










ORIGINAL CONTRIBUTION

Website usability analysis of United States emergency medicine residencies

Edwin Fundingsland¹  | Joseph Fike¹  | Joshua Calvano¹  | Ali Raja MD²  |
Deborah Lai³  | Sara Silacci⁴  | Mary Haas MD⁵  | Teresa Chan MD⁶  |
Shuhan He MD⁷ 

¹Rocky Vista University College of Osteopathic Medicine, Parker, Colorado, USA

²Department of Emergency Medicine, Massachusetts General Hospital, Boston, Massachusetts, USA

³Division of Psychology and Language Sciences, University College London, London, UK

⁴Center for Innovation in Digital HealthCare, Massachusetts General Hospital, Boston, Massachusetts, USA

⁵Department of Emergency Medicine, University of Michigan Medical School, Ann Arbor, Michigan, USA

⁶Division of Emergency Medicine, Department of Medicine, Program for Faculty Development, Faculty of Health Sciences, McMaster University, Hamilton, Ontario, Canada

⁷Center for Innovation in Digital HealthCare, Massachusetts General Hospital, Boston, Massachusetts, USA

Correspondence

Edwin Fundingsland, Rocky Vista University College of Osteopathic Medicine, 8401 S. Chambers Road, Parker, CO 80134, USA.
Email: edwin.fundingsland@rvu.edu

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Abstract

Objectives: The Council of Residency Directors (CORD) in Emergency Medicine (EM) has recommended that all residency programs should conduct virtual interviews for the 2020 to 2021 application cycle due to the COVID-19 pandemic. While factors such as geographical region, city, program size, or hospital affiliation are not modifiable, EM residencies can bridge the information gap created by a lack of face-to-face interaction by representing themselves digitally. Measuring usability provides an objective method for EM residencies to improve their Web presence and effectively represent themselves to applicants.

Methods: Our sample set included 55 U.S. EM residency program websites. Using methodology replicated from previous literature on health care website usability, we divided usability into four categories for quantifiable analysis: *accessibility*, *marketing*, *content quality*, and *technology*. Analysis was performed on each website and scored in all four categories. A “general usability” score was calculated for each website using a composite of the key factors within the four categories. Using a weighted percentage across all of the factors, an overall score was calculated.

Results: Content quality was the overall highest scoring category (mean \pm SD = 5.4, SE = 0.33). The overall lowest performing category was technology (mean \pm SD = 0.8 \pm 0.09, SE = 0.01).

Conclusions: Measuring usability can help EM residency programs identify ways to improve their Web presence. To effectively promote their programs, residencies need quality content that communicates their key features. Our recommendation is for all residency programs to periodically perform website audits and apply the usability measures outlined to improve their digital presence, especially during times when face-to-face interactions will be limited.

KEYWORDS

emergency medicine residencies, digital health, healthcare website, usability testing, website usability, Web crawler

INTRODUCTION

Background

With COVID-19 upending the traditional residency application process, residency programs and medical students are finding themselves needing to adapt to changes in the 2020 to 2021 cycle. This is primarily due to fewer opportunities for in-person contact and communication. The Coalition for Physician Accountability has made several recommendations in an effort to minimize in-person interaction with residency programs including the limitation of away rotations, conduction of virtual interviews, and virtual orientation and tours.¹ The Council of Residency Directors (CORD) in Emergency Medicine (EM) has recommended that all EM residency programs conduct their interviews virtually.² Similarly, the Association of Faculties of Medicine of Canada Resident Matching Committee (ARMC) decided that all interviews for the 2021 Medicine Subspecialty Match, Pediatric Subspecialty Match, and Family Medicine/Enhanced Skills Match will be in a virtual format including those for local candidates.³ Traditionally, EM residency interviews have allowed programs to showcase their cities and facilities. Interviews have also conventionally offered students and programs the opportunity to interact socially through events such as mixers and/or dinners. These factors remain difficult to overcome virtually. Additionally, CORD has recommended that students and EM residency programs work to minimize the amount of visiting student rotations, to reduce the amount of travel during this pandemic.² Although two EM rotations including one home and one “away” or “visiting” clerkship was the pre-COVID-19 standard recommendation for medical students, students may now only be able to rotate at their home program.⁴ Visiting student rotations have traditionally afforded more contact between applicants, personnel, and programs, allowing for improved assessment of compatibility. These rotations give students the chance to learn the setting (i.e., county, community, academic) they prefer and augment their perception of overall “fit.”⁵ Due to these changes, both students and EM residency programs will make high-stakes decisions with less information than in previous years. Although programs cannot change the circumstances surrounding COVID-19 or their own nonmodifiable factors (i.e., geographical region, city, program size, hospital affiliation), they can better represent themselves digitally via their websites and social media. A residency program's website is often their first impression on an applicant. Although the content contained on the website is crucial, the manner in which this content is presented is also important. Understanding the technical aspects of website usability can help one website stand out from another and should not be overlooked when building a website. With a lack of face-to-face interaction, programs can minimize the information gap by enhancing their website usability.

