Online Resource 1 Supplement data table for Table 6 in main article. This table contains all the references with their corresponding identified complexity viewpoints by keyword

Origin	References	Identified complexity viewpoint by keyword										
		Social		*Process*			*System*					*Tooling*
		Organization (incl. strategies and culture)	**Designers / Human developers**	**Process / Method**	**Activity/ Task**	**Project**	**Domain / Discipline**	**Product**	**System**	**Design Knowledge**	**Design Information / Data**	**Tools/ IT system / Software application**
DSM	[1]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
DSM	[2]	✓	✓	✓		✓	✓	✓	✓		✓	✓
DSM	[3]	✓	✓	✓	✓	✓	✓	✓			✓	✓
DSM	[4]	✓	✓	✓	✓			✓	✓			✓
DSM	[5]		✓	✓	✓			✓	✓		✓	✓
DSM	[6]	✓	✓	✓	✓		✓	✓	✓		✓	
DSM	[7]	✓	✓	✓		✓		✓	✓		✓	
DSM	[8]	✓	✓	✓	✓		✓	✓	✓		✓	✓
DSM	[9]	✓	✓	✓	✓		✓	✓	✓		✓	✓
DSM	[10]	✓	✓	✓				✓	✓			✓
DSM	[11]	✓		✓	✓			✓	✓		✓	
Knowledge, Product	[12]	✓	✓	✓		✓		✓	✓	✓	✓	
Knowledge, Product	[13]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge, Product	[14]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Knowledge, Tool	[15]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Knowledge, Model	[16]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Knowledge	[17]	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Knowledge	[18]	✓	✓	✓		✓	✓		✓	✓	✓	✓
Knowledge	[19]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Knowledge	[20]	✓	✓	✓	✓			✓		✓	✓	✓
Knowledge	[21]	✓	✓		✓		✓	✓	✓	✓	✓	✓
Knowledge	[22]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Knowledge	[23]	✓	✓		✓	✓				✓	✓	✓
Knowledge	[24]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Knowledge	[25]	✓	✓	✓			✓	✓	✓	✓	✓	✓
Knowledge	[26]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

Origin	References	Identified complexity viewpoint by keyword										
		Social		*Process*			*System*					*Tooling*
		Organization (incl. strategies and culture)	Designers / Human developers	Process / Method	Activity/ Task	Project	Domain / Discipline	Product	System	Design Knowledge	Design Information / Data	Tools/ IT system / Software application
Knowledge	[27]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[28]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[29]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[30]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[31]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[32]	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Knowledge	[33]	✓	✓	✓	✓			✓	✓	✓	✓	✓
Knowledge	[34]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Knowledge	[35]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Knowledge	[36]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Knowledge	[37]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Knowledge	[38]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Knowledge	[39]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Knowledge	[40]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Knowledge, Product	[41]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Model	[42]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Model, Process, Product	[43]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model, Product	[44]	✓	✓	✓			✓	✓	✓		✓	✓
Model	[45]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Model	[46]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model	[47]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[48]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[49]	✓	✓	✓		✓	✓	✓	✓		✓	✓
Model	[50]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[51]	✓	✓	✓	✓		✓		✓	✓	✓	✓
Model	[52]		✓	✓	✓		✓		✓			✓
Model	[53]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Model	[54]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[55]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model	[56]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model	[57]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Origin	References	Identified complexity viewpoint by keyword										
		Social		*Process*			*System*					*Tooling*
		Organization (incl. strategies and culture)	Designers / Human developers	Process / Method	Activity/ Task	Project	Domain / Discipline	Product	System	Design Knowledge	Design Information / Data	Tools/ IT system / Software application
Model	[58]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[59]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model	[60]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Model	[61]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[62]	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Model	[63]		✓	✓	✓	✓	✓		✓			✓
Model	[64]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Model	[65]		✓	✓	✓		✓	✓	✓	✓	✓	✓
Model	[66]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[67]		✓	✓	✓		✓		✓		✓	✓
Model	[68]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[69]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Model	[70]		✓	✓	✓	✓			✓		✓	✓
Process, Product	[71]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process, Product	[72]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[73]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Process	[74]	✓	✓	✓		✓	✓		✓	✓	✓	✓
Process	[75]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[76]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[77]	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Process	[78]	✓	✓	✓	✓	✓	✓	✓		✓		✓
Process	[79]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[80]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[81]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[82]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Process	[83]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[84]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[85]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Process	[86]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Process	[87]	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Process	[88]		✓				✓	✓	✓		✓	✓
Process	[89]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Origin	References	Identified complexity viewpoint by keyword										
		Social		*Process*			*System*					*Tooling*
		Organization (incl. strategies and culture)	Designers / Human developers	Process / Method	Activity/ Task	Project	Domain / Discipline	Product	System	Design Knowledge	Design Information / Data	Tools/ IT system / Software application
Process	[90]		✓	✓	✓		✓	✓	✓		✓	✓
Process	[91]	✓	✓	✓	✓	✓		✓	✓		✓	✓
Process	[92]	✓	✓	✓	✓			✓	✓	✓	✓	✓
Process	[93]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[94]	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Process	[95]	✓	✓	✓		✓		✓	✓		✓	✓
Process	[96]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[97]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Process	[98]	✓	✓	✓			✓	✓	✓		✓	✓
Process	[99]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Product	[100]	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Product	[101]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Product	[102]	✓	✓	✓	✓	✓	✓	✓	✓			✓
Product	[103]	✓		✓		✓	✓	✓	✓		✓	✓
Product	[104]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Product	[105]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Product	[106]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Product	[107]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Product	[108]	✓	✓	✓	✓	✓	✓	✓			✓	✓
Product	[109]	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Product	[110]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Product	[111]	✓	✓	✓	✓			✓			✓	✓
Product	[112]	✓	✓	✓	✓			✓			✓	✓
Product	[113]	✓	✓	✓	✓	✓		✓		✓	✓	✓
Product	[114]	✓	✓	✓	✓	✓		✓		✓	✓	✓
Product	[115]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Product	[116]		✓	✓	✓	✓		✓	✓		✓	✓
Product	[117]	✓	✓	✓		✓		✓	✓	✓		✓
Product	[118]	✓	✓	✓		✓		✓	✓		✓	✓
Product	[119]	✓		✓	✓	✓	✓	✓			✓	✓
Product	[120]	✓		✓	✓		✓	✓	✓		✓	✓
Product	[121]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

