

29

Semana
de la **Salud**
Ocupacional

Somos prevención, bienestar y vida



43° Congreso de Ergonomía, Higiene,
Medicina y Seguridad Ocupacional.
Forum UPB, Medellín - Colombia
1, 2 y 3 de noviembre de 2023

Enfoque sociotécnico para la Investigación de accidentes

Organiza:

CSOA CORPORACIÓN DE SALUD
OCUPACIONAL Y AMBIENTAL

Patricia Canney
Juan Carlos Medina



Organiza:

CSOA CORPORACIÓN DE SALUD
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Recorrido Histórico: principales modelos y metodologías



Los modelos de Investigación

Los métodos de investigación necesariamente incorporan o representan un modelo, es decir, un conjunto de suposiciones sobre cómo ocurren los accidentes y cuáles son los factores importantes.

Las prácticas siempre hacen algunas suposiciones sobre cómo ocurren los accidentes y qué se debe hacer para prevenirlos

Han cambiado en el tiempo



La Causalidad



Imagen tomada de
Sidney Dekker
Maser Class Foundations of
Safety science 2020

La Teoría Dominó



Heinrich - Bird
(1929 – 1960)



W. H. Heinrich (1931)



El modelo propuesto por Heinrich es lineal, considerando solo el entorno inmediato, incluida la gestión de línea

“Bird (1966) plantea la falta de control como la principal causa de pérdidas, ya sean humanas, de propiedad, en los procesos o que afectan al medioambiente”



SCAT Chart – Systematic Cause Analysis Technique

DESCRIPTION OF ACCIDENT OR INCIDENT

EVALUATION OF LOSS POTENTIAL IF NOT CONTROLLED

Loss Severity Potential: Major (1-4) Serious (5-7) Minor (8)

Probability of Occurrence: High (1-3) Moderate (4) Low (5)

Frequency of Exposure: Frequent (1-3) Moderate (4) Low (5)

TYPE OF CONTACT OR NEAR CONTACT WITH ENERGY OR SUBSTANCE

1. Direct Contact (Electrical Shock) (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	2. Indirect Contact (Electrical Shock) (See Cx's 1, 11, 12, 13, 14, 15, 16, 17, 18)	3. Contact with Sharp Object (Puncture) (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	4. Contact with Toxic Substance (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	5. Contact with Hot Surface (Burn) (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	6. Contact with Moving Part (Mechanical Injury) (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	7. Contact with Falling Object (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	8. Contact with Vehicle (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	9. Contact with Radiation (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	10. Contact with Noise (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	11. Contact with Vibration (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	12. Contact with Air Pollution (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	13. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	14. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	15. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	16. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	17. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	18. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	19. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	20. Contact with Other Hazardous Environment (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)
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(I.C.'s) IMMEDIATE CAUSES

