🐎 Springer Link

The Palgrave Encyclopedia of the Possible

Living Edition
| Editors: Vlad Petre Glăveanu (Editor-in-Chief)

Human-Systems Integration

- Guy André Boy (1) (2) Email author (guy.andre.boy@gmail.com)

1. CentraleSupélec, Paris Saclay University, , Gif-sur-Yvette, France
2. ESTIA Institute of Technology, , Bidart, France

Abstract

Human-systems integration (HSI) denotes a possible evolution of two disciplines, that are Human Factors and Ergonomics (HFE) and Human-Computer Interaction (HCI), that led to Human-Centered Design (HCD), more specifically within the field of Systems Engineering (SE). HSI pragmatically considers the Technology, Organizations, and People (TOP) Model that supports integration of Technology, Organizations, and People during the whole life cycle of a system. HSI is inherently multi-agent, takes the system approach, and looks for the elicitation of emergent systemic properties through human-in-the-loop simulations (Virtual HCD). Human and machine are represented as systems defined by their structures and functions, which are characterized using the "context-resource orthogonality" framework. This encyclopedia entry provides HSI psychological and sociotechnical foundations, based on a nonlinear and self-organizing system perspective that departs from the traditional linear reductionist approach in psychology and engineering. This HSI epistemological endeavor addresses concepts such as separability, familiarity, emergence, tangibility, agonist-antagonist processes, symbiotic cognitive, and physical structures and functions.

Keywords

Human-systems integration   Tangibility   Human-centered design
System science   Systems engineering   Systems of systems   Complexity

Open-nonlinear self-organizing systems   Emergent properties
Human-in-the-loop simulation   Multi-agent modeling   TOP model
This is a preview of subscription content, log in to check access.

References

Bernard-Weil, É. (2003). Ago-antagonistic systems. In M. Mugur-Schächter & A. van der Merwe (Eds.), *Quantum mechanics, mathematics, cognition and action. Fundamental theories of physics* (An international book series on the fundamental theories of physics: Their clarification, development and application) (Vol. 129, pp. 325–348). Dordrecht: Springer. ISBN 978-1-4020-1120-7.
CrossRef (https://doi.org/10.1007/0-306-48144-8_9)
Google Scholar (http://scholar.google.com/scholar_lookup?title=Ago-antagonistic%20systems&author=%C3%89.%20Bernard-Weil&pages=325-348&publication_year=2003)

Boy, G. A. (Ed.). (2011). *Handbook of human-machine interaction: A human-centered design approach*. Ashgate. CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.
Google Scholar (https://scholar.google.com/scholar?q=Boy%2C%20G.%20A.%20%28Ed.%29.%20%282011%29.%20Handbook%20of%20human-machine%20interaction%3A%20A%20human-centered%20design%20approach.%20Ashgate.%20CRC%20Press%2C%20Taylor%20%26%20Francis%20Group%2C%20Boca%20Raton%2C%20Florida%2C%20USA.)

Boy, G. A. (2013). *Orchestrating human-centered design*. Springer. ISBN 978-1-4471-4338-3. London, UK.
Google Scholar (https://scholar.google.com/scholar?q=Boy%2C%20G.%20A.%20%282013%29.%20Orchestrating%20human-centered%20design.%20Springer.%20ISBN%20978-1-4471-4338-3.%20London%2C%20UK.)

Boy, G. A. (2015). On the complexity of situation awareness. *Proceedings 19th Triennial Congress of the IEA*, Melbourne, Australia, 9–14.
Google Scholar (https://scholar.google.com/scholar?q=Boy%2C%20G.%20A.%20%282015%29.%20On%20the%20complexity%20of%20situation%20awareness.%20Proceedings%2019th%20Triennial%20Congress%20of%20the%20IEA%2C%20Melbourne%2C%20Australia%2C%209%E2%80%9314.)

Boy, G. A. (2017). Human-centered design of complex systems: An experience-based approach. *Design Science Journal*. Cambridge University Press, Vol. 3.
https://www.cambridge.org/core/journals/design-science/article/humancentered-design-of-complex-systems-an-experiencebased-approach/F726100E2E7D0C825CB526FD7412C48E
 (https://www.cambridge.org/core/journals/design-science/article/humancentered-design-of-complex-systems-an-experiencebased-approach/F726100E2E7D0C825CB526FD7412C48E)

Boy, G. A. (2020). *Human systems integration: From virtual to tangible*. Boca

Raton: CRC, Taylor & Francis.

