*Human Factors in Design, Engineering, and Computing*, Vol. 238, 2026, 579–589
https://doi.org/10.54941/ahfe1008290

# An Analysis of Handoff Processes in Global Teams

**Daniel Fernandes da Cunha, Katleen Karla Barbosa Picanço, Barbara Annitza Torres Silva, Lanier Menezes dos Santos, and Erick Costa Bezerra**

Sidia Instituto de Ciência e Tecnologia, Manaus, AM, Brazil

## ABSTRACT

In the current software development sector, effective design handoff processes are essential. Teams must ensure seamless collaboration and knowledge transfer among members in diverse geographical locations. This study explores challenges and opportunities in design handoff for global teams, aiming to identify best practices and strategies for improving delivery methods. The analysis includes factors like cross-cultural communication, time zone differences, communication technologies, and semiotics. We administered a questionnaire to identify gaps in design handoff processes between multicultural teams. Based on the results, we discussed the findings to further explore issues surrounding these workflows. By examining this critical aspect of global team dynamics, the research offers significant insights for businesses and organizations seeking to enhance design delivery processes in international collaboration environments.

**Keywords:** Design handoff, Global teams, Cross-cultural

## INTRODUCTION

Corporate globalization and increased remote work have made collaboration between geographically distributed teams more common (Mohrman, 1999), particularly when it comes to software development teams (Leinonen and Roto, 2023). This model distributes teams globally, challenging designers during handoffs due to cultural differences, potentially making communication between teams difficult.

During software development, the design handoff is a collaborative process where designers transfer concepts and guidelines for a product or its graphical implementation via code (Feng and Zhang, 2022). This facilitates efficient team collaboration, enabling smooth execution in projects that may face challenges due to cultural diversity, especially in interpreting processes versus results (Annamalai Vasantha et al., 2014).

The design handoff process serves as an effective mediator, enabling a smooth and structured transition between project stages. This facilitates the flow of information, knowledge, and tasks, regardless of team's geographical locations. When companies promote digital transformation, this process helps minimize team disparities, ensuring alignment with common goals and strategies (Leinonen and Roto, 2023). By preventing activity fragmentation

Received August 14, 2026; Revised September 26, 2026; Accepted October 7, 2026; Available online December 1, 2026

© 2026 The Authors. This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 License.
For more information, see https://creativecommons.org/licenses/by-nc-nd/4.0/

and redundant efforts, it maximizes operational efficiency within diverse cultural backgrounds.

The design handoff process between multicultural teams can be analyzed in several ways. These include studying and interpreting each team's social anthropology, their cultural origins, evolution, and information interpretation, as well as generally understanding the results of collaborative work, taking into account the spoken language and time zone (Annamalai Vasantha et al., 2014). In this sense, understanding how global teams conduct design handoffs, along with related impacts and challenges, helps apply best practices for effective, clear delivery.

This article aims to analyze the design handoff process from the perspective of developers, designers, and other professionals in global teams. By shedding light on communication issues common in distributed contexts and providing actionable solutions, teams can deliver more effectively and assertively. Addressing these communication barriers enhances productivity, increases efficiency, and ultimately contributes to the success of global teams.

The remaining sections of this work are organized as follows: Section 2 presents a literature review establishing the context underlying the research. Section 3 outlines the methodology. Section 4 details the survey and its characteristics. Section 5 discusses the survey results. Finally, Section 6 concludes and suggests future research in this area.

## BACKGROUND

Information exchange between team members from varying cultures can be challenging due to disparities in communication methods (Annamalai Vasantha et al., 2014). Intercultural communication skills are needed to manage potential misconceptions and develop empathy among team members (Gudykunst, 2003).

Furthermore, semiotics, or the study of signs and symbols (Yakin and Totu, 2014), plays an important role in the handover process. By acknowledging the importance of non-verbal cues and adopting standardized observation techniques, global teams can overcome linguistic barriers and ensure the efficient transfer of tasks and responsibilities. In the following paragraphs, we will explore these concepts.

### Literature Review

The software development sector is an environment where fluid communication is essential. Deliveries depend on effective communication and negotiations among parties (Atwood et al., 1999). However, cultural disparities in a multinational setting pose certain challenges, as these differences can often lead to miscommunication.