Website usability for EM residency programs

Usability extends beyond a website's external appearance; it also encompasses variables of “user experience” including website errors

and overall ease of navigation.⁶ Previous research has analyzed usability in e-commerce, e-government, mobile news apps, and library websites.⁷⁻¹⁰ With regard to health care-related websites, usability has been analyzed in hospital, children's hospital, cancer center, and digital health care center websites.¹¹⁻¹⁴ A website with enhanced usability tends to garner higher levels of engagement and therefore better accomplishes its goals.¹⁵⁻¹⁷ Accordingly, industries outside of health care have established standardized guidelines for measuring usability in the areas of *accessibility*, *content quality*, *marketing*, and *technology*.¹⁵⁻¹⁷ Expectations of user experience have been established, and health care websites are facing pressures to conform to these requirements.^{18,19}

Because EM residency program websites will now play a larger role than ever in recruiting potential applicants, the importance of evaluating and optimizing usability has increased. Residency program websites have previously been analyzed for content quality within the specialties of general surgery, neurosurgery, diagnostic and interventional radiology, dermatology, physical medicine and rehabilitation, cardiothoracic surgery, urology, orthopedic surgery, otolaryngology, plastic surgery, vascular surgery, and radiation oncology.¹⁹⁻³⁰ To the best of our knowledge, no prior analysis of EM residency website usability has been performed. This analysis may inform EM residencies how to improve their online presence and more effectively represent themselves to potential applicants.

Objectives

Aim 1 was to categorize EM residency programs and their websites; aim 2 was to utilize a previously published usability scoring system to objectively and quantitatively analyze their websites;¹¹ and aim 3 was to identify themes to suggest areas of improvement among EM residency websites.

METHODS

We conducted a cross-sectional usability audit of U.S. EM residency websites.

Sample selection

Our target website population was U.S. EM residency programs. We started with 251 programs that were listed as Accreditation Council for Graduate Medical Education (ACGME) accredited on the Electronic Residency Application Service (ERAS) website. We refined our sample set by only including programs that use their own primary domain or subdomain. Programs using a subpage of a larger domain (i.e., hospital or university) were excluded as the analysis would include non-residency-related content (i.e., patient care, patient portals, residency programs other than EM). Without using the exclusion criteria there would likely be artificially high scores

for pages with a large primary domain that added a small residency subpage. Websites that were inconclusive or showed errors upon analysis were also excluded. Our final sample set included 55 U.S. EM residency programs. This process is represented in Figure 1.

Overview

All data were collected between May 27, 2020, and June 7, 2020, using tools that assessed the website usability of each program. We replicated a methodology that was previously outlined by Calvano et al.¹¹ who ranked the usability of digital health care center websites. We maintained the definitions and scoring system described by Calvano et al. and applied the same formulas to determine the usability of the websites assessed in our study. The four categories that were identified and defined in previous literature as aspects of usability are:

1. Accessibility—ability of users with lower levels of computer literacy to access and navigate the website.
2. Marketing—ability of the website to be found through search engines.
3. Content quality—lack of grammatical errors, frequency of content updates, content relevancy, and readability.
4. Technology—website download speed, quality of the programming code, and website infrastructure.¹¹⁻¹³

Data analysis

We built a database of ACGME-accredited EM residency program websites that used their own primary domain or subdomain. We then scored each website according to a variety of usability tools outlined thoroughly by Calvano et al. in Data Supplement S1, Table S1 (available as supporting information in the online version of this paper, which is available at <http://onlinelibrary.wiley.com/doi/10.1002/aet2.10604/full>). These tools were selected based on the ability

of the tool to analyze a given target factor (i.e., website speed) in a user-friendly way. The primary tool used for website evaluation was a “Web crawler.” A Web crawler uses the website’s URL to create a topographical map of a website and its subpages to analyze it for errors, content, and metadata including titles, keywords, and descriptions.³¹ There were two authors involved in data gathering and rating who were thoroughly trained by an expert. Both raters familiarized themselves with the instruction manuals associated with each tool to ensure an accurate and reproducible analysis. The same two authors then divided the tools among themselves with only one author assigned to each tool and collected data for their given set of tools. This ensured that the data gathered using a certain tool was not influenced by different computer capabilities or Internet connections, thereby minimizing potential discrepancies. Factors that may rely on the users’ Internet connection (i.e., speed) were run using two different tools and averaged to provide fair and accurate values.

The resulting scores given by each tool were then assigned to one of four categories: 1) accessibility, 2) content, 3) marketing, or 4) technology. A “general usability” score was calculated using a combination of key factors relating to each of the four categories. Finally, an “overall usability” score, which looked at variables across the previous categories, was used to provide a ranking system. A description, information about the rating scale, and the significance of each category are described in Table S1, which Calvano et al. provided for our explicit use.