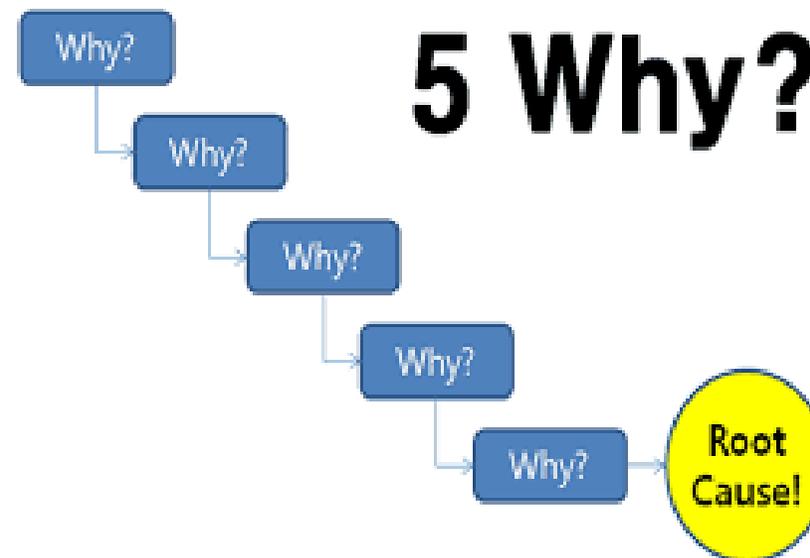
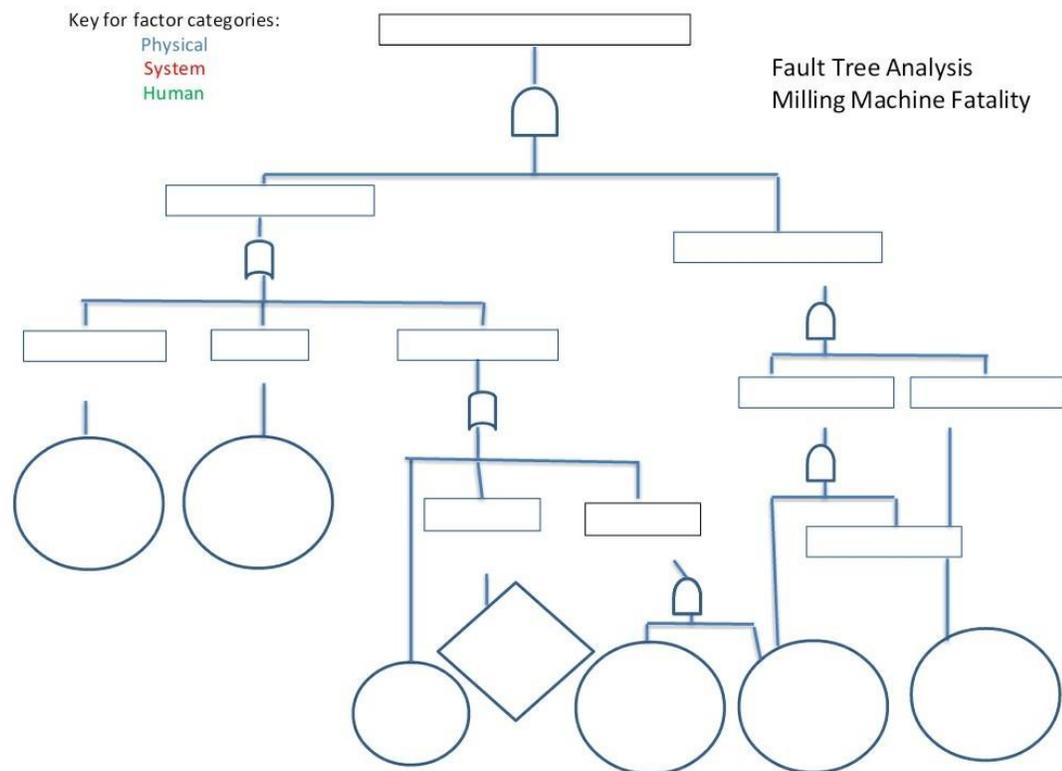
1. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	2. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	3. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	4. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	5. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	6. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	7. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	8. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	9. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	10. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	11. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	12. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	13. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	14. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	15. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	16. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	17. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	18. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	19. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)	20. Missing Safety Guard (See Cx's 1, 2, 4, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18)
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(B.C.'s) BASIC UNDERLYING CAUSES

