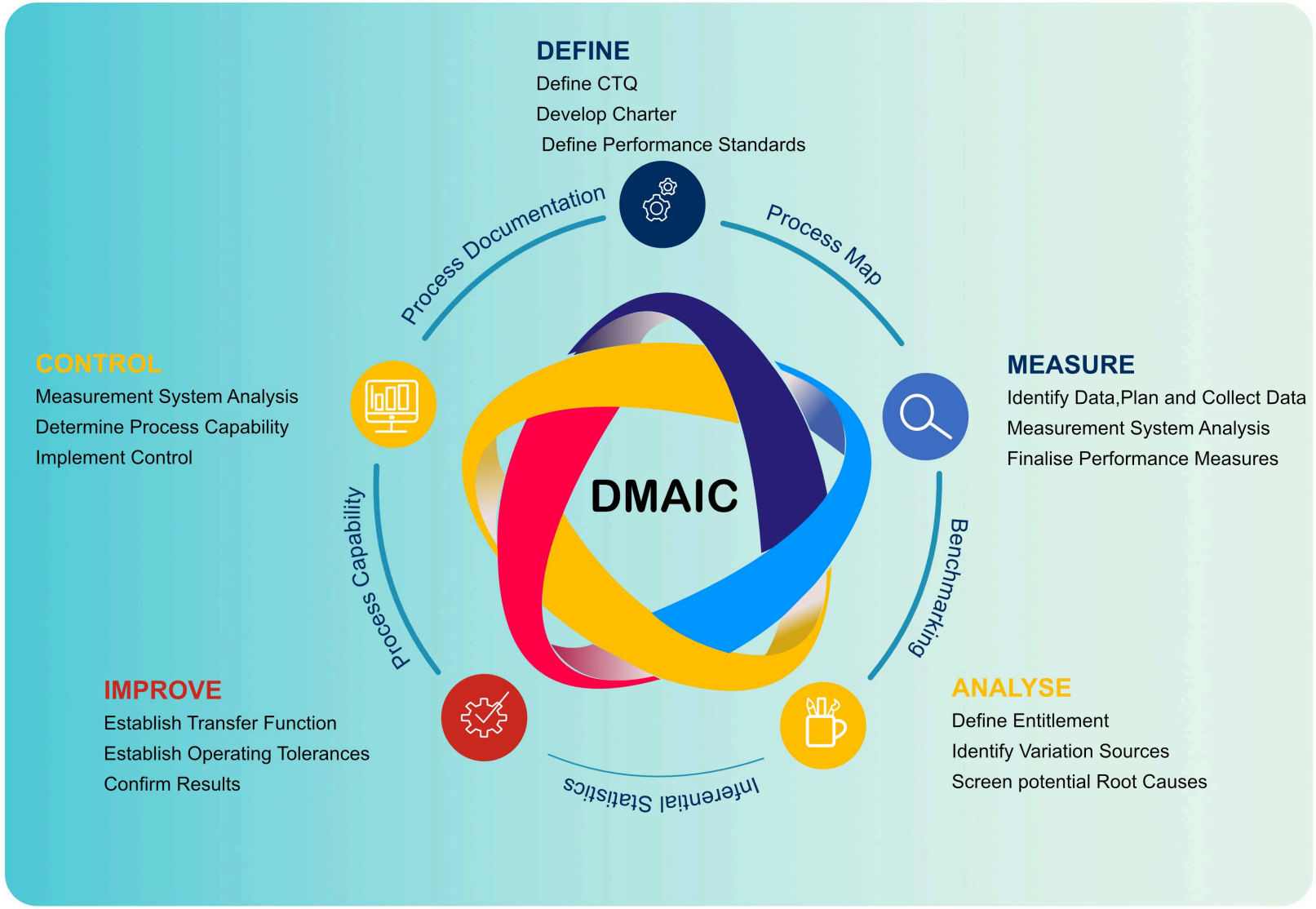
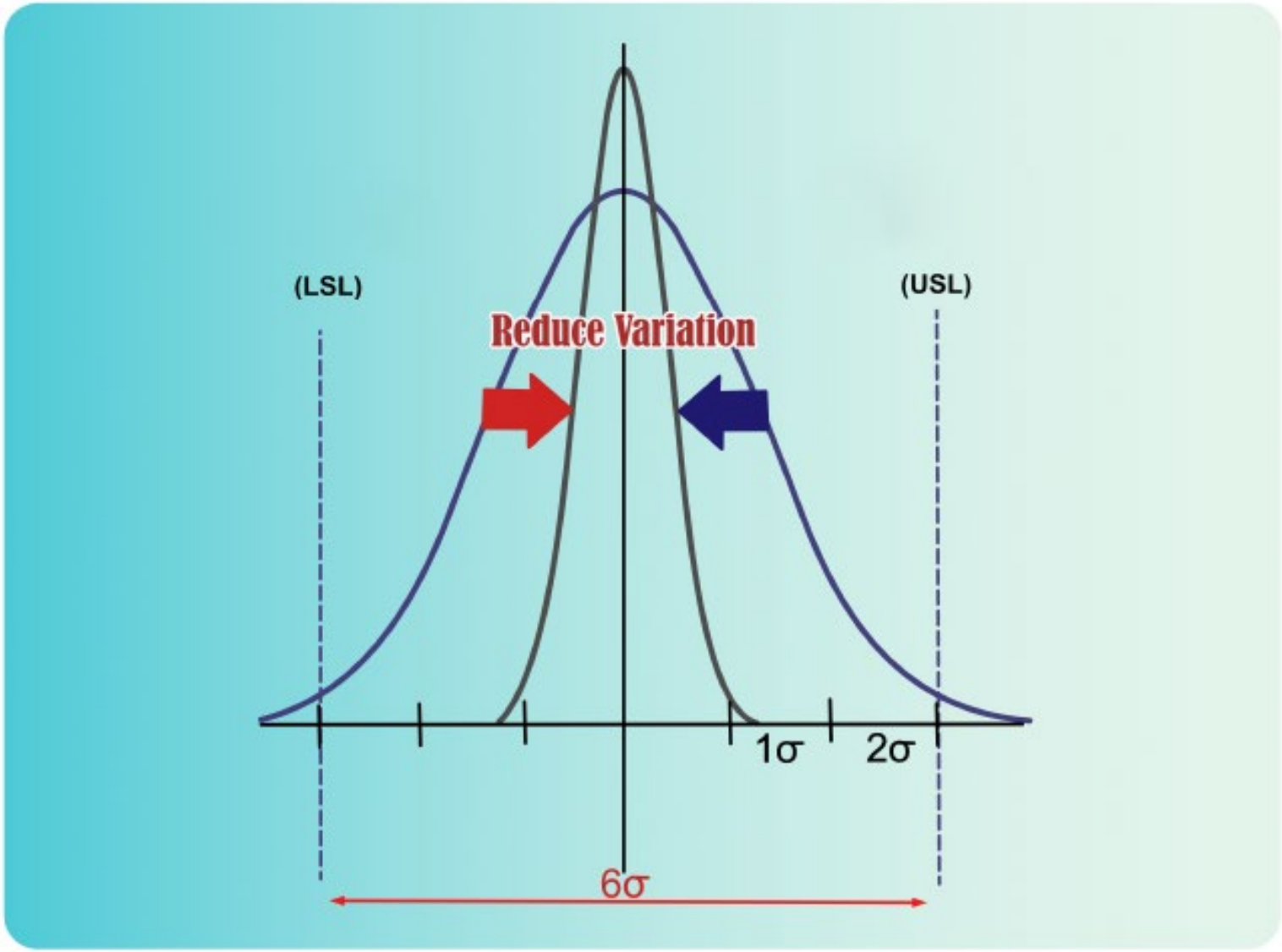
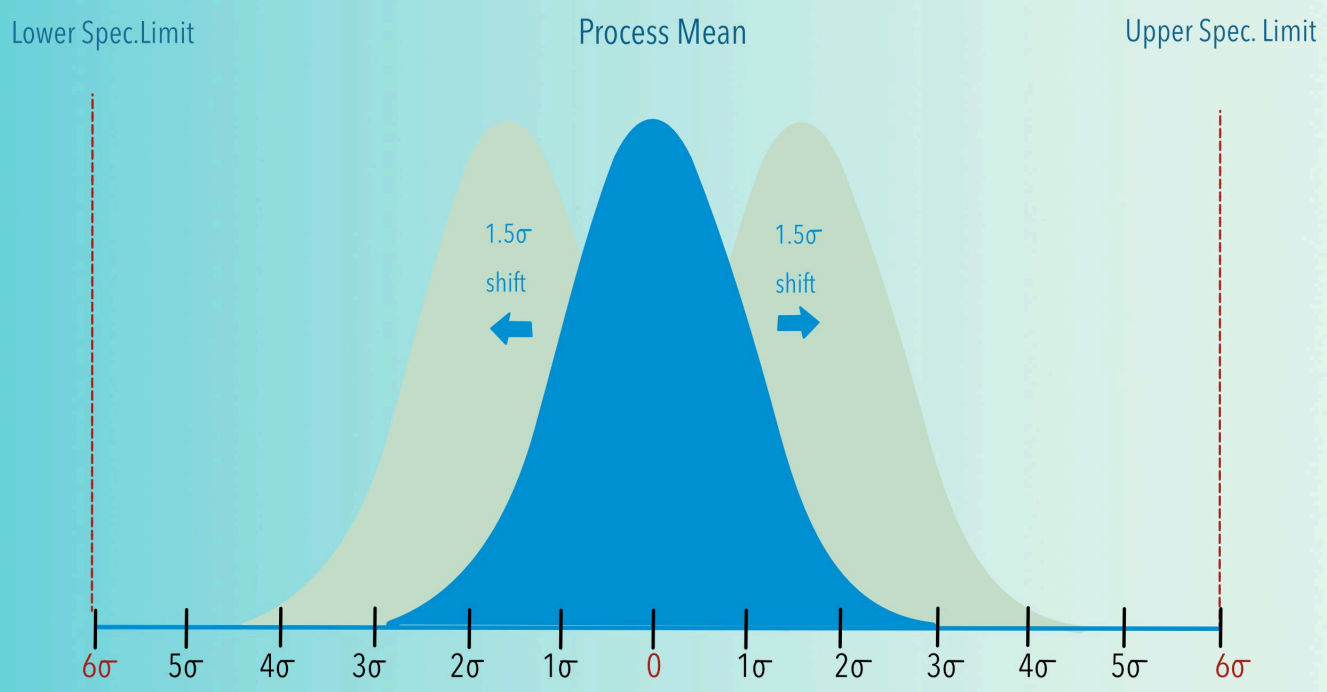