CrossRef (https://doi.org/10.1201/9780429351686)

Google Scholar (http://scholar.google.com/scholar_lookup?
title=Human%20systems%20integration%3A%20From%20virtual%20to%20tan
gible&author=GA.%20Boy&publication_year=2020)

Boy, G. A.. (2021). Managing uncertainty in life-critical systems. In Gudela Grote
& Mark Griffin (Eds.), Chapter for the *Handbook of Uncertainty Management in
Work Organizations*. Oxford University Press. Oxford, England.

Google Scholar (https://scholar.google.com/scholar?
q=Boy%2C%20G.%20A..%20%282021%29.%20Managing%20uncertainty%20in
%20life-
critical%20systems.%20In%20Gudela%20Grote%20%26%20Mark%20Griffin%2
0%28Eds.%29%2C%20Chapter%20for%20the%20Handbook%20of%20Uncertai
nty%20Management%20in%20Work%20Organizations.%20Oxford%20Universit
y%20Press.%20Oxford%2C%20England.)

Boy, G.A., Dezemery, J., Hein, A.M., Lu Cong Sang, R., Masson, D., Morel, C., &
Villeneuve, E. (2020). *PRODEC: Combining procedural and declarative
knowledge for human-centered design*. Technical Report. FlexTech Chair,
CentraleSupélec & ESTIA.

Google Scholar (https://scholar.google.com/scholar?
q=Boy%2C%20G.A.%2C%20Dezemery%2C%20J.%2C%20Hein%2C%20A.M.%2
C%20Lu%20Cong%20Sang%2C%20R.%2C%20Masson%2C%20D.%2C%20More
l%2C%20C.%2C%20%26%20Villeneuve%2C%20E.%20%282020%29.%20PROD
EC%3A%20Combining%20procedural%20and%20declarative%20knowledge%20
for%20human-
centered%20design.%20Technical%20Report.%20FlexTech%20Chair%2C%20Ce
ntraleSup%C3%A9lec%20%26%20ESTIA.)

Card, S. K., Moran, T. P., & Newell, A. (1983). *The psychology of human-
computer interaction*. Hillsdale: Erlbaum.

Google Scholar (http://scholar.google.com/scholar_lookup?
title=The%20psychology%20of%20human-
computer%20interaction&author=SK.%20Card&author=TP.%20Moran&author=
A.%20Newell&publication_year=1983)

Carpenter, T. P. (1986). Conceptual knowledge as a foundation for procedural
knowledge. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case
of mathematics*. Lawrence Erlbaum Associates, pp. 113–132.

Google Scholar (https://scholar.google.com/scholar?
q=Carpenter%2C%20T.%20P.%20%281986%29.%20Conceptual%20knowledge
%20as%20a%20foundation%20for%20procedural%20knowledge.%20In%20J.%
20Hiebert%20%28Ed.%29%2C%20Conceptual%20and%20procedural%20knowl
edge%3A%20The%20case%20of%20mathematics.%20Lawrence%20Erlbaum%2
0Associates%2C%20pp.%20113%E2%80%93132.)

Corbett, A. T., & Anderson, J. R. (1994). Knowledge tracing: Modeling the
acquisition of procedural knowledge. *User modeling and user-adapted
interaction, 4*(4), 253–278.

Google Scholar (https://scholar.google.com/scholar?
q=Corbett%2C%20A.%20T.%2C%20%26%20Anderson%2C%20J.%20R.%20%2
81994%29.%20Knowledge%20tracing%3A%20Modeling%20the%20acquisition%
20of%20procedural%20knowledge.%20User%20modeling%20and%20user-

adapted%20interaction%2C%204%284%29%2C%20253%E2%80%93278.)