Origin	References	Identified complexity viewpoint by keyword										
		Social		*Process*			*System*					*Tooling*
		Organization (incl. strategies and culture)	Designers / Human developers	Process / Method	Activity/ Task	Project	Domain / Discipline	Product	System	Design Knowledge	Design Information / Data	Tools/ IT system / Software application
Tool	[122]	✓	✓	✓		✓	✓	✓	✓		✓	✓
Tool	[123]		✓	✓	✓	✓		✓	✓		✓	✓
Tool	[124]	✓	✓	✓	✓	✓		✓		✓		✓
Tool	[125]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Tool	[126]		✓	✓	✓	✓	✓	✓	✓		✓	✓
Tool	[127]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tool	[128]	✓		✓			✓	✓	✓	✓		✓
Tool	[129]		✓	✓			✓	✓	✓		✓	✓
Tool	[130]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Tool	[131]	✓	✓		✓			✓	✓	✓	✓	✓
Tool	[132]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tool	[133]		✓				✓		✓			✓
Tool	[134]	✓	✓			✓	✓		✓	✓	✓	✓
Tool	[135]	✓	✓			✓	✓		✓			✓

REFERENCES

[1] T. R. Browning, "Design Structure Matrix Extensions and Innovations: A Survey and New Opportunities," *IEEE Trans. Eng. Manag.*, vol. 63, no. 1, pp. 27–52, Feb. 2016.

[2] V. Holley, M. Jankovic, and B. Yannou, "Physical interface ontology for management of conflicts and risks in complex systems," *Concurr. Eng. Res. Appl.*, vol. 22, no. 2, pp. 148–161, 2014.

[3] C. A. Shajahan, N. Firoz, S. Mohammed, V. R. Pramod N, and Ashim, "Managing Iterations in Product Development Process Using Dependency Structure Matrix," *J. Phys. Conf. Ser.*, vol. 1355, p. 12024, 2019.

[4] S. Li and L. Chen, "Identification of clusters and interfaces for supporting the implementation of change requests," *IEEE Trans. Eng. Manag.*, vol. 61, no. 2, pp. 323–335, 2014.

[5] S. Diagne, A. Coulibaly, and F. De Bertrand De Beuvron, "Complex product modeling based on a Multi-solution eXtended Conceptual Design Semantic Matrix for behavioral performance assessment," *Comput. Ind.*, vol. 75, pp. 101–115, Jan. 2016.

[6] S. Jung, O. Asikoglu, and T. W. Simpson, "A method to evaluate direct and indirect design dependencies between components in a product architecture," *Res. Eng. Des.*, vol. 29, no. 4, pp. 507–530, Oct. 2018.

[7] M. Wang, A. Höfer, and H. Friedrich, "Conceptual design of suspensions with integrated electric motors on the basis of DSM," in *20 TH INTERNATIONAL DEPENDENCY AND STRUCTURE MODELING CONFERENCE*, 2018, pp. 105–114.

[8] T. Habib, "Multidisciplinary Product Decomposition and Analysis Based on Design Structure Matrix Modeling," in *7th World Conference on Mass Customization, Personalization, and Co-Creation (MCPC)*, 2014, pp. 409–423.

[9] G. B. Loureiro, J. Carlos, E. Ferreira, P. Henrique, and Z. Messerschmidt, "Design structure network (DSN): a method to make explicit the product design specification process for mass customization," *Res. Eng. Des.*, vol. 31, pp. 197–220, Feb. 2020.

[10] O. Ezzat *et al.*, "A DSM Clustering Method for Product and Service Modularization," in *IFIP Advances in Information and Communication Technology*, 2019, vol. 566, pp. 375–382.

[11] I. Westphal, M. Freitag, and K. D. Thoben, "Visualization of interactions between product and service lifecycle management," in *IFIP Advances in Information and Communication Technology*, 2015, vol. 460, pp. 575–582.