DEFINE
Define CTQ
Develop Charter
Define Performance Standards
Process Documentation
Process Map
CONTROL
Measurement System Analysis
Determine Process Capability
Implement Control
MEASURE
Identify Data,Plan and Collect Data
Measurement System Analysis
Finalise Performance Measures
DMAIC
Process Capability
Benchmarking
IMPROVE
Establish Transfer Function
Establish Operating Tolerances
Confirm Results
Inferential Statistics
ANALYSE
Define Entitlement
Identify Variation Sources
Screen potential Root Causes


(LSL)
(USL)
Reduce Variation
1σ
2σ
6σ

Six Sigma Statistically Visualised

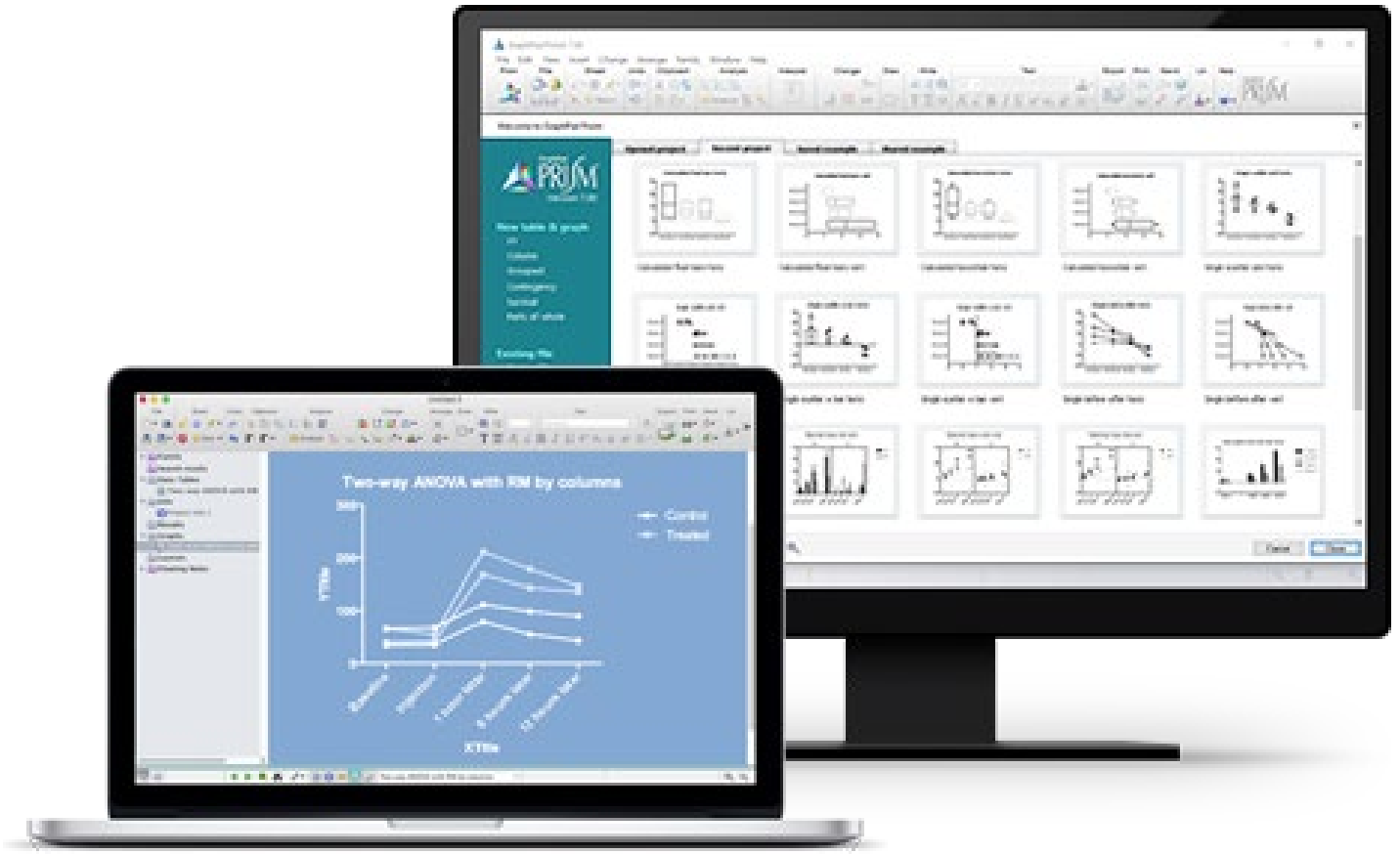


The term Six Sigma is based on a statistical concept defective items can be minimised by maintaining 6 standard deviations (6 Sigmas) between the process mean(average)and its Upper and lower specifications