<p>1. Inadequate Physical/Psychological Capability</p> <p>1.1 Inadequate height, weight, age, strength, coordination</p> <p>1.2 Poor health stage of body condition</p> <p>1.3 Inadequate vision, hearing, touch, taste, smell</p> <p>1.4 Inadequate mental alertness</p> <p>1.5 Inadequate reaction time</p> <p>1.6 Inadequate judgment</p> <p>1.7 Inadequate memory</p> <p>1.8 Inadequate concentration</p> <p>1.9 Inadequate endurance</p> <p>1.10 Inadequate physical fitness</p> <p>1.11 Inadequate psychological fitness</p> <p>1.12 Inadequate psychological stability</p> <p>1.13 Inadequate psychological flexibility</p> <p>1.14 Inadequate psychological adaptability</p> <p>1.15 Inadequate psychological resilience</p> <p>1.16 Inadequate psychological tolerance</p> <p>1.17 Inadequate psychological resistance</p> <p>1.18 Inadequate psychological endurance</p> <p>1.19 Inadequate psychological stamina</p> <p>1.20 Inadequate psychological vigor</p> <p>1.21 Inadequate psychological energy</p> <p>1.22 Inadequate psychological power</p> <p>1.23 Inadequate psychological force</p> <p>1.24 Inadequate psychological strength</p> <p>1.25 Inadequate psychological intensity</p> <p>1.26 Inadequate psychological depth</p> <p>1.27 Inadequate psychological breadth</p> <p>1.28 Inadequate psychological scope</p> <p>1.29 Inadequate psychological range</p> <p>1.30 Inadequate psychological extent</p> <p>1.31 Inadequate psychological magnitude</p> <p>1.32 Inadequate psychological grandeur</p> <p>1.33 Inadequate psychological loftiness</p> <p>1.34 Inadequate psychological sublimity</p> <p>1.35 Inadequate psychological nobility</p> <p>1.36 Inadequate psychological dignity</p> <p>1.37 Inadequate psychological decorum</p> <p>1.38 Inadequate psychological propriety</p> <p>1.39 Inadequate psychological respectability</p> <p>1.40 Inadequate psychological reputation</p> <p>1.41 Inadequate psychological esteem</p> <p>1.42 Inadequate psychological honor</p> <p>1.43 Inadequate psychological glory</p> <p>1.44 Inadequate psychological fame</p> <p>1.45 Inadequate psychological renown</p> <p>1.46 Inadequate psychological notoriety</p> <p>1.47 Inadequate psychological infamy</p> <p>1.48 Inadequate psychological dishonor</p> <p>1.49 Inadequate psychological disgrace</p> <p>1.50 Inadequate psychological shame</p> <p>1.51 Inadequate psychological humiliation</p> <p>1.52 Inadequate psychological degradation</p> <p>1.53 Inadequate psychological debasement</p> <p>1.54 Inadequate psychological devaluation</p> <p>1.55 Inadequate psychological depreciation</p> <p>1.56 Inadequate psychological devaluation</p> <p>1.57 Inadequate psychological devaluation</p> <p>1.58 Inadequate psychological devaluation</p> <p>1.59 Inadequate psychological devaluation</p> <p>1.60 Inadequate psychological devaluation</p>	<p>2. Inadequate Information</p> <p>2.1 Lack of knowledge</p> <p>2.2 Lack of understanding</p> <p>2.3 Lack of insight</p> <p>2.4 Lack of perception</p> <p>2.5 Lack of awareness</p> <p>2.6 Lack of realization</p> <p>2.7 Lack of comprehension</p> <p>2.8 Lack of comprehension</p> <p>2.9 Lack of comprehension</p> <p>2.10 Lack of comprehension</p> <p>2.11 Lack of comprehension</p> <p>2.12 Lack of comprehension</p> <p>2.13 Lack of comprehension</p> <p>2.14 Lack of comprehension</p> <p>2.15 Lack of comprehension</p> <p>2.16 Lack of comprehension</p> <p>2.17 Lack of comprehension</p> <p>2.18 Lack of comprehension</p> <p>2.19 Lack of comprehension</p> <p>2.20 Lack of comprehension</p> <p>2.21 Lack of comprehension</p> <p>2.22 Lack of comprehension</p> <p>2.23 Lack of comprehension</p> <p>2.24 Lack of comprehension</p> <p>2.25 Lack of comprehension</p> <p>2.26 Lack of comprehension</p> <p>2.27 Lack of comprehension</p> <p>2.28 Lack of comprehension</p> <p>2.29 Lack of comprehension</p> <p>2.30 Lack of comprehension</p> <p>2.31 Lack of comprehension</p> <p>2.32 Lack of comprehension</p> <p>2.33 Lack of comprehension</p> <p>2.34 Lack of comprehension</p> <p>2.35 Lack of comprehension</p> <p>2.36 Lack of comprehension</p> <p>2.37 Lack of comprehension</p> <p>2.38 Lack of comprehension</p> <p>2.39 Lack of comprehension</p> <p>2.40 Lack of comprehension</p> <p>2.41 Lack of comprehension</p> <p>2.42 Lack of comprehension</p> <p>2.43 Lack of comprehension</p> <p>2.44 Lack of comprehension</p> <p>2.45 Lack of comprehension</p> <p>2.46 Lack of comprehension</p> <p>2.47 Lack of comprehension</p> <p>2.48 Lack of comprehension</p> <p>2.49 Lack of comprehension</p> <p>2.50 Lack of comprehension</p>	<p>3. Inadequate Judgment</p> <p>3.1 Inadequate judgment</p> <p>3.2 Inadequate judgment</p> <p>3.3 Inadequate judgment</p> <p>3.4 Inadequate judgment</p> <p>3.5 Inadequate judgment</p> <p>3.6 Inadequate judgment</p> <p>3.7 Inadequate judgment</p> <p>3.8 Inadequate judgment</p> <p>3.9 Inadequate judgment</p> <p>3.10 Inadequate judgment</p> <p>3.11 Inadequate judgment</p> <p>3.12 Inadequate judgment</p> <p>3.13 Inadequate judgment</p> <p>3.14 Inadequate judgment</p> <p>3.15 Inadequate judgment</p> <p>3.16 Inadequate judgment</p> <p>3.17 Inadequate judgment</p> <p>3.18 Inadequate judgment</p> <p>3.19 Inadequate judgment</p> <p>3.20 Inadequate judgment</p> <p>3.21 Inadequate judgment</p> <p>3.22 Inadequate judgment</p> <p>3.23 Inadequate judgment</p> <p>3.24 Inadequate judgment</p> <p>3.25 Inadequate judgment</p> <p>3.26 Inadequate judgment</p> <p>3.27 Inadequate judgment</p> <p>3.28 Inadequate judgment</p> <p>3.29 Inadequate judgment</p> <p>3.30 Inadequate judgment</p> <p>3.31 Inadequate judgment</p> <p>3.32 Inadequate judgment</p> <p>3.33 Inadequate judgment</p> <p>3.34 Inadequate judgment</p> <p>3.35 Inadequate judgment</p> <p>3.36 Inadequate judgment</p> <p>3.37 Inadequate judgment</p> <p>3.38 Inadequate judgment</p> <p>3.39 Inadequate judgment</p> <p>3.40 Inadequate judgment</p> <p>3.41 Inadequate judgment</p> <p>3.42 Inadequate judgment</p> <p>3.43 Inadequate judgment</p> <p>3.44 Inadequate judgment</p> <p>3.45 Inadequate judgment</p> <p>3.46 Inadequate judgment</p> <p>3.47 Inadequate judgment</p> <p>3.48 Inadequate judgment</p> <p>3.49 Inadequate judgment</p> <p>3.50 Inadequate judgment</p>	<p>4. 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NTC 3701 de 1995