[12] P. E. Arduin, J. Le Duigou, M. H. Abel, and B. Eynard, "Knowledge sharing in design based on product lifecycle management system," in *Smart Innovation, Systems and Technologies*, 2015, vol. 35, pp. 507–517.

[13] J. R. Jupp and M. Nepal, “BIM and PLM: Comparing and learning from changes to professional practice across sectors,” *IFIP Adv. Inf. Commun. Technol.*, vol. 442, pp. 41–50, 2014.
[14] G. Bruno, D. Antonelli, R. Korf, J. Lentes, and N. Zimmermann, “Exploitation of a Semantic Platform to Store and Reuse PLM Knowledge,” in *IFIP Advances in Information and Communication Technology*, 2014, vol. 438, no. PART 1, pp. 59–66.
[15] R. Mordinyi, E. Serral, and F. J. Ekaputra, “Semantic Data Integration: Tools and Architectures,” in *Semantic Web Technologies for Intelligent Engineering Applications*, Springer International Publishing, 2016, pp. 181–217.
[16] Y. Chen and J. Jupp, “Model-based systems engineering and through-life information management in complex construction,” in *Product Lifecycle Management to Support Industry 4.0. PLM 2018. IFIP Advances in Information and Communication Technology*, 2018, vol. 540, pp. 80–92.
[17] T. Boge and K. Falk, “A3 Architecture Views-A Project Management Tool?,” in *29th Annual INCOSE International Symposium*, 2019, pp. 971–987.
[18] Z. Alexeeva, D. Perez-Palacin, and R. Mirandola, “Design decision documentation: A literature overview,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2016, vol. 9839 LNCS, pp. 84–101.
[19] Y. Chen and J. Jupp, “BIM and Through-Life Information Management: A Systems Engineering Perspective,” in *Advances in Informatics and Computing in Civil and Construction Engineering*, Springer International Publishing, 2019, pp. 137–146.
[20] W. J. Kettinger, Y. Li, J. M. Davis, and L. Kettinger, “The roles of psychological climate, information management capabilities, and IT support on knowledge-sharing: An MOA perspective,” *Eur. J. Inf. Syst.*, vol. 24, no. 1, pp. 59–75, Jan. 2015.
[21] S. Liu and P. Zaraté, “Knowledge based decision support systems: A survey on technologies and application domains,” in *Lecture Notes in Business Information Processing*, 2014, vol. 180 LNBIP, pp. 62–72.
[22] J. Stjepandić, W. J. C. Verhagen, H. Liese, and P. Bermell-Garcia, “Knowledge-based engineering,” in *Concurrent Engineering in the 21st Century: Foundations, Developments and Challenges*, Springer International Publishing, 2015, pp. 255–286.
[23] S. Zhang, “Knowledge Management Environment for Collaborative Design in Product Development,” in *IFIP Advances in Information and Communication Technology*, 2019, vol. 567, pp. 475–480.
[24] S. E. Schapke, J. Beetz, M. König, C. Koch, and A. Borrmann, “Collaborative data management,” in *Building Information Modeling: Technology Foundations and Industry Practice*, Springer International Publishing, 2018, pp. 251–277.
[25] L. Hou and R. J. Jiao, “Data-informed inverse design by product usage information: a review, framework and outlook,” *Journal of Intelligent Manufacturing*, vol. 31, no. 3. Springer, pp. 529–552, 01-Mar-2020.
[26] W. qiang Li and Y. Li, “A study on the collaborative management method of product design cycle knowledge,” *Multimed. Tools Appl.*, vol. 77, no. 21, pp. 27877–27894, Nov. 2018.
[27] Y. Sen, “Knowledge as a Valuable Asset of Organizations: Taxonomy, Management and Implications,” Springer, Cham, 2019, pp. 29–48.
[28] A. Mayr *et al.*, “Towards a Knowledge-Based Design Methodology for Managing the Complexity in the Integrated Product and Process Development of Electric Motors,” in *Advances in Production Research*, Springer International Publishing, 2019, pp. 112–125.
[29] A. Zouari, “Knowledge versioning dynamics during the design process in a concurrent engineering environment,” *Lect. Notes Mech. Eng.*, vol. 789, pp. 11–20, 2015.
[30] M. Levy, I. Hadar, and I. Aviv, “A requirements engineering methodology for knowledge management solutions: integrating technical and social aspects,” *Requir. Eng.*, vol. 24, no. 4, pp. 503–521, Dec. 2019.
[31] C. Hennig, A. Viehl, B. Kämpgen, and H. Eisenmann, “Ontology-based design of space systems,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2016, vol. 9982 LNCS, pp. 308–324.
[32] M. Sabou, O. Kovalenko, F. J. Ekaputra, and S. Biffl, “Semantic Web Solutions in Engineering,” in *Semantic Web Technologies for Intelligent Engineering Applications*, Springer International Publishing, 2016, pp. 281–296.
[33] G. Bruno, E. Traini, and F. Lombardi, “A Knowledge-Based System for Collecting and Integrating Production Information,” in *IFIP Advances in Information and Communication Technology*, 2019, vol. 568, pp. 163–170.
[34] A. Al Khatib, D. Fleche, M. Mahdjoub, J. B. Bluntzer, and J. C. Sagot, “Preparation of CAD model for collaborative design meetings: Proposition of a CAD add-on,” *Adv. Mech. Des. Eng. Manuf. Lect. Notes Mech. Eng.*, pp. 861–870, 2017.
[35] S. Sukumaran and K. Chandran, “The unspoken requirements - eliciting tacit knowledge as building blocks for knowledge management systems,” *Lect. Notes Bus. Inf. Process.*, vol. 224, pp. 26–40, 2015.
[36] D. Ahlers, M. Mehrpoor, K. Kristensen, and J. Krogstie, “Challenges for information access in multi-disciplinary product design and engineering settings,” in *The 10th International Conference on Digital Information Management, ICDIM 2015*, 2016, pp. 109–114.
[37] T. McDermott, J. Zentner, and N. Bollweg, “Thinking from the system architecture: A better methodology for capture of collaborative knowledge,” in *2014 International Conference on Collaboration Technologies and Systems (CTS)*, 2014, pp. 472–473.