According to Gudykunst (2003), intercultural communication falls into a communication hole typically focused on communication between two individuals from different locations, generating ideas, and negotiating them. Both parties consistently seek consensus. When this type of communication occurs between continents, they could be even more challenging, as greater distances often correlate with increased cultural diversity.

The communication interpretation in design and its handoff process is complex, as each society has its own cultural identity (Misuko, 2004). This requires a sensitive and adaptable approach, especially since symbols or colors may carry different meanings across societies.

According to Yakin and Totu (2014), semiotics, a field linking symbol systems and their meanings, focuses on systematic methods for structuring and operationalizing symbols, providing clear communication between parties. In this note, two prominent scholars, Leed-Hurtwitz (1993) and Eco (1976), compare semiotics and communication views as inherently human, defining semiotics as the study of signs functioning as symbols and signals. Complementing this view, Misuko (2004) affirms that designers play a crucial role in creating and reproducing cultural signs to facilitate understanding.

The basic definition of handoff, or handover, is a short-term knowledge transfer (Leinonen and Roto, 2023). In this paper, the term "handoff" refers to "handover" and "delivery". In the context of product design, it is frequently used to describe the process where designers prepare graphical work for developers to implement through code (Feng and Zhang, 2022). Nevertheless, the term "handoff" can be misleading, as it implies handing over and disregarding artifacts. In practice, designers and developers collaborate to refine these artifacts continually, requiring mutual and persistent effort (Maudet et al., 2017).

In the context of design handoff with globalization and technological advancements, Misuko (2004) states that designers have experienced new learning and challenges due to competitive landscape and more complex market. This complexity arises from new organizational methods for national and multinational companies, information networks, and influences.

For an effective design transition, team must be aware of critical design handoff challenges and collaborate to resolve them. Since designers and developers often work separately, efficient information exchange and uninterrupted progress are essential (Maudet et al., 2017).

Park et al. (2008) discovered significant differences in how text is used to represent the interaction between designers and developers. It was discovered that programmers use more verbose descriptions while designers' experience with tools like Photoshop[1] and PowerPoint[2] influences their natural expression of behaviors.

In this case, different languages may affect the design handoff quality, which may lead to problems such as redundant efforts to meet misinterpreted requirements, unsatisfactory market response, and misalignment between user needs and functionality (Leinonen and Roto, 2023).

Common issues include cultural, linguistic, and time zone differences, along with unclear communication, which often prolong processes (Annamalai Vasantha et al., 2014). Team members should proactively address these issues to ensure smooth transitions between project stages.

In summary, cross-cultural teams are more conscious of linguistic and social differences. This awareness influences linguistic aspects, whether due to

[1]Photoshop: https://www.adobe.com/br/creativecloud/business/teams/photoshop.html

[2]PowerPoint: https://www.microsoft.com/pt-br/microsoft-365/powerpoint

speaking confidence, comprehension, or limited foreign language proficiency, and social freedom in interactions (Annamalai Vasantha et al., 2014).

## Related Works

Although the literature presents several studies addressing collaboration in distributed teams and design-to-development communication, existing research, such as Queiroz et al. (2024), predominantly focuses on proposing supporting tools, or evaluating communication practices, while treating handoff as a secondary aspect of broader software development workflows.

One notable exception is the research presented by Walny et al. (2020), which explores the design handoff process in the realm of collaborative data visualization projects, where designers and developers have to communicate the complexities of visualization designs through handoff process.

Using observations made in five multidisciplinary projects conducted between 2012 and 2019, the authors explore the challenges associated with the communication and coordination of the design-to-development transition process. Six recurring challenges in the handoff process have been identified, demonstrating the shortcomings of existing handoff practices in managing complicated collaborative processes.

Additionally, according to the authors, existing design handoff tools do not provide much assistance in the area of documenting design implementation logic. Thus, the authors believe that there is need for specific handoff tools that will assist in the areas of documentation, prototyping, validation, and collaboration.

Even though the paper makes an effort to provide the most comprehensive analysis of the handoff process so far, the scope of the study is necessarily limited to data visualization projects due to the specifics of these projects in terms of the interdependence of data structure and visualization.

Consequently, while the identified issues offer valuable insights into handoff practices, they do not fully address the broader design handoff process found in general digital product development. This limitation reinforces the need for further empirical studies that investigate handoff across different product domains, organizational contexts, and distributed design teams, which is the focus of the present research.