seafish


Ploys and hacks

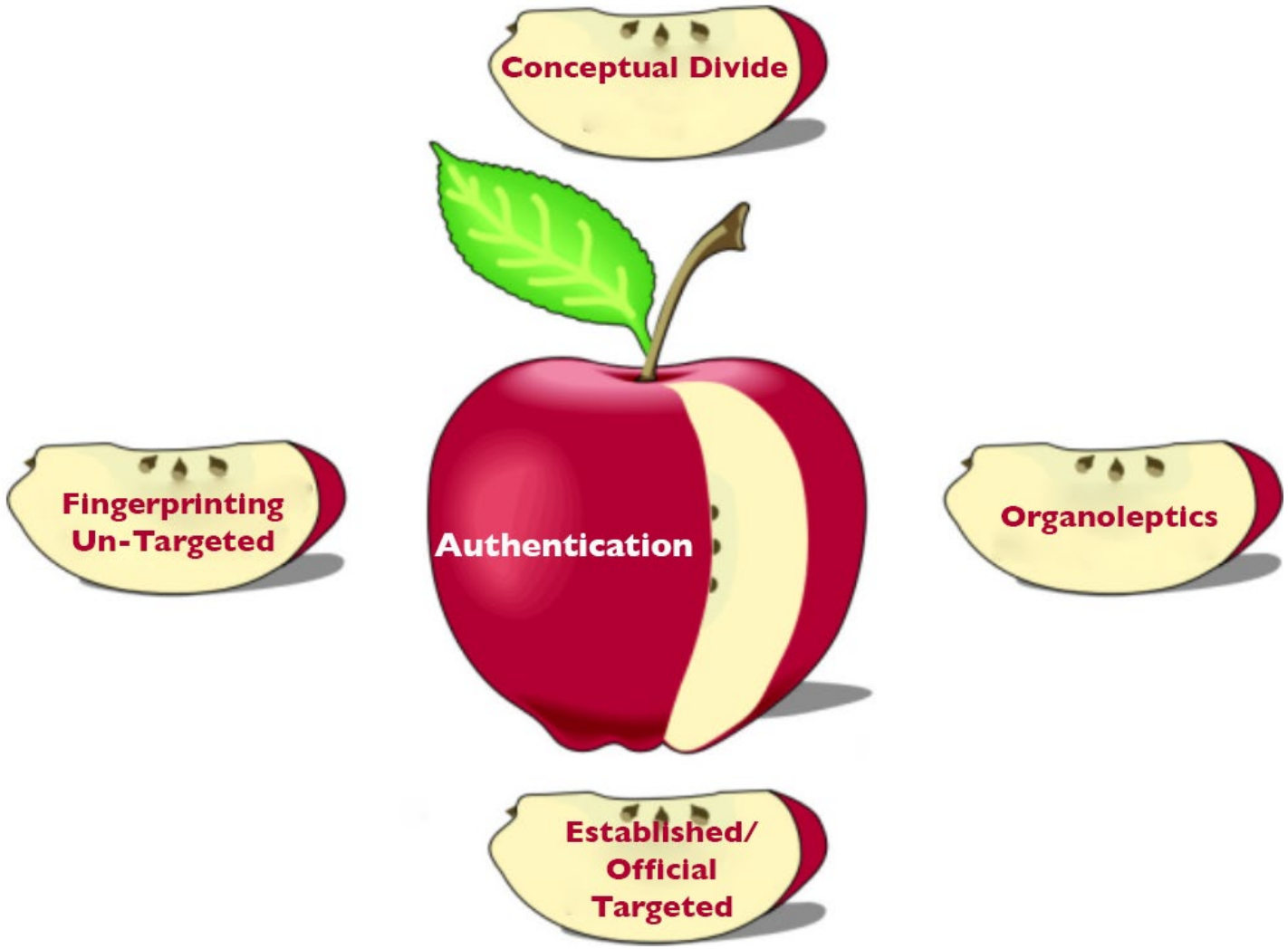
Graph Pad – www.graphpad.com



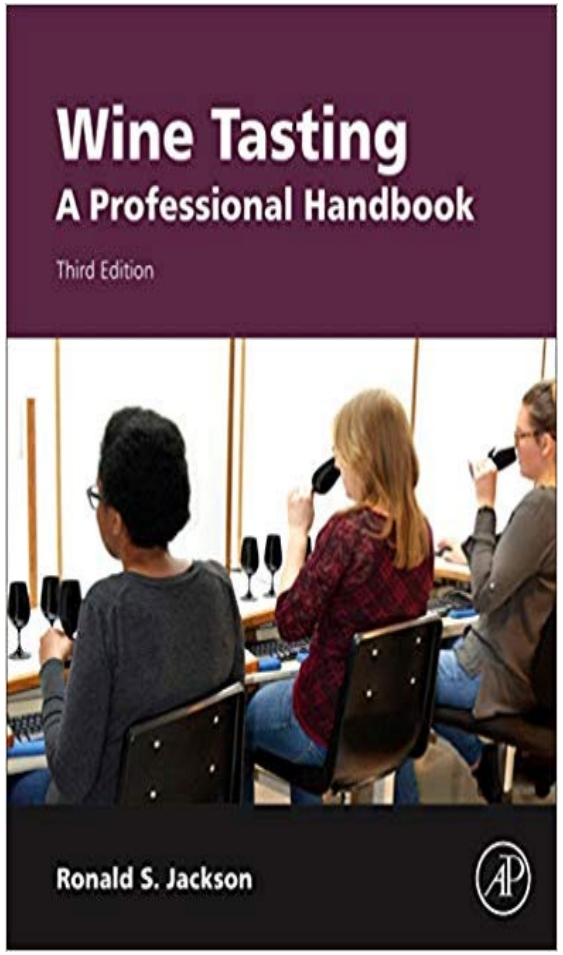
Process control summary

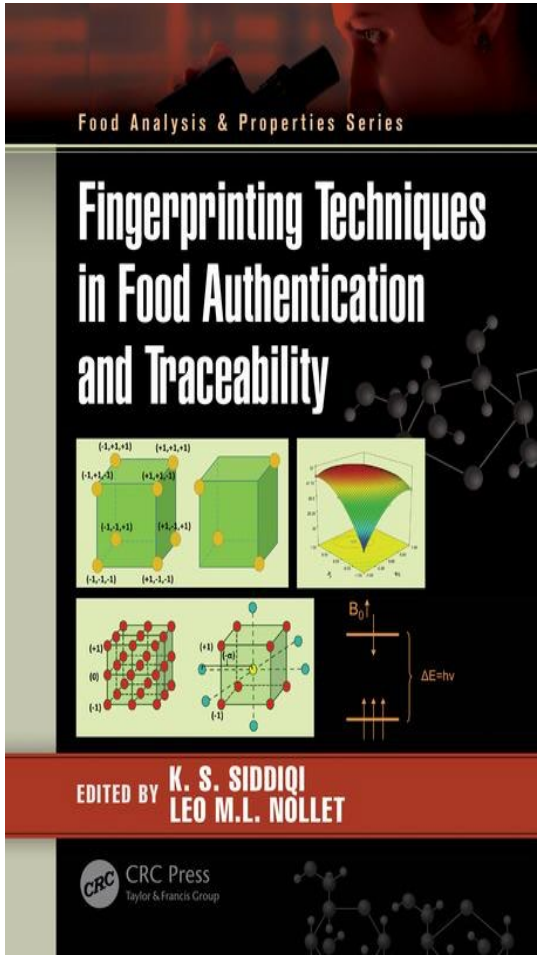
Authentication

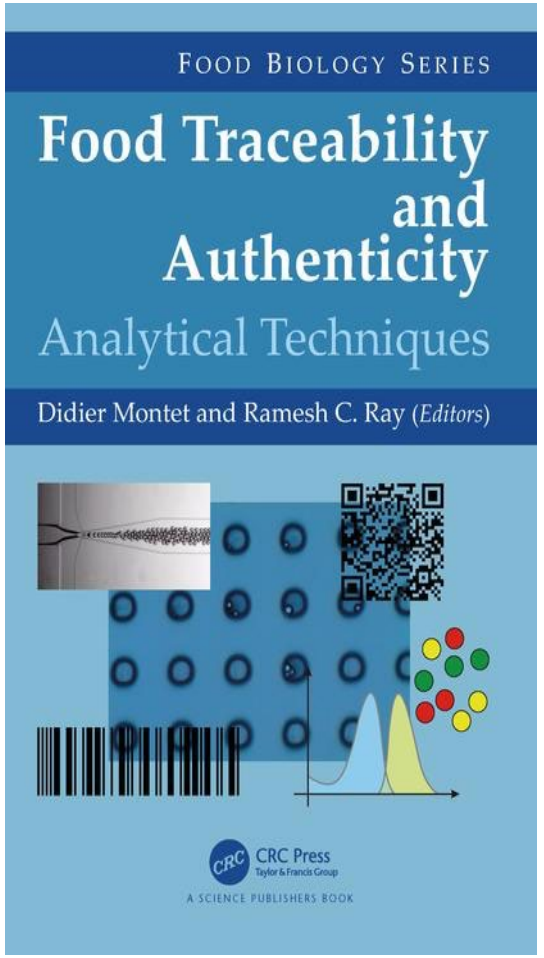
Authentication overview

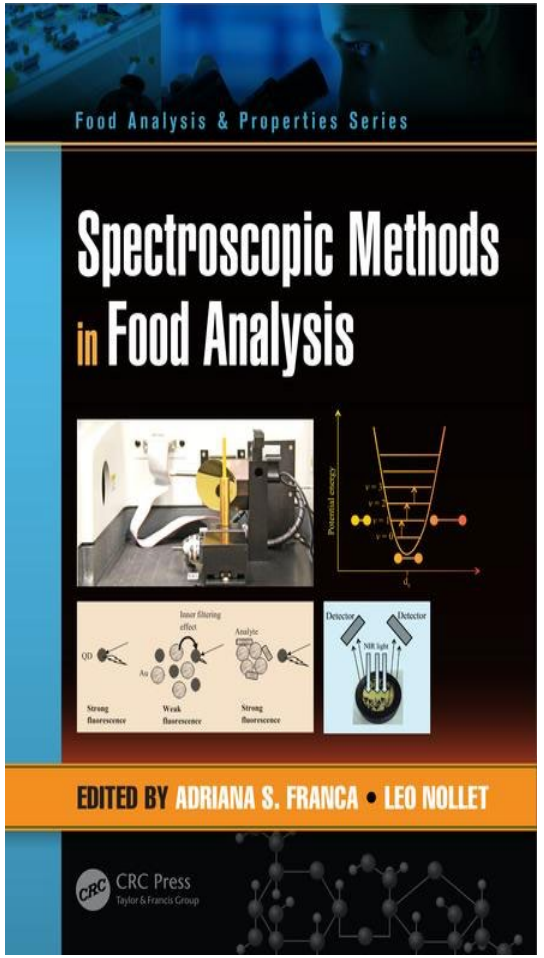

Conceptual Divide
Fingerprinting