[38] C. A. Rivera, J. Poza, G. Ugalde, and G. Almandoz, "A Knowledge Based System architecture to manage and automate the electrical machine design process," in *Proceedings of the 2017 IEEE International Workshop of Electronics, Control, Measurement, Signals and their Application to Mechatronics, ECMSM 2017*, 2017, pp. 1–6.

[39] L. C. Anderson and C. A. Kieliszewski, "A Socio-Technical Perspective in Support of Information Sharing for Diverse Teams in Today's Workplace," in *Proceedings - 2017 IEEE 3rd International Conference on Collaboration and Internet Computing, CIC 2017*, 2017, vol. 2017-Janua, pp. 416–420.

[40] F. Toepfer and T. Naumann, "Towards Cross-Linked Development of Highly Complex Products," in *Proceedings of the 21st International Conference on Engineering Design (ICED17)*, 2017, vol. 2, no. August, pp. 279–288.

[41] J. Camba, M. Contero, and G. Salvador-herranz, "Implementation challenges of annotated 3D models in collaborative design environments," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 8683, pp. 222–229, 2014.

[42] W. K. Vaneman and R. Carlson, "Model-based systems engineering implementation considerations," in *SysCon 2019 - 13th Annual IEEE International Systems Conference, Proceedings*, 2019.

[43] M. Eigner, T. Dickopf, H. Apostolov, P. Schaefer, K.-G. Fai\s st, and A. Ke\s sler, "System Lifecycle Management: Initial Approach for a Sustainable Product Development Process Based on Methods of Model Based Systems Engineering," no. July, pp. 287–300, 2014.

[44] S. Li, H. El-Mounayri, W. Zhang, B. Schindel, and J. Sherey, "Implementation of systems engineering model into product lifecycle management platform," in *IFIP Advances in Information and Communication Technology*, 2016, vol. 467, pp. 601–608.

[45] R. Cloutier, B. Sauser, M. Bone, and A. Taylor, "Transitioning systems thinking to model-based systems engineering: Systemigrams to SysML models," *IEEE Trans. Syst. Man, Cybern. Syst.*, vol. 45, no. 4, pp. 662–674, Apr. 2015.

[46] C. Tschirner, L. Bretz, R. Dumitrescu, and J. Gausemeier, "Applying Model-Based Systems Engineering for Product Engineering Management Concepts for Industrial Application," *IEEE Syst. J.*, 2015.

[47] T. Amorim, A. Vogelsang, F. Pudlitz, P. Gersing, and J. Philipps, "Strategies and Best Practices for Model-Based Systems Engineering Adoption in Embedded Systems Industry," in *Proceedings - 2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering in Practice, ICSE-SEIP 2019*, 2019, pp. 203–212.

[48] J. D'Ambrosio and G. Soremekun, "Systems engineering challenges and MBSE opportunities for automotive system design," *2017 IEEE Int. Conf. Syst. Man, Cybern. SMC 2017*, vol. 2017-Janua, pp. 2075–2080, 2017.

[49] U. Shani and H. Broodney, "Reuse in model-based systems engineering," *9th Annu. IEEE Int. Syst. Conf. SysCon 2015 - Proc.*, pp. 77–83, 2015.

[50] A. Garro and A. Tundis, "Modeling of system properties: Research challenges and promising solutions," in *1st IEEE International Symposium on Systems Engineering, ISSE 2015 - Proceedings*, 2015, pp. 324–331.

[51] B. P. Zeigler, J. W. Marvin, and J. J. Cadigan, "Systems engineering and simulation: Converging toward noble causes," in *Proceedings - Winter Simulation Conference*, 2019, vol. 2018-Decem, pp. 3742–3752.

[52] M. Nikolaidou, G. D. Kapos, A. Tsadimas, V. Dalakas, and D. Anagnostopoulos, "Simulating SysML models: Overview and challenges," *2015 10th Syst. Syst. Eng. Conf. SoSE 2015*, pp. 328–333, 2015.

[53] Z. Huang, S. Swalgen, H. Davidz, and J. Murray, "MBSE-assisted FMEA approach - Challenges and opportunities," in *Proceedings - Annual Reliability and Maintainability Symposium*, 2017.