Análisis de árbol de fallas (Watson, 1961 citado en Ericson, 1999) y los cinco porqués (5 Why's) (Ohno, 1988).



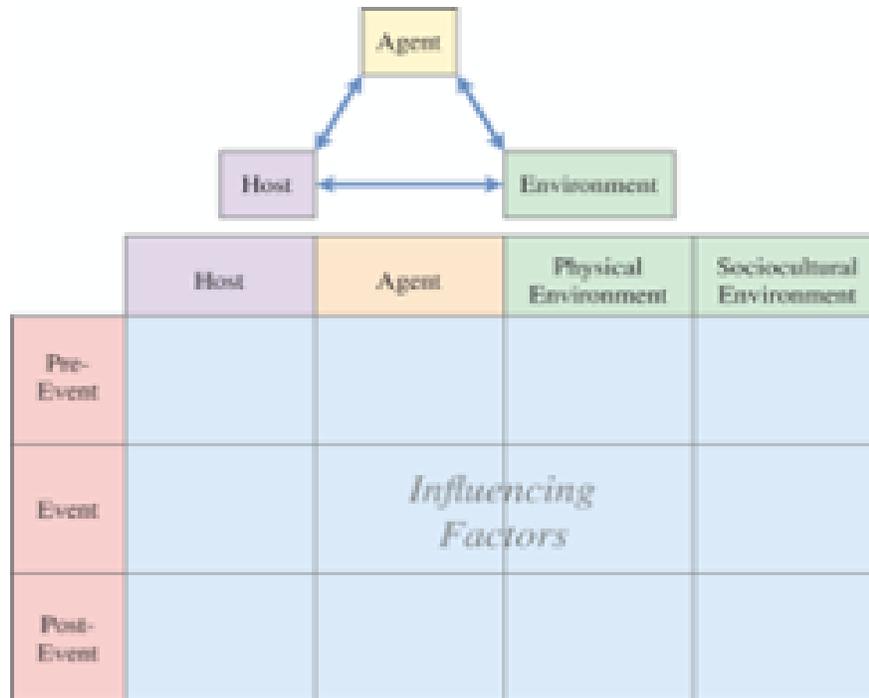
https://www.google.com/search?q=5+why%2684s+image&tbmsisch&chips=q:5+why+image_online_chips:whys:9kChmG9FAmo%3D&hies&sa=X&ved:2ahUKewjpbHU5paCaxVrFikFHcBGdVQQ4YoAXoECAEQMD&biw=1369&bih=682#imgrc=SwMc8YX7mOuDM