Un-Targeted
Authentication
Organoleptics
Established/
Official
Targeted

Sources

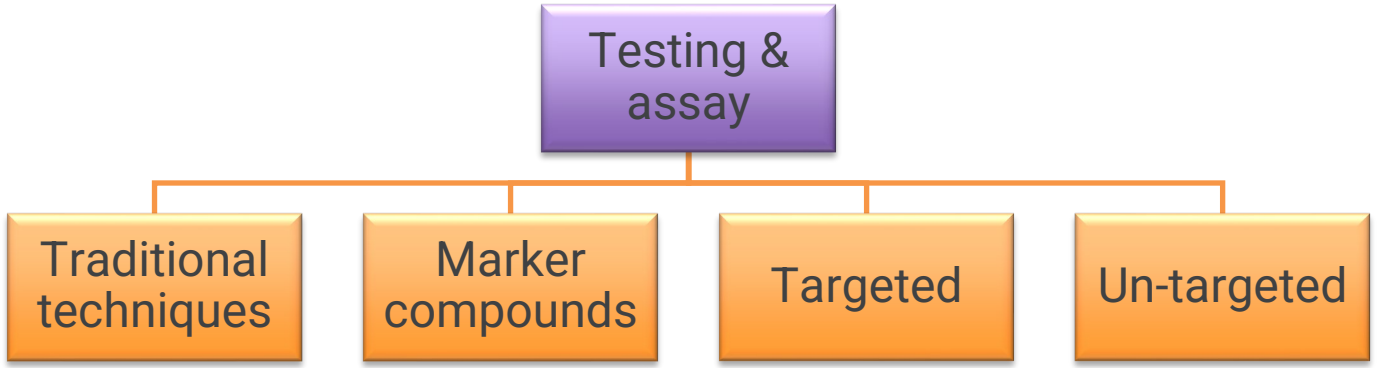

Wine Tasting
A Professional Handbook
Third Edition
Ronald S. Jackson


Food Analysis & Properties Series
Fingerprinting Techniques in Food Authentication and Traceability
EDITED BY K. S. SIDDIQI LEO M.L. NOLLET
CRC Press
Taylor & Francis Group