[54] A. Vogelsang, T. Amorim, F. Pudlitz, P. Gersing, and J. Philipps, "Should i stay or should i go?: On forces that drive and prevent mbse adoption in the embedded systems industry," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2017, vol. 10611 LNCS, pp. 182–198.

[55] M. Bajaj, B. Cole, and D. Zwemer, "Architecture To Geometry - Integrating System Models With Mechanical Design," *Aiaa Sp. 2016*, pp. 1–19, 2016.

[56] V. Arnould, "Using model-driven approach for engineering the system engineering system," in *2018 13th System of Systems Engineering Conference, SoSE 2018*, 2018, pp. 608–614.

[57] M. Pasquinelli, L. Molina-Tanco, A. Reyes-Lecuona, and M. Cencetti, "Extending the System Model," in *Dynamics of Long-Life Assets: From Technology Adaptation to Upgrading the Business Model*, S. Grösser, A. Reyes-Lecuona, and G. Granholm, Eds. 2017, pp. 169–189.

[58] J. Denil, R. Salay, C. Paredis, and H. Vangheluwe, "Towards agile model-based systems engineering," *CEUR Workshop Proc.*, vol. 2019, pp. 424–429, 2017.

[59] M. Schäfer, F. Bitsch, S. Weißleder, and F. Wartenberg, "Challenges for MBSE and PLE for legacy product-based system environments," in *Proceedings of the 7th International Conference on Complex Systems Design and Management, CSD and M Paris 2016*, 2016, no. 131030, pp. 3–15.

[60] A. M. Madni and M. Sievers, "Model-based systems engineering: Motivation, current status, and needed advances," in *Disciplinary Convergence in Systems Engineering Research*, Springer International Publishing, 2017, pp. 311–325.

[61] R. Leroux, M. Pantel, I. Ober, and J.-M. Bruel, "Model-Based Systems Engineering for Systems Simulation," in *Leveraging Applications of Formal Methods, Verification and Validation. Distributed Systems. ISoLA 2018. Lecture Notes in Computer Science*, T. Margaria and B. Steffen, Eds. Springer, Cham, 2018, pp. 429–448.

[62] C. Dumitrescu, P. Tessier, C. Salinesi, S. Gérard, A. Dauron, and R. Mazo, "Capturing Variability in Model Based Systems Engineering," in *Complex Systems Design & Management*, Aiguier.