# METHODOLOGY

This research is grounded in Misuko's (2004) perspective, emphasizing the analytical respect for cultural diversity, and investigates gaps in design handoff processes within multicultural teams. We employed a cross-sectional survey methodology, aligned with Bryman's (2003) definition of systematic quantifiable data collection to discern behavioral patterns. This approach is further supported by Lazar et al. (2017) and Babbie (1999) for its efficacy in explaining behavior and exploring new grounds.

Participants were recruited through a non-probabilistic convenience sample. Invitations were distributed via the authors' professional networks and corporate email within a single organization. This approach enabled efficient access

to professionals with direct global-team experience, but it does not support statistical generalization beyond the sampled population (see Limitations, on Section V). Our sample included 64 responses. Following Marconi and Lakatos' (1999) framework, the questionnaire comprised 20 items (Table 1) assessing time zones, tools, documentation, and cultural barriers.

According to Mattar (1994), questionnaires should be pre-tested at the stage of development of the instrument. Therefore, before distributing the questionnaire among the invited public, a pilot test was conducted with two respondents from the target audience, refining ambiguous terminology (e.g., "cultural barriers" operationalized as language misunderstandings). Given the small pilot size, this step should be understood as a face-validity check rather than a formal psychometric validation of the instrument.

Data were collected over six weeks (May–June 2026) using Microsoft Forms, enabling real-time response monitoring. Exclusion criteria (not participating in global teams and not having experience with design handovers) yielded 57 valid responses (avg. completion: 12 minutes).

**Table 1:** Survey questions.

| | Question | Answer |
|---|---|---|
| 1 | Do you work or used to work on a global team? | Yes - No |
| 2 | Have you ever participated in design handoff processes (transferring designs from designers to developers) in product or software development teams | Yes - No |
| 3 | What is your current role | Developer - Designer - Tester - Other |
| 4 | How long have you worked in globally distributed teams? | Less than 1 year - 1-3 years - 4-6 years - Over 7 years |
| 5 | What is the predominant time zone difference between your team and others? | 1-4 h - 5-8 h - 9-12 h - Over 12 h |
| 6 | How often do synchronous interactions (e.g., live meetings) occur with members from other time zones? | Daily - Weekly - Monthly - Rarely - Never |
| 7 | How critical is the geographical distribution's impact on design handoff efficiency? (Scale 1-5: 1 = None, 5 = Critical) | Scale of 1 - 5 |
| 8 | Which of the following tools are used to share design assets? | Figma - Adobe XD - Sketch - Axure - Wiki - Other |
| 9 | Do the adopted tools efficiently support asynchronous work? | Yes - No - Partially |
| 10 | How is continuous feedback incorporated during design handoff? | Comment platforms - Scheduled reviews Iterative documentation - Other |
| 11 | Are formal documentation standards implemented (e.g. reusable components, token guides)? | Yes - No - Partially |

*(Continued)*

**Table 1:** Continued.

| | Question | Answer |
|---|---|---|
| 12 | Have cultural barriers ever caused rework in handoff? | Yes - No - Partially |
| 13 | How frequently do language differences create ambiguities? | Daily - Weekly - Monthly - Rarely - Never |
| 14 | Does your team use intercultural training? | Yes - No |
| 15 | If yes, rate its usefulness (Scale 1-5). | Scale of 1 - 5 |
| 16 | Which of the following strategies mitigate language barriers? | Technical glossaries - Peer review by advanced speakers -Automated translation - Other |
| 17 | Rate your satisfaction with the clarity of design handoff specifications. (Scale 1-5: 1 = Very dissatisfied, 5 = Very satisfied) | Scale of 1 - 5 |
| 18 | Does the current process improve collaboration between designers and developers? | Yes - No |
| 19 | How is handoff quality evaluated? | Post-implementation feedback - Error KPIs - Customer Satisfaction - We do not evaluate handoff quality - Other |
| 20 | Suggest one urgent improvement for the process. | Open |

It is important to note that the study was conducted entirely in our corporate environment, focusing on employees who interact with other teams around the world. We restricted the research scope to these employees to maintain the relevance of opinions on work internationalization.