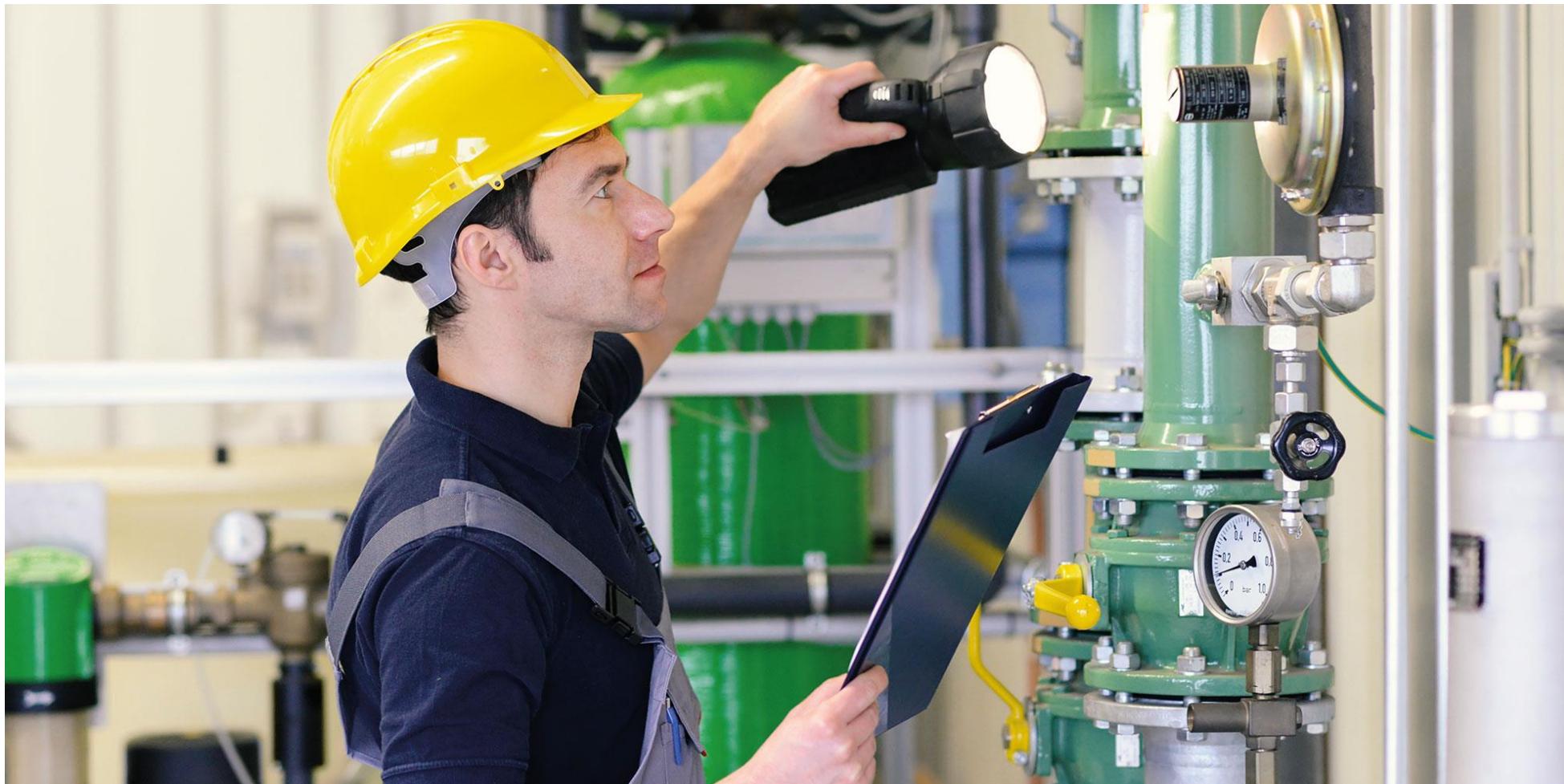
“Se ha visto que los factores causales de los accidentes residen en el **agente**, en el **huésped** y en el **medio ambiente**. El mecanismo de la ocurrencia del accidente es el proceso por el cual los tres componentes interactúan para producir un resultado, el accidente: no es la causa del accidente”. (**Gordon, 1949**, op. Cit., Pág.509)

“Turner en relación con los accidentes graves definió el período de incubación como "la acumulación de un conjunto de eventos inadvertidos que están en desacuerdo con lo aceptado creencias sobre los peligros y las normas para evitarlos". (**Turner, 1978**, pág. 85).



La matriz de Haddon es un modelo conceptual que organiza los factores que influyen en las fases de ocurrencia de un accidente (evento): previa al evento, del evento y posterior al evento, y en los dominios del huésped, el agente y el entorno similares a los componentes de la tríada epidemiológica.