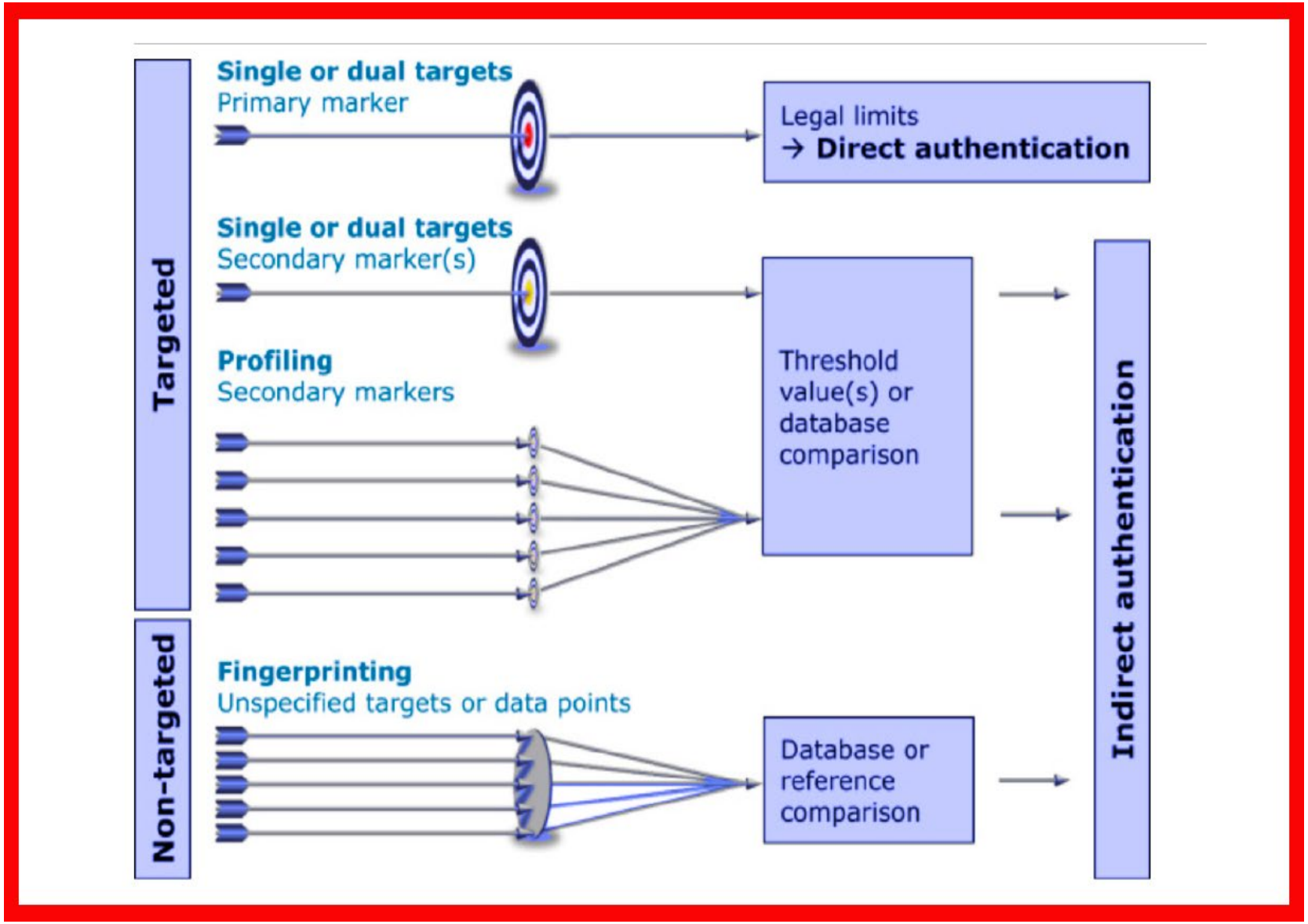

Food Biology Series
Food Traceability and Authenticity
Analytical Techniques
Didier Montet and Ramesh C. Ray (Editors)
CRC Press
Taylor & Francis Group
A SCIENCE PUBLISHERS BOOK


Food Analysis & Properties Series
Spectroscopic Methods in Food Analysis
EDITED BY ADRIANA S. FRANCA • LEO NOLLET
CRC Press
Taylor & Francis Group

Conceptual divide



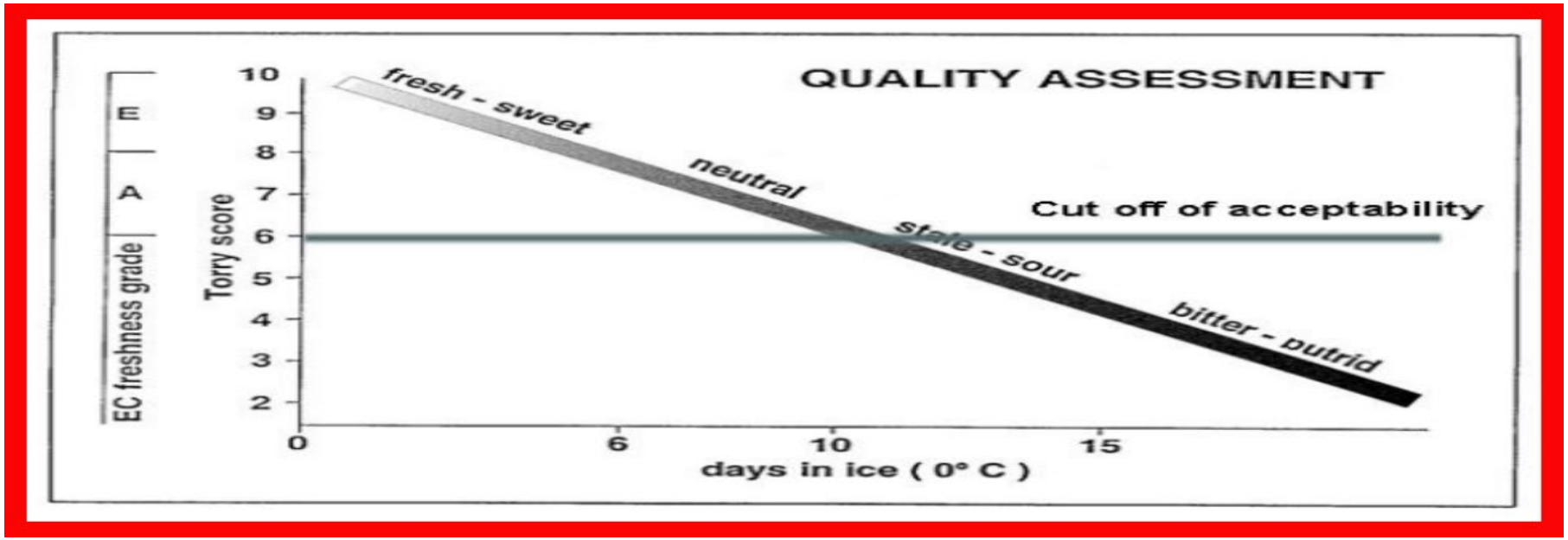
Forensics – targeted vs un-targeted analysis