## Ethical Consideration

We informed all participants about the study's purpose through a dedicated section above the survey form, ensuring clarity on the voluntary nature of participation and anonymity assurance. As highlighted on the dedicated section, consent was obtained as participants opted to complete the questionnaire. No personally identifiable information was collected, and the survey was configured to avoid receiving any personal information. Participants were notified of their right to withdraw at any time by submitting a formal request to the provided email address. A storage period was defined from May 10, 2026, to January 1, 2027. After this period, all data will be permanently deleted.

## RESULTS

Time zone differences present significant challenges, with 40% (23) of participants exceeding 12-hour gaps and 39% (22) facing 9-12 hours difference. These gaps create significant barriers to real-time collaboration. Only 18% (10) of teams hold daily meetings, while 23% (13) conduct weekly

discussions and 18% (10) have monthly synchronous meetings. Notably 25% (14) rarely engage in such conversations, and 18% (10) never do. The average moderate geographical influence on efficiency (3.6/5) indicates that although teams have effectively managed time-related challenges, they could significantly improve distributed collaboration processes.

Geographical influence on handoff efficacy shows an average 3.6/5, while specification clarity satisfaction rate is 3.7/5. This indicates that while document quality is acceptable, issues faced due to the geographically distributed collaboration have negatively impacted process efficacy. Despite these challenges, 79% (45) of participants express favorable experiences related to collaborative effort between designers and developers, indicating that global teams have developed effective adaptation strategies for cross-functional collaboration.

Fragmentation exists in the tool ecosystem across platforms: Wiki platforms 42% (24) , Figma 39% (22), Adobe XD 21% (12), Axure 16% (9), Sketch 9% (5), and other tools (e.g., Confluence , Jira, Perforce) 14% (8). This diversity results from specialization and the lack of comprehensive tools addressing all aspects of the handoff process. The prevalence of Wiki platforms among other tools further indicates that documentation, information management, and accessibility are critical in distributed collaboration environments.

However, tool effectiveness in asynchronous mode remains at 93%. Within this group, 53% (30 people) report full efficiency, while 40% (23 people) report partial effectiveness. The remaining 7% (4 people), who claim no effectiveness, indicate that implementation issues and other factors can hinder technology use.

The documentation process shows inconsistency, as data indicates that only 53% (30) of respondents have established procedures, 37% (21) have partial systems, and 11% (6) lack documentation entirely. This variation creates significant teamwork challenges, as documentation critically enables knowledge transfer across time and space. Nearly half of respondents missing standardized processes suggest organizations undervalue documentation as essential infrastructure for distributed work, treating it as optional rather than mandatory.

Regarding feedback integration, teams clearly tend to use comment boards 58% (33), which support asynchronous information gathering and discussing design requirements. On the other hand, iterative documentation 40% (23) has emerged as an additional feedback recording method. Finally, global teams use scheduled reviews 18% (10) the least, likely due to their scheduling challenges.

Cultural barriers affect handoff effectiveness greatly. Rework attributable to cultural factors was reported by 37% (21) of respondents, while 46% (26) reported partial effects. The prevalence of partial cultural impact suggests that many teams experience intermittent or situation-specific challenges, rather than consistent, predictable patterns of misunderstanding.

Intercultural training is extremely rare, as only 19% (11) of surveyed respondents offer it, while 81% (46) give no support for building cultural competency in teams. This training gap significantly hinders efforts to

address rework and inefficiency caused by cultural misunderstandings. The few respondents providing such training average a 3.4/5 effectiveness score.

Language ambiguity is a pervasive issue: 51% (29) of participants face this challenge weekly, while 47% (27) report rare but significant instances. No daily occurrences of linguistic ambiguity were documented, indicating that work groups have likely developed mechanisms to manage routine communication but still struggle with technical jargon, contextual meanings, and culturally laden expressions.

Efforts to address this issue appear moderately implemented: peer review by advanced speakers 42% (24) and automated translation 42% (24) were the most cited strategies, followed by technical glossaries 40% (23) and other approaches (e.g., dedicated localization teams, English-first documentation) 9% (5).

Evaluation procedures for handoff quality vary significantly: 37% (21) use post-implementation feedback, 33% (19) evaluate customer satisfaction, 26% (15) report no formal evaluation at all, 11% (6) use error KPIs, and 2% (1) cited other methods (e.g., collecting tester feedback). This gap represents a major governance deficiency, as such practices would allow them to evaluate their handoff effectiveness, identify improvement opportunities, and measure the change's impact on performance.