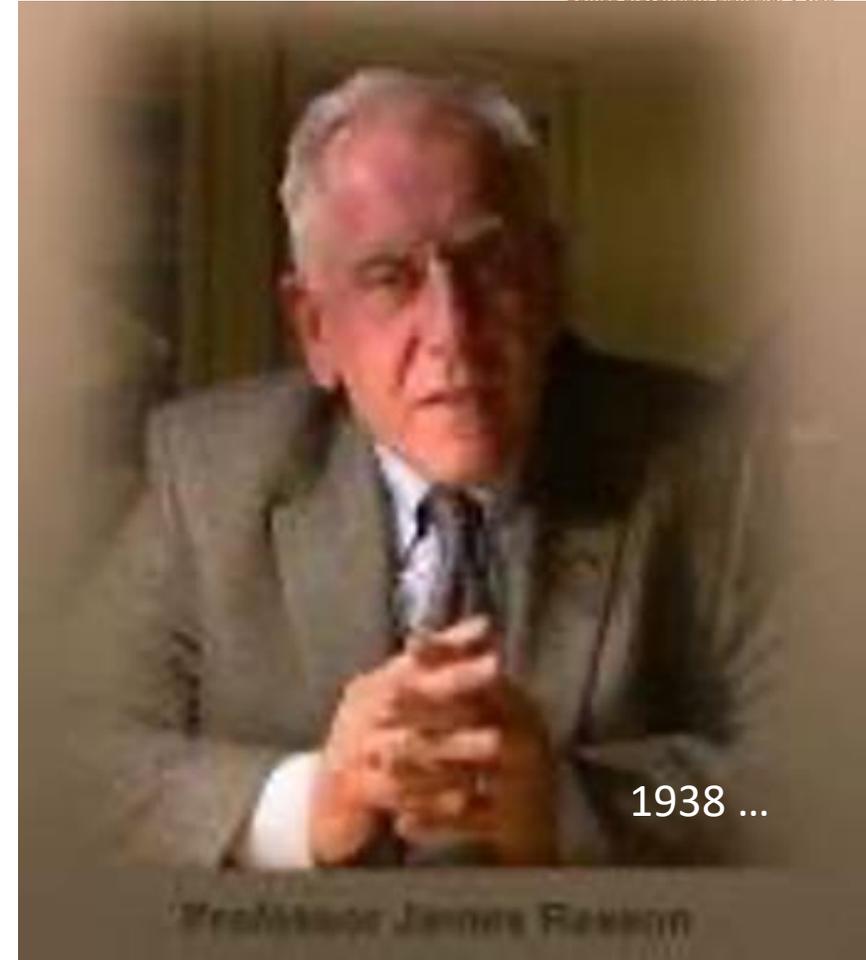




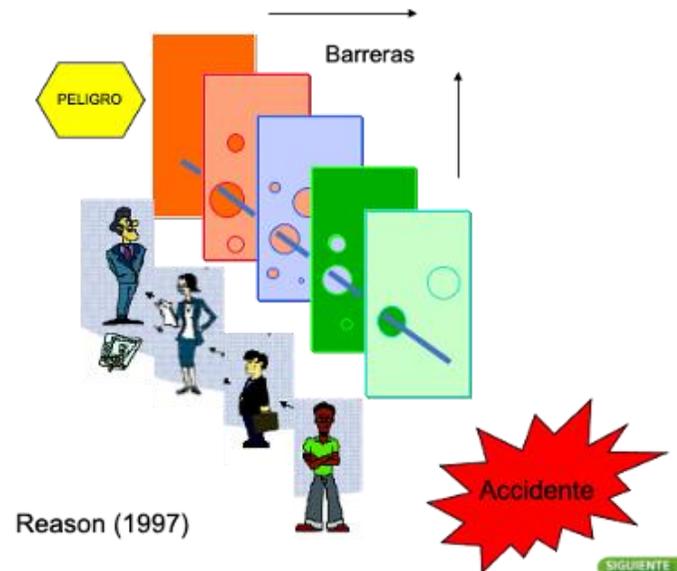
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En los años 70 y 80 varios desastres inspiraron al investigador James Reason a proponer el “modelo del queso Suizo” (1990)

En lugar de ser los principales instigadores de un accidente, los operarios tienden a ser los herederos de los defectos del sistema ... su parte es la de agregar la guarnición final a una infusión letal cuyos ingredientes ya se han cocinado durante mucho tiempo (Reason 1990 pág. 173)