Diaper, D., & Stanton, N. (Eds.). (2004). *The handbook of task analysis for human-computer interaction*. Mahwah: Lawrence Erlbaum Associates, Publishers.
Google Scholar (http://scholar.google.com/scholar_lookup?
title=The%20handbook%20of%20task%20analysis%20for%20human-computer%20interaction&publication_year=2004)

Endsley, M. R. (1995a). Measurement of situation awareness in dynamic systems. *Human Factors, 37*(1), 65–84.
CrossRef (https://doi.org/10.1518/001872095779049499)
Google Scholar (http://scholar.google.com/scholar_lookup?
title=Measurement%20of%20situation%20awareness%20in%20dynamic%20systems&author=MR.%20Endsley&journal=Human%20Factors&volume=37&issue=1&pages=65-84&publication_year=1995)

Endsley, M. R. (1995b). Toward a theory of situation awareness in dynamic systems. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 37*(1), 32–64.
CrossRef (https://doi.org/10.1518/001872095779049543)
Google Scholar (http://scholar.google.com/scholar_lookup?
title=Toward%20a%20theory%20of%20situation%20awareness%20in%20dynamic%20systems&author=MR.%20Endsley&journal=Human%20Factors%3A%20The%20Journal%20of%20the%20Human%20Factors%20and%20Ergonomics%20Society&volume=37&issue=1&pages=32-64&publication_year=1995)

Endsley, M. R. (1998). A comparative analysis of SAGAT and SART for evaluations of situation awareness. In *Proceedings of the human factors and ergonomics society 42nd annual meeting* (pp. 82–86). Santa Monica: The Human Factors and Ergonomics Society.
Google Scholar (http://scholar.google.com/scholar_lookup?
title=A%20comparative%20analysis%20of%20SAGAT%20and%20SART%20for%20evaluations%20of%20situation%20awareness&author=MR.%20Endsley&pages=82-86&publication_year=1998)

Endsley, M. R., & Garland, D. J. (Eds.). (2000). *Situation awareness analysis and measurement*. Mahwah: Lawrence Erlbaum Associates.
Google Scholar (http://scholar.google.com/scholar_lookup?
title=Situation%20awareness%20analysis%20and%20measurement&publication_year=2000)

Hiebert, J., & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. Conceptual and procedural knowledge: The case of mathematics, 2, 1–27.
Google Scholar (https://scholar.google.com/scholar?
q=Hiebert%2C%20J.%2C%20%26%20Lefevre%2C%20P.%20%281986%29.%20Conceptual%20and%20procedural%20knowledge%20in%20mathematics%3A%20An%20introductory%20analysis.%20Conceptual%20and%20procedural%20knowledge%3A%20The%20case%20of%20mathematics%2C%202%2C%201%E2%80%9327.)

Hollnagel, E., Woods, D. D., & Leveson, N. (Eds.). (2006). *Resilience engineering. Concepts and precepts*. Ashgate: Hampshire.
Google Scholar (http://scholar.google.com/scholar_lookup?

title=Resilience%20engineering.%20Concepts%20and%20precepts&publication_
year=2006)

Kaptelinin, V., & Nardi, B. (2006). *Acting with technology: Activity theory and interaction design*. MIT Press, Cambridge, Massachussetts, USA.
Google Scholar (https://scholar.google.com/scholar?
q=Kaptelinin%2C%20V.%2C%20%26%20Nardi%2C%20B.%20%282006%29.%2
0Acting%20with%20technology%3A%20Activity%20theory%20and%20interacti
on%20design.%20MIT%20Press%2C%20Cambridge%2C%20Massachussetts%2
C%20USA.)

Kirwan, B., & Ainsworth, L. (Eds.). (1992). *A guide to task analysis*. Taylor and Francis, Boca Raton, Florida, USA.
Google Scholar (https://scholar.google.com/scholar?
q=Kirwan%2C%20B.%2C%20%26%20Ainsworth%2C%20L.%20%28Eds.%29.%
20%281992%29.%20A%20guide%20to%20task%20analysis.%20Taylor%20and
%20Francis%2C%20Boca%20Raton%2C%20Florida%2C%20USA.)

Klochko, V. E. (2007). The logic of the development of psychological knowledge and the problem of the method of science. *Methodology and History of Psychology, 2*(1), 5–19.
Google Scholar (https://scholar.google.com/scholar?
q=Klochko%2C%20V.%20E.%20%282007%29.%20The%20logic%20of%20the%
20development%20of%20psychological%20knowledge%20and%20the%20probl
em%20of%20the%20method%20of%20science.%20Methodology%20and%20Hi
story%20of%20Psychology%2C%202%281%29%2C%205%E2%80%9319.)