M., F. Boulanger, D. Krob, and C. Marchal, Eds. Springer International Publishing, 2014, pp. 125–139.
[63] S. Wolny, A. Mazak, C. Carpella, V. Geist, and M. Wimmer, “Thirteen years of SysML: a systematic mapping study,” *Softw. Syst. Model.*, vol. 19, no. 1, pp. 111–169, Jan. 2020.
[64] H. Hick, M. Bajzek, and C. Faustmann, “Definition of a system model for model-based development,” *SN Appl. Sci.*, vol. 1, no. 9, pp. 1–15, Sep. 2019.
[65] L. Berardinelli, A. Mazak, O. Alt, M. Wimmer, and G. Kappel, “Model-Driven Systems Engineering: Principles and application in the CPPS domain,” in *Multi-Disciplinary Engineering for Cyber-Physical Production Systems: Data Models and Software Solutions for Handling Complex Engineering Projects*, Springer International Publishing, 2017, pp. 261–299.
[66] G. Liebel, N. Marko, M. Tichy, A. Leitner, and J. Hansson, “Model-based engineering in the embedded systems domain: an industrial survey on the state-of-practice,” *Softw. Syst. Model.*, vol. 17, no. 1, pp. 91–113, Feb. 2018.
[67] N. Albarello and H. Kim, “Application of an MBSE Approach for the Integration of Multidisciplinary Design Processes,” in *Complex Systems Design & Management*, Springer International Publishing, 2014, pp. 85–96.
[68] T. Huldt and I. Stenius, “State-of-practice survey of model-based systems engineering,” *Syst. Eng.*, vol. 22, pp. 134–145, Jul. 2019.
[69] M. Chami, A. Aleksandraviciene, A. Morkevicius, and J.-M. Bruel, “Towards Solving MBSE Adoption Challenges: The D3 MBSE Adoption Toolbox,” in *28th Annual INCOSE International Symposium*, 2018, pp. 1463–1477.
[70] B. A. Morris, D. Harvey, K. P. Robinson, and S. C. Cook, “Issues in Conceptual Design and MBSE Successes: Insights from the Model-Based Conceptual Design Surveys,” in *26th Annual INCOSE International Symposium (IS 2016)*, 2016, pp. 269–282.
[71] C. Zheng, M. Bricogne, J. Le Duigou, and B. Eynard, “Survey on mechatronic engineering: A focus on design methods and product models,” *Adv. Eng. Informatics*, vol. 28, no. 3, pp. 241–257, 2014.
[72] Y. Li, U. Roy, and J. S. Saltz, “Towards an integrated process model for new product development with data-driven features (NPD 3),” *Res. Eng. Des.*, vol. 30, no. 2, pp. 271–289, Apr. 2019.
[73] C. Zheng, P. Hehenberger, J. Le Duigou, M. Bricogne, and B. Eynard, “Multidisciplinary design methodology for mechatronic systems based on interface model,” *Res. Eng. Des.*, vol. 28, no. 3, pp. 333–356, 2017.
[74] Y. Cao, Y. Liu, X. Ye, J. Zhao, and S. Gao, “Software-physical synergetic design methodology of mechatronic systems based on formal functional models,” *Res. Eng. Des.*, vol. 31, no. 2, pp. 235–255, Apr. 2020.
[75] C. Melville, X. T. Yan, and L. Gu, “TiV-model-an attempt at breaching the industry adoption barrier for new complex system design methodologies,” in *Mechatronic Futures: Challenges and Solutions for Mechatronic Systems and Their Designers*, Springer International Publishing, 2016, pp. 41–57.
[76] P. Hehenberger, T. J. Howard, and J. Torry-Smith, “From mechatronic systems to cyber-physical systems: Demands for a new design methodology?,” in *Mechatronic Futures: Challenges and Solutions for Mechatronic Systems and Their Designers*, Springer International Publishing, 2016, pp. 147–163.
[77] C. Hollauer, L. Becerril, N. Kattner, D. Weidmann, N. Chucholowski, and U. Lindemann, “Adaptable mechatronic engineering design processes: Process reference model and methodology,” in *Smart Innovation, Systems and Technologies*, 2017, vol. 65, pp. 597–607.
[78] P. E. Vermaas, “Design Methodology and Engineering Design,” in *Engineering Identities, Epistemologies and Values*, Springer, Cham, 2015, pp. 147–159.
[79] D. C. Wynn and P. J. Clarkson, “Process models in design and development,” *Res. Eng. Des.*, vol. 29, no. 2, pp. 161–202, Apr. 2018.
[80] L. Kathrein, A. Lüder, K. Meixner, D. Winkler, and S. Biffl, “Product/ion-Aware Analysis of Collaborative Systems Engineering Processes,” in *Security and Quality in Cyber-Physical Systems Engineering*, Springer International Publishing, 2019, pp. 151–185.
[81] M. V. Pereira Pessôa and J. M. Jauregui Becker, “Smart design engineering: a literature review of the impact of the 4th industrial revolution on product design and development,” *Res. Eng. Des.*, vol. 31, no. 2, pp. 175–195, Apr. 2020.
[82] M. Bricogne, J. Le Duigou, and B. Eynard, “Design Processes of Mechatronic Systems,” in *Mechatronic Futures*, P. Hehenberger and D. Bradley, Eds. Springer International Publishing Switzerland, 2016, pp. 75–89.
[83] M. Marchesi and D. T. Matt, “Application of Axiomatic Design to the Design of the Built Environment: A Literature Review,” in *Axiomatic Design in Large Systems*, Springer International Publishing, 2016, pp. 151–174.
[84] M. Törngren and U. Sellgren, “Complexity Challenges in Development of Cyber-Physical Systems,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, vol. 10760 LNCS, Springer Verlag, 2018, pp. 478–503.
[85] W. E. Eder, “Engineering Design: Role of Theory, Models, and Methods,” in *An Anthology of Theories and Models of Design*, Springer London, 2014, pp. 197–217.
[86] M. Stacey, C. Eckert, and R. Hillerbrand, “Process models: plans, predictions, proclamations or prophecies?,” *Res. Eng. Des.*, vol. 31, no. 1, pp. 83–102, Jan. 2020.
[87] A. Jakjoud, M. Zrikem, C. Baron, and A. Ayadi, “SysPEM: Toward a consistent and unified system process engineering metamodel,” *J. Intell. Manuf.*, vol. 27, no. 1, pp. 149–166, Mar. 2016.
[88] A. Cicchetti, F. Ciccozzi, and A. Pierantonio, “Multi-view approaches for software and system modelling: a systematic literature review,” *Softw. Syst. Model.*, vol. 18, no. 6, pp. 3207–3233, Dec. 2019.
[89] R. Curran, X. Zhao, and W. J. C. Verhagen, “Concurrent engineering and integrated aircraft design,” in *Concurrent Engineering in the 21st Century: Foundations, Developments and*