Análisis de barreras

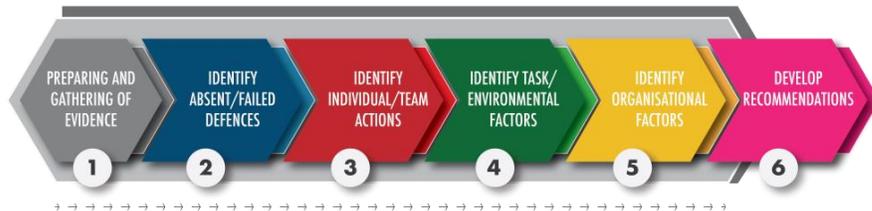


Tripod Beta

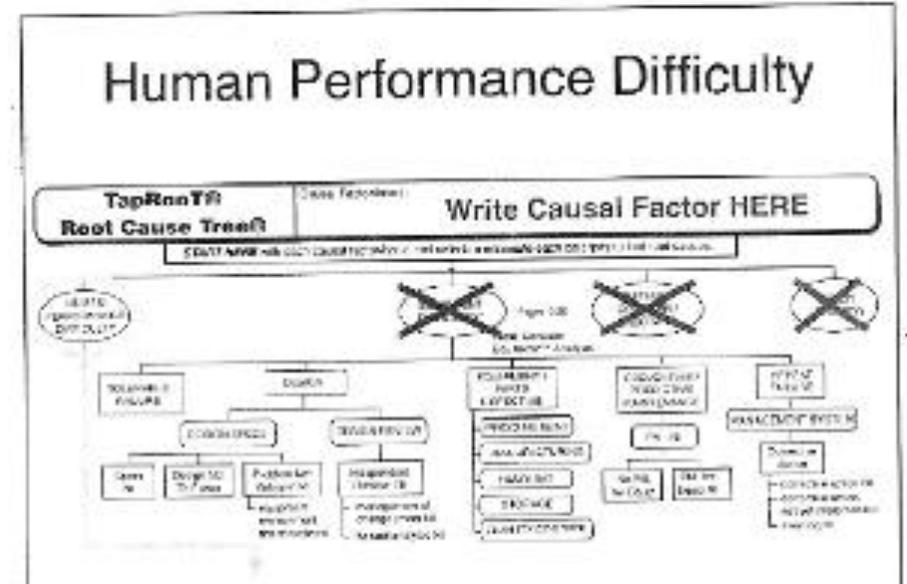
“Para comprender por qué sucedió el incidente, se determinan qué barreras existen para evitar que esos objetos y agentes actúen de la manera en que lo hicieron y por qué fallaron. Tripod Beta nos enseña a mirar las causas inmediatas del acto que condujo al incidente, los precursores psicológicos y, en última instancia, las deficiencias organizativas subyacentes”.



ICAM Analysis



Tap Root

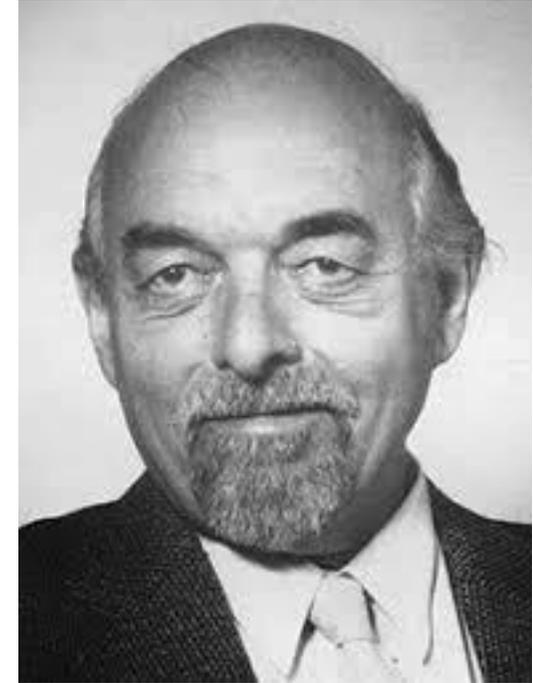
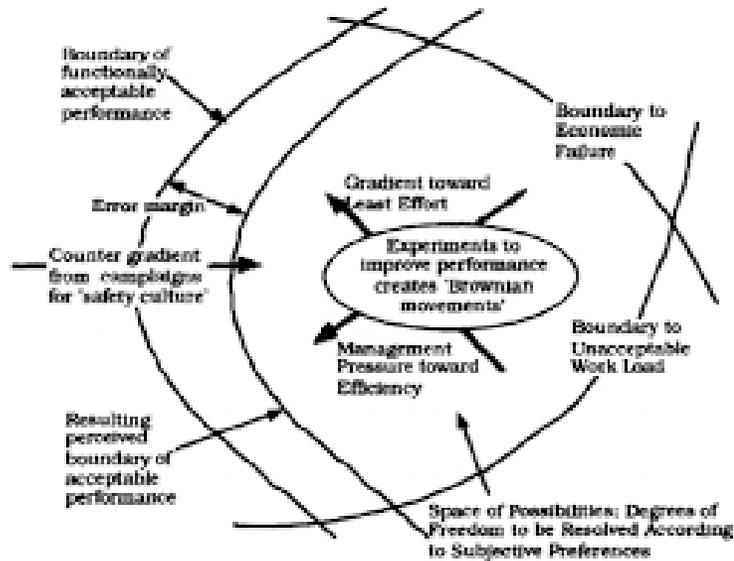


Bow Tie



Modelos sistémicos

“En vez de tratar los incidentes como causa efecto, describe las pérdidas como el comportamiento inesperado de un sistema en el que se dan relaciones no controladas entre sus partes constituyentes. En otras palabras, los incidentes no son creados por una combinación de fallas activas y latentes, son el resultado del funcionamiento humano y de la tecnología que parecen racionales a nivel local, pero que sin saberlo crean condiciones inseguras dentro del sistema que permanecen sin corregir.”