Leplat, J. (2008). *Repères pour l'analyse de l'activité en ergonomie*. Paris: Presses Universitaires de France.
Google Scholar (http://scholar.google.com/scholar_lookup?
title=Rep%C3%A8res%20pour%20l%27analyse%20de%20l%27activit%C3%A9%
20en%20ergonomie&author=J.%20Leplat&publication_year=2008)

Lewicki, P., Czyzewska, M., & Hoffman, H. (1987). Unconscious acquisition of complex procedural knowledge. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*(4), 523.
Google Scholar (https://scholar.google.com/scholar?
q=Lewicki%2C%20P.%2C%20Czyzewska%2C%20M.%2C%20%26%20Hoffman%
2C%20H.%20%281987%29.%20Unconscious%20acquisition%20of%20complex
%20procedural%20knowledge.%20Journal%20of%20Experimental%20Psycholo
gy%3A%20Learning%2C%20Memory%2C%20and%20Cognition%2C%2013%28
4%29%2C%20523.)

McCormick, R. (1997). Conceptual and procedural knowledge. *International journal of technology and design education, 7*(1–2), 141–159.
Google Scholar (https://scholar.google.com/scholar?
q=McCormick%2C%20R.%20%281997%29.%20Conceptual%20and%20procedur
al%20knowledge.%20International%20journal%20of%20technology%20and%20
design%20education%2C%207%281%E2%80%932%29%2C%20141%E2%80%93
159.)

Mindell, D. A. (2008). *Digital Apollo: Human and machine in spaceflight*. Cambridge, MA: MIT Press. ISBN: 9780262134972.
CrossRef (https://doi.org/10.7551/mitpress/7734.001.0001)
Google Scholar (http://scholar.google.com/scholar_lookup?

title=Digital%20Apollo%3A%20Human%20and%20machine%20in%20spaceflig
ht&author=DA.%20Mindell&publication_year=2008)

Mori, G., Paterno, F., & Santoro, C. (2002). CTTE: Support for developing and
analyzing task models for interactive system design. *IEEE Transactions on
Software Engineering, 28*(8), 797–813.
https://doi.org/10.1109/TSE.2002.1027801
(https://doi.org/10.1109/TSE.2002.1027801).
CrossRef (https://doi.org/10.1109/TSE.2002.1027801)
Google Scholar (http://scholar.google.com/scholar_lookup?
title=CTTE%3A%20Support%20for%20developing%20and%20analyzing%20tas
k%20models%20for%20interactive%20system%20design&author=G.%20Mori&
author=F.%20Paterno&author=C.%20Santoro&journal=IEEE%20Transactions%
20on%20Software%20Engineering&volume=28&issue=8&pages=797-
813&publication_year=2002&doi=10.1109%2FTSE.2002.1027801)

Newell, A., Simon, H. A. (1971). *Human Problem Solving* Prentice Hall,
Englewood Cliffs.
Google Scholar (https://scholar.google.com/scholar?
q=Newell%2C%20A.%2C%20Simon%2C%20H.%20A.%20%281971%29.%20Hu
man%20Problem%20Solving%20Prentice%20Hall%2C%20Englewood%20Cliffs.
)

Piaget, J. (1936). *Origins of intelligence in the child.* London: Routledge & Kegan
Paul.
Google Scholar (https://scholar.google.com/scholar?
q=Piaget%2C%20J.%20%281936%29.%20Origins%20of%20intelligence%20in%
20the%20child.%20London%3A%20Routledge%20%26%20Kegan%20Paul.)

Rasmussen, J. (1986). *Information processing and human-machine interaction.*
North-Holland, Amsterdam.
Google Scholar (https://scholar.google.com/scholar?
q=Rasmussen%2C%20J.%20%281986%29.%20Information%20processing%20a
nd%20human-machine%20interaction.%20North-Holland%2C%20Amsterdam.)

Schneider, M., Rittle-Johnson, B., & Star, J. R. (2011). Relations among
conceptual knowledge, procedural knowledge, and procedural flexibility in two
samples differing in prior knowledge. *Developmental Psychology, 47*(6), 1525.
Google Scholar (https://scholar.google.com/scholar?
q=Schneider%2C%20M.%2C%20Rittle-
Johnson%2C%20B.%2C%20%26%20Star%2C%20J.%20R.%20%282011%29.%2
0Relations%20among%20conceptual%20knowledge%2C%20procedural%20kno
wledge%2C%20and%20procedural%20flexibility%20in%20two%20samples%20
differing%20in%20prior%20knowledge.%20Developmental%20Psychology%2C
%2047%286%29%2C%201525.)