Challenges, Springer International Publishing, 2015, pp. 571–605.
[90] O. Bielefeld, V. Sizikov, and N. Schlüter, "Research of the Possibilities for Using and Linking TRIZ Methods with Systems Engineering," in *IFIP Advances in Information and Communication Technology*, 2019, vol. 572, pp. 174–186.
[91] C. Haskins and K. S. Ruud, "Systems engineering: Making people talk!," in *Disciplinary Convergence in Systems Engineering Research*, Springer International Publishing, 2017, pp. 1081–1093.
[92] A. Pla, P. Gay, J. Meléndez, and B. López, "Petri net-based process monitoring: A workflow management system for process modelling and monitoring," *J. Intell. Manuf.*, vol. 25, no. 3, pp. 539–554, Oct. 2014.
[93] S. Biffl, A. Lüder, and D. Winkler, "Multi-Disciplinary Engineering for Industrie 4.0: Semantic Challenges and Needs," in *Semantic Web Technologies for Intelligent Engineering Applications*, Springer International Publishing, 2016, pp. 17–51.
[94] C. Weber, "Modelling Products and Product Development Based on Characteristics and Properties," in *An Anthology of Theories and Models of Design*, Springer London, 2014, pp. 327–352.
[95] N. P. Suh, "Challenges in Designing and Implementing Large Systems (Overcoming Cost Overruns and Missed Project Schedules)," in *Axiomatic Design in Large Systems*, Springer International Publishing, 2016, pp. 273–309.
[96] J. F. Maier, D. C. Wynn, W. Biedermann, U. Lindemann, and P. J. Clarkson, "Simulating progressive iteration, rework and change propagation to prioritise design tasks," *Res. Eng. Des.*, vol. 25, no. 4, pp. 283–307, Jun. 2014.
[97] R. Mehr and A. Lüder, "Managing Complexity Within the Engineering of Product and Production Systems," in *Security and Quality in Cyber-Physical Systems Engineering*, Springer International Publishing, 2019, pp. 57–79.
[98] Y. Mordecai and D. Dori, "I5 : A Model-Based Framework for Architecting System-of-Systems Interoperability, Interconnectivity, Interfacing, Integration, and Interaction," in *INCOSE International Symposium*, 2013, pp. 1234–1255.
[99] K. Paetzold, "Product and Systems Engineering/CA* tool chains," in *Multi-Disciplinary Engineering for Cyber-Physical Production Systems: Data Models and Software Solutions for Handling Complex Engineering Projects*, Springer International Publishing, 2017, pp. 27–62.
[100] L. Horvath, "New method for enhanced driving of entity generation in RFLP structured product model," in *Proceedings of the 2017 12th IEEE Conference on Industrial Electronics and Applications, ICIEA 2017*, 2018, vol. 2018-Febru, pp. 541–546.
[101] F. Zeng, B. Li, P. Zheng, and S. S. Q. Xie, "A modularized generic product model in support of product family modeling in One-of-a-Kind Production," in *2014 IEEE International Conference on Mechatronics and Automation, IEEE ICMA 2014*, 2014, pp. 786–791.
[102] A. Deuter, A. Otte, M. Ebert, and F. Possel-Dölken, "Developing the Requirements of a PLM/ALM Integration: An Industrial Case Study," in *Procedia Manufacturing*, 2018, vol. 24, pp. 107–113.
[103] M. Bitzer, M. Vielhaber, and J. Kaspar, "Product lifecycle management - How to adapt PLM to support changing product development processes in industry?," *Proc. Nord. Nord. 2016*, vol. 1, 2016.
[104] W. Wang, P. Lünnemann, S. Neumeyer, H. Hayka, and R. Stark, "Product Development in Collaborative Networks-An Expert View on Current Challenges and Future Trends," in *17th Working Conference on Virtual Enterprises (PRO-VE)*, 2016, pp. 302–312.
[105] D. Gerhard, "Product lifecycle management challenges of CPPS," in *Multi-Disciplinary Engineering for Cyber-Physical Production Systems: Data Models and Software Solutions for Handling Complex Engineering Projects*, Springer International Publishing, 2017, pp. 89–110.
[106] A. K. Behera *et al.*, "Sharing design definitions across product life cycles," *Res. Eng. Des.*, vol. 30, no. 3, pp. 339–361, Jul. 2019.
[107] J. D. Camba, M. Contero, G. Salvador-Herranz, and R. Plumed, "Synchronous communication in PLM environments using annotated CAD models," *J. Syst. Sci. Syst. Eng.*, vol. 25, no. 2, pp. 142–158, 2016.
[108] V. Nosenzo, S. Tornincasa, E. Bonisoli, and M. Brino, "Open questions on Product Lifecycle Management (PLM) with CAD /CAE integration," *Int. J. Interact. Des. Manuf.*, vol. 8, no. 2, pp. 91–107, Apr. 2014.
[109] C. C. Wu, C. F. Ho, W. H. Hung, and K. H. Kung, "PLM usage behavior and technology adaptation," in *Communications in Computer and Information Science*, vol. 473, Springer Verlag, 2014, pp. 76–91.
[110] S. Matthiesen, P. Grauberger, F. Bremer, and K. Nowoseltschenko, "Product models in embodiment design: an investigation of challenges and opportunities," *SN Appl. Sci.*, vol. 1, no. 9, pp. 1–11, Sep. 2019.
[111] A. Katzenbach, S. Handschuh, R. Dotzauer, and A. Fröhlich, "Product lifecycle visualization," in *Concurrent Engineering in the 21st Century: Foundations, Developments and Challenges*, Springer International Publishing, 2015, pp. 287–318.
[112] M. Huhtala, M. Lohtander, and J. Varis, "Product data management – Defining the used terms," *IFIP Adv. Inf. Commun. Technol.*, vol. 442, pp. 387–396, 2014.
[113] M. Rossi, L. Cattaneo, J. Le Duigou, S. Fugier-Garrel, S. Terzi, and B. Eynard, "Lean product development and the role of PLM," in *IFIP Advances in Information and Communication*

Technology, 2016, vol. 492, pp. 183–192.