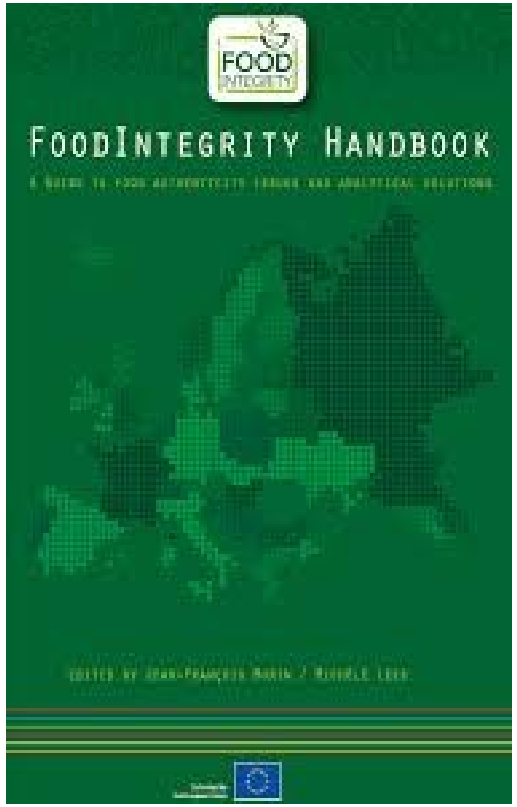
Simple quantification

Organoleptics

Organoleptics



Targeted authentication



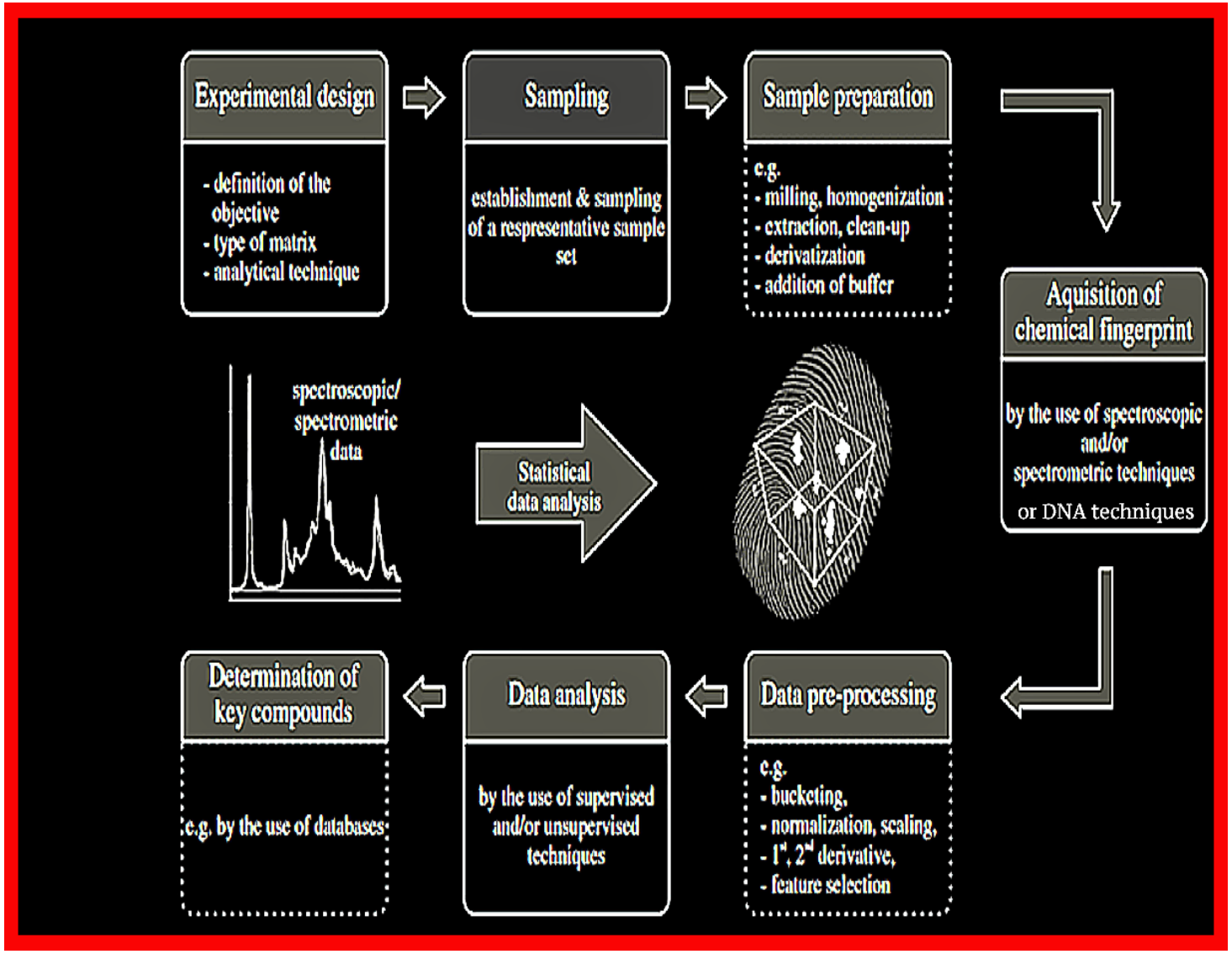
4. Overview of methods for authenticity testing

The following tables provide a summary of the official and commonly used methods respectively and the authenticity issues they address.

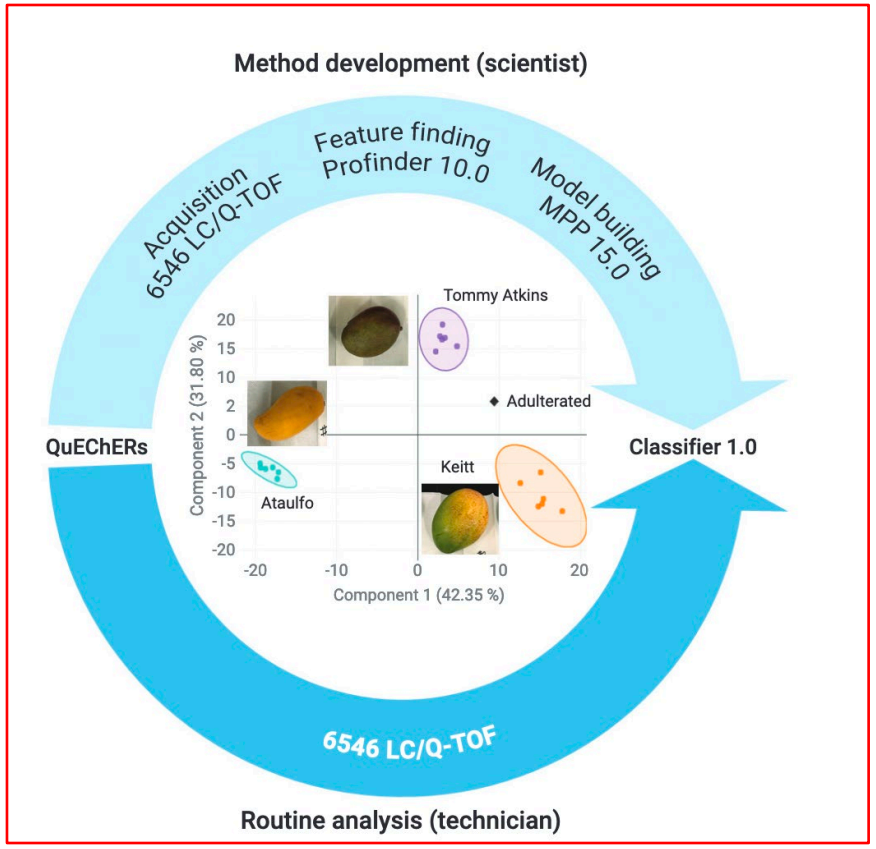
Table 3: Official methods for authenticity testing of meat and meat products