## DISCUSSION

Based on the results obtained, it is possible to conduct a deeper analysis of the key problems revealed and suggest recommendations that can be used to solve each of them. The recommendations that follow are made with regard to the dimensions explored within this research.

Regarding time management, the results show that for the coordination of distributed teams to be successful, organizational and technological efforts are needed. To achieve efficient time management, organizations should implement systems such time-zone overlap windows and develop a robust asynchronous communication infrastructure. Additionally, introducing effective asynchronous collaboration systems with indicators such as window utilization rates and meeting equity indices is crucial.

Beyond improving scheduling practices, organizations should also establish mechanisms to continuously refine these processes. To build on these achievements, organizations should first develop standardized methods, create a knowledge repository of effective collaboration practices, and establish success metrics. It is essential to focus on the practices that have been employed by the most satisfied teams so that the same successful approach can be implemented in onboarding procedures.

Another critical aspect identified concerns the technological ecosystem supporting handoff activities. Optimizing tool utilization in global design handoffs requires systematic audits to identify redundancies, gaps, and integration opportunities across the technology stack. The success of implementation also requires comprehensive training programs which focus on advanced capabilities, along with periodic assessments of the tool's effectiveness.

In addition to improving tool ecosystems, the results highlight the importance of establishing consistent documentation practices. Effective documentation in global design handoffs requires establishing comprehensive standards for both structural and substantive matters.

This is consistent with the related work by Walny et al. (2020), who asserts that proper handoff requires adequate and complete documentation in order to preserve the intentions of the designer during implementation.

Therefore, organizations should establish frameworks that outline all necessary details for proper documentation processes, including necessary document components, formatting standards, version control methods, and maintenance practices. Organizations should also conduct regular training on documentation tools and cognitive skills to ensure documentation effectively addresses implementation questions and other considerations.

Given that 24% of respondents reported no formal evaluation of handoff quality at all, these findings emphasize the need for systematic evaluation throughout the development process. Organizations should define handoff quality evaluation frameworks using different metrics throughout the life cycle of the product. In particular, it is required to evaluate the quality of specifications provided during the handoff using different metrics, such as number of clarification requests, number of iterations needed to implement requirements, and developer satisfaction ratings.

## Limitations

This study faces several limitations that warrant consideration. First, the sample scope was confined to a single corporate environment, with 57 valid respondents, which limits the generalizability of findings to other organizational cultures or industries.

Second, the data are self-reported and cross-sectional, collected at a single point in time; the percentages presented in Section IV should therefore be interpreted as descriptive patterns within this sample rather than as causal or statistically validated effects, since no significance or correlation testing was performed across subgroups (e.g., role, tenure, or time-zone band).

Third, unmeasured confounders (such as team size, project complexity, or leadership style) may significantly moderate handoff efficacy; for instance, agile-oriented teams might exhibit distinct behaviors compared to waterfall-driven groups, warranting targeted investigation with a controlled comparative design.

Finally, the rapid evolution of collaboration tools may render specific recommendations outdated over time. Taken together, these constraints indicate that our findings should be read as an exploratory scaffold rather than a definitive model; future work should adopt inferential statistical methods and multi-organization sampling to validate and generalize the patterns identified here, with explicit metrics to track efficacy and guide refinements.

## CONCLUSION

This paper analyses design handoff processes in global teams. It identifies the most common solutions used within the industry. We applied a 20-question questionnaire to identify patterns in this sample. We received 57 valid responses from professionals working on global teams in the software sector.

The survey results provided valuable insights into challenges teams face during design handoffs and their impact on cohesion and performance. Considering the research conducted, managing handoff processes between global teams becomes essential to guarantee fluid, successful collaboration among software development teams.

However, approaches can be considerably different across teams, as processes and tools vary according to individual scenarios. This variation leads to issues like inconsistent documentation standards and fragmented tool ecosystems. If executed poorly, this process may cause communication errors among team members.

Other factors such as time differences, linguistic barriers, and cultural diversity increase these challenges. Thus, insufficient training and poor communication channels make problems with handoff processes worse. The findings highlight that organizations should recognize the importance of effective handoff processes and take proactive steps to address identified problems.

To mitigate these challenges, organizations need a balanced approach focusing on creating standardized frameworks to define roles and align expectations, ensuring consistent quality. However, protocols must remain flexible to adapt to diverse global professionals' needs and specific scenarios. Striking this balance between standardization and adaptability helps maintain quality without restricting team dynamics.