Schwaber, K. (1997). Scrum development process. In J. Sutherland, D. Patel, C.
Casanave, J. Miller, & G. Hollowell (Eds.), *OOPSLA business objects design and
implementation workshop proceedings.* London: Springer.
Google Scholar (https://scholar.google.com/scholar?
q=Schwaber%2C%20K.%20%281997%29.%20Scrum%20development%20proces
s.%20In%20J.%20Sutherland%2C%20D.%20Patel%2C%20C.%20Casanave%2C
%20J.%20Miller%2C%20%26%20G.%20Hollowell%20%28Eds.%29%2C%20OO
PSLA%20business%20objects%20design%20and%20implementation%20worksh

op%20proceedings.%20London%3A%20Springer.)

Schwaber, K. (2004). *Agile Project Management with scrum*. Microsoft Press. ISBN 978-0-7356-1993-7.
Google Scholar (http://scholar.google.com/scholar_lookup?title=Agile%20Project%20Management%20with%20scrum&author=K.%20Schwaber&publication_year=2004)

Star, J. R. (2005). Reconceptualizing procedural knowledge. *Journal for research in mathematics education*, 404–411.
Google Scholar (https://scholar.google.com/scholar?q=Star%2C%20J.%20R.%20%282005%29.%20Reconceptualizing%20procedural%20knowledge.%20Journal%20for%20research%20in%20mathematics%20education%2C%20404%E2%80%93411.)

Sutherland, J. (2014). *Scrum: The art of doing twice the work in half the time*. Crown Business, New York, USA. ISBN-13: 978-0385346450.
Google Scholar (https://scholar.google.com/scholar?q=Sutherland%2C%20J.%20%282014%29.%20Scrum%3A%20The%20art%20of%20doing%20twice%20the%20work%20in%20half%20the%20time.%20Crown%20Business%2C%20New%20York%2C%20USA.%20ISBN-13%3A%20978-0385346450.)

Taleb, N. N. (2007). *The black swan: The Impact of the Highly Improbable*. New York: Random House. ISBN 978-1-4000-6351-2. Expanded 2nd ed in 2010, ISBN 978-0812973815.
Google Scholar (https://scholar.google.com/scholar?q=Taleb%2C%20N.%20N.%20%282007%29.%20The%20black%20swan%3A%20The%20Impact%20of%20the%20Highly%20Improbable.%20New%20York%3A%20Random%20House.%20ISBN%20978-1-4000-6351-2.%20Expanded%202nd%20ed%20in%202010%2C%20ISBN%20978-0812973815.)

Vygotsky, L. S., Luria, A. R., Knox, J. E., Golod, V. I. & Knox, J. E. (1993). *Studies on the History of Behavior: Ape, Primitive, and Child*. Psychology Press, New York. ISBN 9780203772683. https://doi.org/10.4324/9780203772683.
Google Scholar (https://scholar.google.com/scholar?q=Vygotsky%2C%20L.%20S.%2C%20Luria%2C%20A.%20R.%2C%20Knox%2C%20J.%20E.%2C%20Golod%2C%20V.%20I.%20%26%20Knox%2C%20J.%20E.%20%281993%29.%20Studies%20on%20the%20History%20of%20Behavior%3A%20Ape%2C%20Primitive%2C%20and%20Child.%20Psychology%20Press%2C%20New%20York.%20ISBN%209780203772683.%20https%3A%2F%2Fdoi.org%2F10.4324%2F9780203772683.)

Willingham, D. B., Nissen, M. J., & Bullemer, P. (1989). On the development of procedural knowledge. *Journal of experimental psychology: learning, memory, and cognition, 15*(6), 1047.
Google Scholar (https://scholar.google.com/scholar?q=Willingham%2C%20D.%20B.%2C%20Nissen%2C%20M.%20J.%2C%20%26%20Bullemer%2C%20P.%20%281989%29.%20On%20the%20development%20of%20procedural%20knowledge.%20Journal%20of%20experimental%20psychology%3A%20learning%2C%20memory%2C%20and%20cognition%2C%2015%286%29%2C%201047.)

Section editors and affiliations

- Samira Bourgeois-Bougrine

There are no affiliations available

How to cite

Cite this entry as:
> Boy G.A. (2021) Human-Systems Integration. In: Glăveanu V.P. (eds) The Palgrave Encyclopedia of the Possible. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-98390-5_13-1

About this entry

- Reprints and Permissions