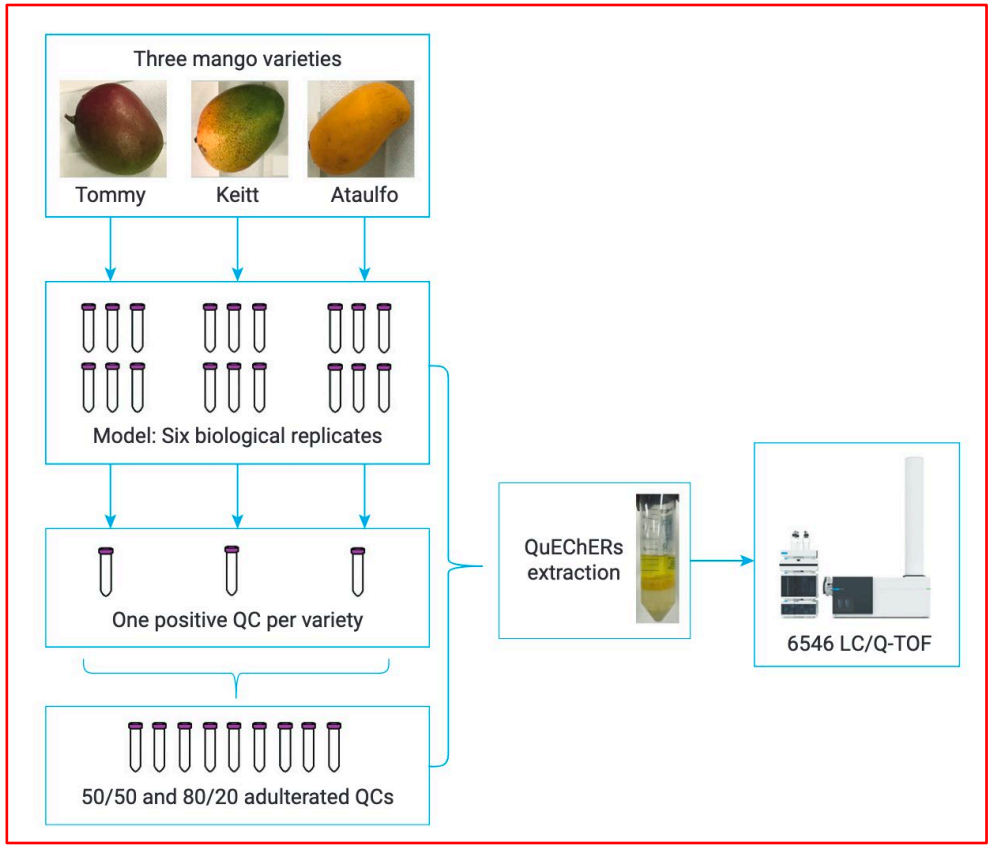
Analytical technique	Indicative data or analyte	Authenticity issue / information
Multiplex PCR	Molecular biomarker	Species substitution
ORBIT (overnight rapid bovine identification test)	Antibodies and antigens	Species substitution
PROFIT (poultry rapid overnight field identification test)	Antibodies and antigens	Species substitution
Kjeldahl	Nitrogen content	Protein substitution
Automated dye binding	Protein content	Protein substitution
Combustion method	Crude protein	Protein substitution
ELISA	Soy proteins	Protein substitution
Gravimetric method	Total fat content	Fat substitution
Colorimetric method	Nitrites and nitrates	Addition of nitrites and nitrates
Spectroscopic method	Nitrites and nitrates	Addition of nitrites and nitrates
Fluorimetric method	Total vitamin C	Addition of ascorbic acid
Spectrometric method	Total phosphorus content	Addition of phosphorus and polyphosphates
Thin layer chromatographic separation	Linear condensed phosphates	Addition of phosphorus and polyphosphates
Gravimetric method	Total phosphorus content	Addition of phosphorus and polyphosphates
Spectroscopic method	Total phosphorus content	Addition of phosphorus and polyphosphates
Thin layer chromatographic method	Synthetic, water-soluble colouring agents	Addition of colouring agents
Titrimetric method	Sulphurous acid (free form)	Addition of sulphur dioxide
Spectroscopic method	Sorbates, ascorbates, benzoates, sulphites	Addition of preservatives
Gravimetric method	Water	Addition of water
Nuclear magnetic resonance	Water	Addition of colouring agents, aromas and preservatives