Future work should incorporate diverse geographic cohorts and mixed-methods validation, investigate new technological interventions (e.g., AI-assisted tools) to mitigate identified linguistic and procedural gaps and explore a larger sample size and comparative case studies in specific global companies to further investigate the relationship between communication strategies, cultural challenges, and handoff efficiency across distinct organizational sections.

## ACKNOWLEDGMENT

This work is the result of the R&D project *Projeto de Engenharia de Software e Ciência de Dados aplicados ao Desenvolvimento de Sistemas*, performed by Sidia Instituto de Ciência e Tecnologia in partnership with Samsung Eletrônica da Amazônia Ltda., using resources from Federal Law No. 8.387/1991, and its disclosure and publicity are under provisions of article 39 of Decree No. 10.521/2020.

## REFERENCES

Annamalai Vasantha, G., L. Felgen, J. Grieb, Lindemann, U., Pulm, U. and Chakrabarti, A. (2014), The impact of cultural aspects on the design process.

Atwood, M., Burns, B., Gairing, D., Girgensohn, A., Lee, A., Turner, T., Alteras-webb, S. and Zimmermann, B. (1999), 'Facilitating communication in software development'.

Babbie, E. (1999), Métodos de pesquisas de survey, Vol. 1, Ed. da UFMG Belo Horizonte.

Bryman, A. (2003), Research methods and organization studies, Vol. 20, Routledge.

Eco, U. (1976), A Theory of Semiotics, Advances in Semiotics, Indiana University Press.

Feng, K. J. K. and Zhang, A. X. (2022), 'From handoffs to co-creation: Deepening collaboration between designers, developers, and data science workers in ux design'.

Gudykunst, W. (2003), Cross-Cultural and Intercultural Communication, SAGE Publications.

Lazar, J., Feng, J. H. and Hochheiser, H. (2017), Research methods in human-computer interaction, Morgan Kaufmann.

Leeds-Hurwitz, W. (1993), Semiotics and Communication: Signs, Codes, Cultures, Taylor & Francis.

Leinonen, A. and Roto, V. (2023), 'Service design handover to user experience design – a systematic literature review', Information and Software Technology 154, 107087.

Marconi, M. d. A. and Lakatos, E. M. (1999), 'Técnicas de pesquisa: pesquisa, planejamento e execução de pesquisas, amostragens e técnicas de pesquisa elaboração, análise e interpretação de dados'.

Mattar, F. N. (1994), 'Pesquisa de marketing: Metodologia, planejamento, execução', Análise 1, 2.

Maudet, N., Leiva, G., Beaudouin-Lafon, M. and Mackay, W. E. (2017), Design Breakdowns: Designer-Developer Gaps in Representing and Interpreting Interactive Systems, in 'CSCW 2017 - ACM Conference on Computer Supported Cooperative Work and Social Computing', Portland, Oregon, United States, pp. 630 – 641.

Misuko, M. O. (2004), 'Design, cultura e identidade, no contexto da globalização', Revista Design em Foco 1(1), 53–66.

Mohrman, S. A. (1999), 'The contexts of geographically dispersed teams and networks', Trends in organizational behavior 6, 63–80.

Park, S. Y., Myers, B. and Ko, A. J. (2008), Designers' natural descriptions of interactive behaviors, in 'Proceedings of the 2008 IEEE Symposium on Visual Languages and Human-Centric Computing', VLHCC '08, IEEE Computer Society, USA, pp. 185–188.

Queiroz, J. S., Arbex, M. V. L., Falcão, T. A., Furtado, P. M., Soares, F. L., Souza, T. B. F., Silva, B. A. T. and Bezerra, E. C. (2024), E2dh: Enhanced easy design handoff, in '2024 Ninth International Conference on Informatics and Computing (ICIC)', pp. 1–6.

Walny, J., Frisson, C., West, M., Kosminsky, D., Knudsen, S., Carpendale, S. and Willett, W. (2020), 'Data changes everything: Challenges and opportunities in data visualization design handoff', IEEE Transactions on Visualization and Computer Graphics 26(1), 12–22.

Yakin, H. S. M. and Totu, A. (2014), 'The semiotic perspectives of Peirce and Saussure: A brief comparative study', Procedia - Social and Behavioral Sciences 155, 4–8.