Jens Rasmussen (1926 – 2018)

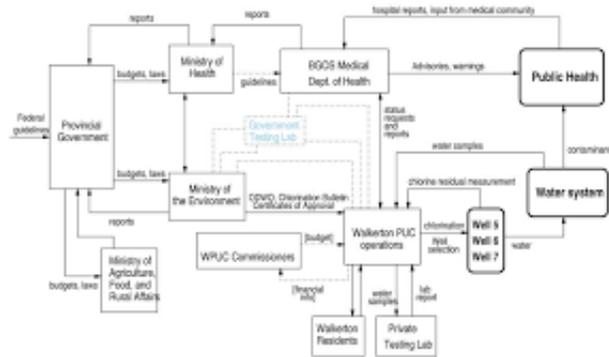
Perrow (1999) discutió la inevitabilidad de los desastres, en lo que él llamó "**Normal Accidents**".

“Analiza el lado social del riesgo tecnológico. Charles Perrow sostiene que el enfoque de ingeniería convencional para garantizar la seguridad (incorporar más advertencias, procedimientos y señales) fracasa porque la complejidad de los sistemas hace que las fallas sean inevitables. Afirma que las precauciones típicas, al aumentar la complejidad, pueden ayudar a crear nuevas categorías de accidentes. Este libro proporciona un marco poderoso para analizar los riesgos y las organizaciones que insistimos en que los ejecutemos”.

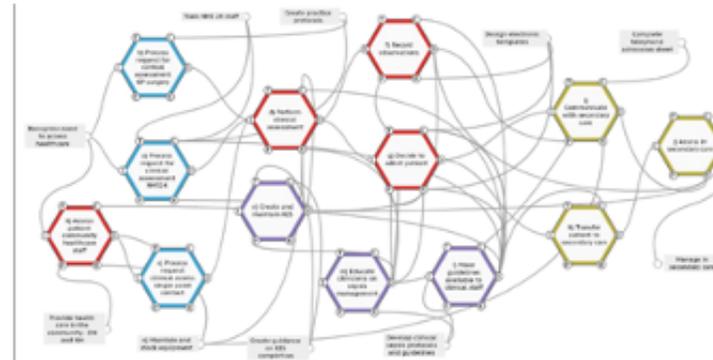
Princeton University Press



STAMP (Leveson 2004, 2011)



Fram (Hollnagel 2004, 2012)



STAMP (System-Theoretic Accident Model and Processes) – Nancy Leveson View Point

Includes

Entire socio-technical system (not just technical part)



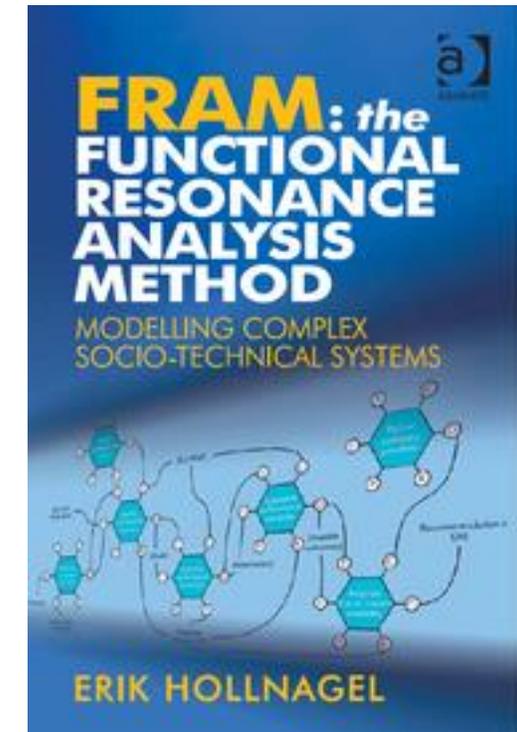
Component Interaction Error

Software and Systems Design Error



Human Error

https://youtu.be/3PkfeP_Z8GA



Usted encuentra... lo que busca

“La práctica de la seguridad y la investigación requieren tomar en cuenta la naturaleza sistémica y compleja de los sistemas socio técnicos”. Le Coze 2017

What you look is What You Find – The consequences of underlying accident models in eight accident investigation manuals. Safety Science

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