Fingerprinting

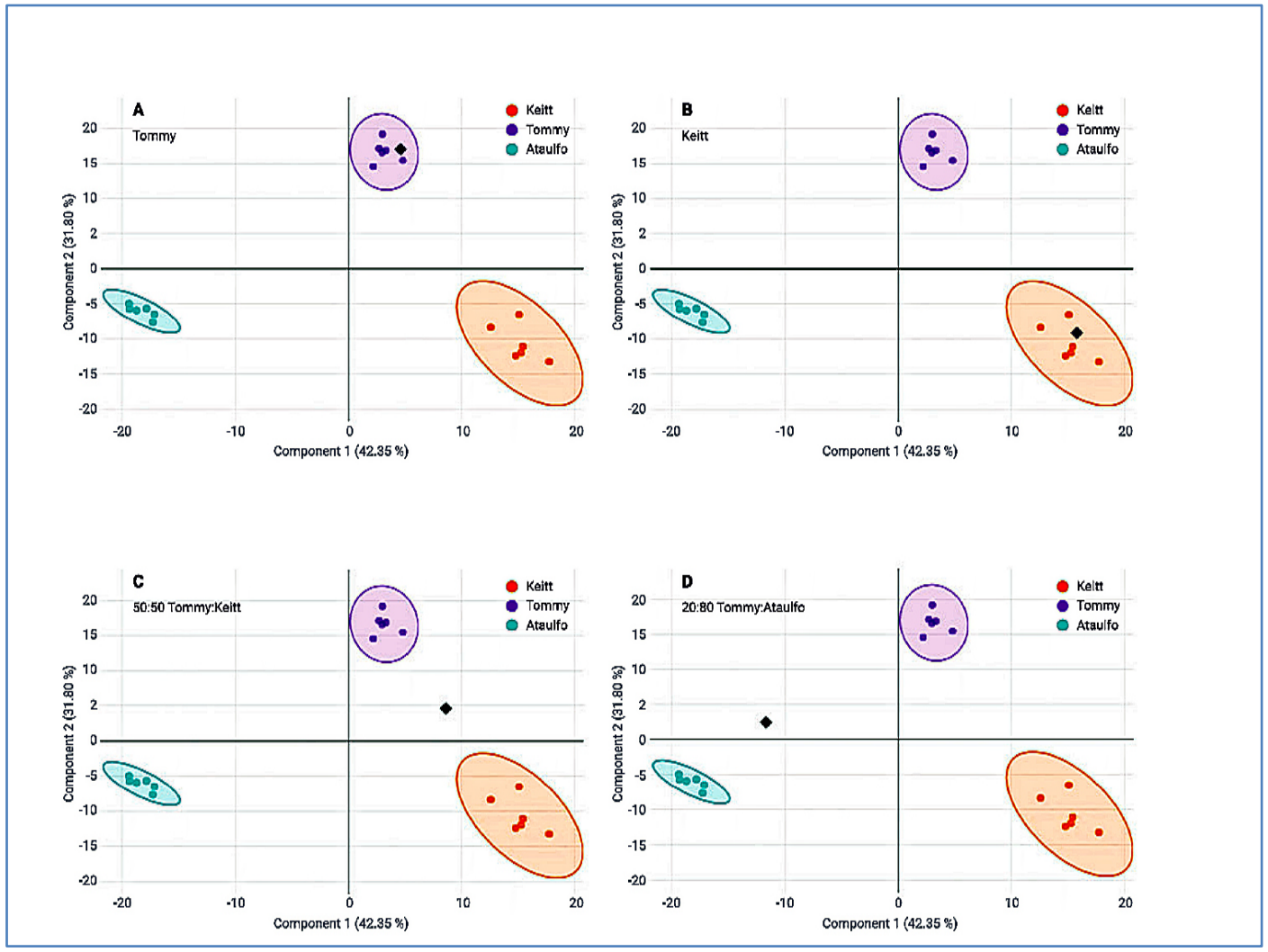


Mass spectrometry



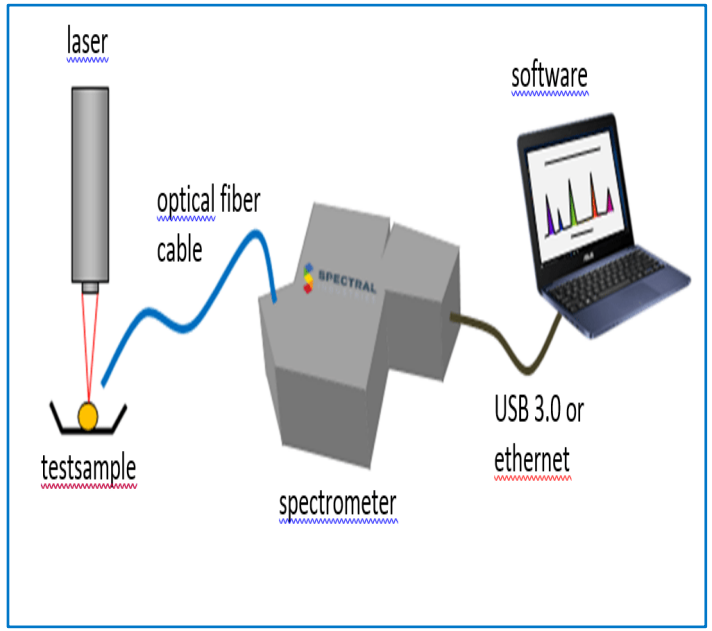


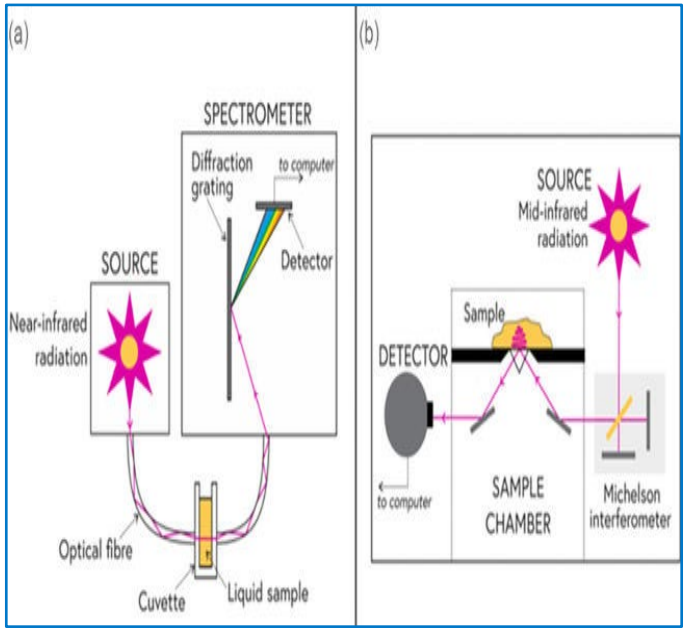
MS profile for the mango case study



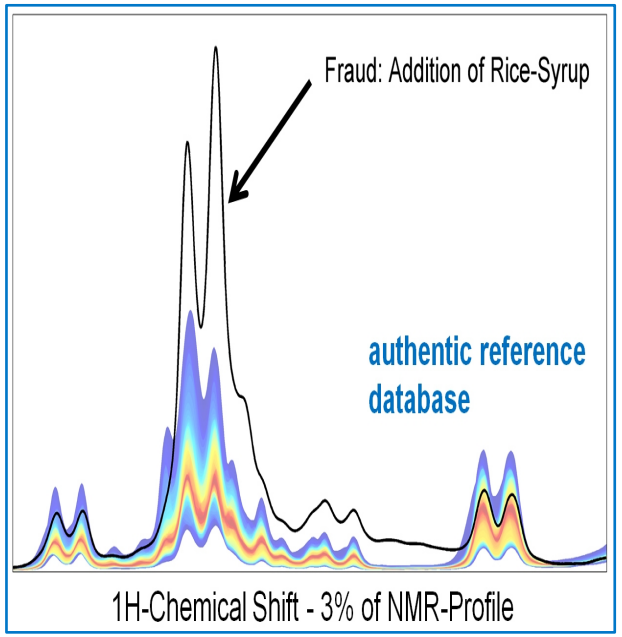
Isotope-ratio mass spectrometry (IRMS)

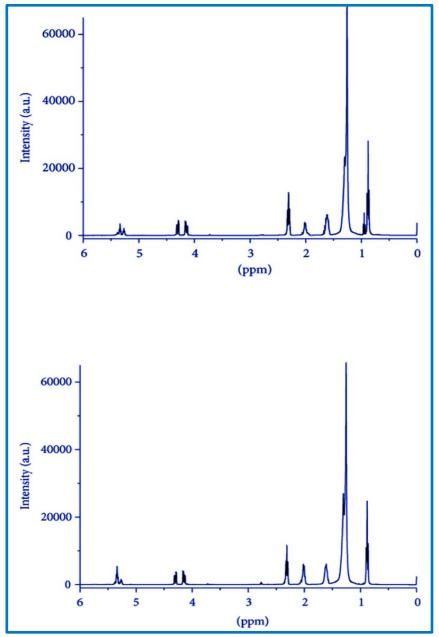
Spectroscopy



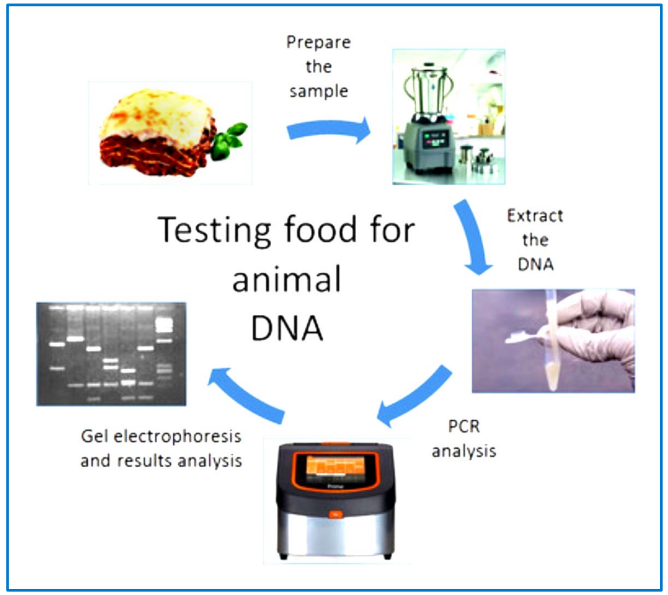


Nuclear magnetic resonance





DNA analysis



Authentication summary

Managing the Verification of Food Authenticity and Integrity

Assuring Food Authenticity & Integrity - Protecting the Food Sector from Threats and Vulnerabilities

Andrew MacLeod
BSc (hons) BSc. Pg Dip (Food Safety) CSci (Food Sci & Tech) FIFST FS Prin (IFST)

seafish

Thank you

Andrew MacLeod
BSc (hons) BSc. Pg Dip (Food Safety) CSci (Food Sci & Tech) FIFST FS Prin (IFST)

Optional contact details