[114] S. Sharma, F. Segonds, N. Maranzana, D. Chasset, and V. Frerebeau, “Towards cloud based collaborative design – analysis in digital PLM environment,” in *IFIP Advances in Information and Communication Technology*, 2018, vol. 540, pp. 261–270.

[115] T. Vosgien, E. Rigger, M. Schwarz, and K. Shea, “A Federated Enterprise Architecture and MBSE Modeling Framework for Integrating Design Automation into a Global PLM Approach,” vol. 517, pp. 36–48, 2017.

[116] F. Noël and D. Dori, “Towards 3D visualization metaphors for better PLM perception,” in *IFIP Advances in Information and Communication Technology*, 2016, vol. 467, pp. 461–475.

[117] B. Koomen, “Set based PLM implementation, a modular approach to PLM process knowledge, management and automation,” in *IFIP Advances in Information and Communication Technology*, 2017, vol. 517, pp. 3–12.

[118] J.-J. Urban-Galindo and S. Ripailles, “PLM at GROUPE PSA,” in *Product Lifecycle Management (Volume 4): The Case Studies*, Springer, Cham, 2019, pp. 29–50.

[119] C. Boton, L. Rivest, D. Forgues, and J. Jupp, “Comparing PLM and BIM from the product structure standpoint,” in *IFIP Advances in Information and Communication Technology*, 2016, vol. 492, pp. 443–453.

[120] D. Weidmann *et al.*, “Product models in mechatronic design: Literature analysis on the interdisciplinary character of product models,” in *PICMET 2017 - Portland International Conference on Management of Engineering and Technology: Technology Management for the Interconnected World, Proceedings*, 2017, vol. 2017-Janua, pp. 1–7.

[121] S. P. Leino, L. Jokinen, J. P. Anttila, and A. Pulkkinen, “Case study on engineering change management and digital manufacturing,” in *IFIP Advances in Information and Communication Technology*, 2015, vol. 467, pp. 591–600.

[122] J. Sztipanovits, T. Bapty, X. Koutsoukos, Z. Lattmann, S. Neema, and E. Jackson, “Model and Tool Integration Platforms for Cyber-Physical System Design,” *Proc. IEEE*, vol. 106, no. 9, pp. 1501–1526, Sep. 2018.

[123] M. Ozkaya, “Are the UML modelling tools powerful enough for practitioners? A literature review,” *IET Software*, vol. 13, no. 5. Institution of Engineering and Technology, pp. 338–354, 01-Oct-2019.

[124] D. Ziegenhagen, A. Speck, and E. Pulvermüller, “Using Developer-tool-Interactions to Expand Tracing Capabilities,” in *Proceedings of the 14th International Conference on Evaluation of Novel Approaches to Software Engineering (ENASE 2019),* 2019, pp. 518–525.

[125] I. Vagliano, D. Ferretto, E. Brusa, M. Morisio, and L. Valacca, “Tool Integration in the Aerospace Domain: A Case Study,” in *Proceedings - International Computer Software and Applications Conference*, 2017, vol. 1, pp. 731–736.

[126] A. Leitner, B. Herbst, and R. Mathijssen, “Lessons Learned from Tool Integration with OSLC,” in *Communications in Computer and Information Science*, 2016, vol. 639, pp. 242–254.

[127] F. Asplund and M. Törngren, “The discourse on tool integration beyond technology, a literature survey,” *J. Syst. Softw.*, vol. 106, pp. 117–131, Aug. 2015.

[128] J. Sztipanovits, T. Bapty, S. Neema, L. Howard, and E. Jackson, “OpenMETA: A model- and component-based design tool chain for cyber-physical systems,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2014, vol. 8415 LNCS, pp. 235–248.

[129] G. Macher, E. Armengaud, and C. Kreiner, “Integration of heterogeneous tools to a seamless automotive toolchain,” in *Communications in Computer and Information Science*, 2015, vol. 543, pp. 51–62.

[130] R. Mordiny, D. Winkler, F. Waltersdorfer, S. Scheiber, and S. Biffl, “Integrating heterogeneous engineering tools and data models: A roadmap for developing engineering system architecture variants,” in *Lecture Notes in Business Information Processing*, 2015, vol. 200, pp. 89–107.

[131] A. Zolotas *et al.*, “Bridging proprietary modelling and open-source model management tools: the case of PTC Integrity Modeller and Epsilon,” *Softw. Syst. Model.*, vol. 19, no. 1, pp. 17–38, Jan. 2020.

[132] S. Imran, M. Buchheit, B. Hollunder, and U. Schreier, “Tool chains in agile ALM environments: A short introduction,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2015, vol. 9416, pp. 371–380.

[133] N. Amálio, R. Payne, A. Cavalcanti, and J. Woodcock, “Checking sysML models for co-simulation,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2016, vol. 10009 LNCS, pp. 450–465.

[134] B. Cole and K. Dinkel, “Multidisciplinary model transformation through simplified intermediate representations,” in *IEEE Aerospace Conference Proceedings*, 2016, vol. 2016-June.

[135] P. G. Larsen, J. Fitzgerald, J. Woodcock, C. Gamble, R. Payne, and K. Pierce, “Features of integrated model-based co-modelling and co-simulation technology,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2018, vol. 10729 LNCS, pp. 377–390.