Accessibility

Accessibility is a category intended to represent how well a website caters to a diverse population, regardless of the level of literacy, technical skills, or presence of disabilities. Accessibility includes the following variables: meta description, functionality, readability, and overall layout. Meta description refers to the “snippet” page summary that appears when a site is the result of a search engine inquiry. Functionality looks at features allowing users to view aspects

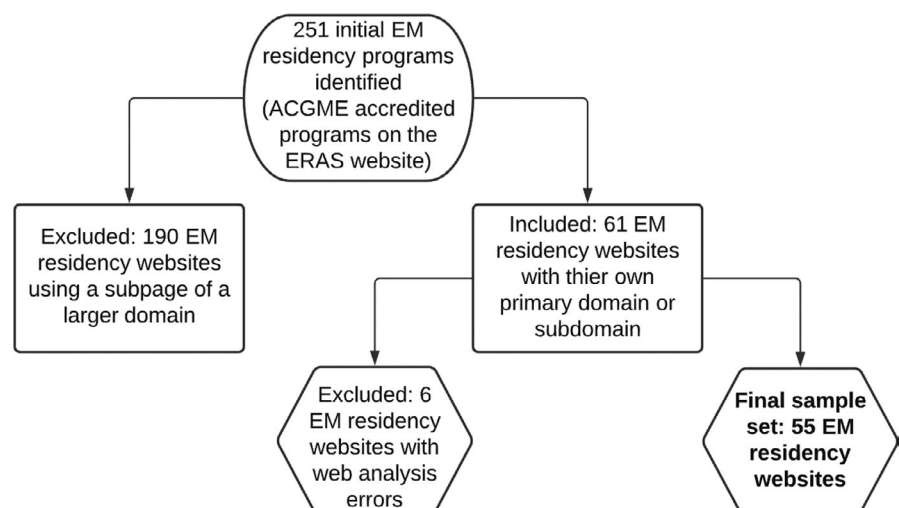


FIGURE 1 Sample selection criteria for EM residency websites

of a website with content levels appropriate for user understanding, regardless of their literacy levels. An estimated 43% of American adults have been observed to have basic or below basic literacy rates.³² The use of assistive technologies also falls under accessibility. This refers to features such as screen readers/magnifiers of a website.³³ With tools to apply algorithmic scales, the websites were ranked on their level of reading difficulty as well as approximating the grade level required for content comprehension in order to grade accessibility.

Content quality

Content quality assesses both the positive and the negative elements of a website's published content. Content quality includes the following variables: information relevance, generated metadata, use of multimedia for imagery, and relevancy of written text. Relevancy refers to the content's pertinence and accuracy to a particular topic at a specific point in time. In our context, websites dedicated to presenting information about an EM residency program were evaluated on the ability to provide both relevant and accurate information to applicants (i.e., application requirements, curriculum details, benefits). Evaluation of multimedia addresses both quantity and quality (i.e., resolution) of a website's multimedia. Metadata function adds support to the composed content. Analysis of written text looks at both grammar and spelling.

Marketing

Marketing addresses the ease of discovery of a particular website. There is specific emphasis on its search engine results pages (SERP). When Internet users place an online search via a search engine (i.e., Google), SERP refers to the order in which websites are presented to the user. Websites that present higher on the list have increased visibility making SERPs a crucial factor in digital marketing. Search engine optimization (SEO) is an entire field dedicated to the optimization of this practice. SEO is an effective way health care websites, including EM residency programs, can create a similar corporate presence to other industries. The specifics of SEO auditing, however, are outside of the scope of this study.

Technology

Technology evaluates a website's technical functionality. Rather than content, it looks at the quality of technological design and performance. This includes front-end design, user experience, back-end coding infrastructure, and server management. Front-end design refers to what is visible to users browsing a website. Analysis of front-end design includes looking at aspects of hypertext markup language (HTML), which assesses the ease of navigation based on layout and how well a website is scalable across different devices (i.e.,

computers, tablets, and mobile phones). Back-end design includes the programming code that runs the website. Programming code and other Web components (i.e., databases) are stored on servers that allow user access on any suitable device. Additionally, the speed of a site (amount of time it takes to load) is server-dependent. This plays an important part in adding and maintaining users. According to a recent Google study, a website that takes longer than 3 seconds to load on a mobile device loses approximately 53% of its users and the average mobile website speed is around 18 seconds.³⁴

General usability

General usability encompasses the metrics from the previous four categories. This score assesses the overall quality of a website and provides a point of reference for EM residencies to begin an audit of their websites. The more specific categories allow them to look for areas of improvement.

Overall usability

Overall usability is the rank order calculation we used for complete assessment of all major and minor variables across the five previous categories. Percentages were assigned accordingly to create a weighted, comprehensive usability ranking system.

RESULTS

Due to individual technical issues on specific websites, six websites were eliminated from our original set of 61. Most of these issues were related to errors with the Web crawler, potentially due to the lack of index restrictions put in place by the website administrators. Scores were assigned to the remaining ($N = 55$) EM residency websites.

Accessibility had a mean (\pm SD) score of 1.9 (\pm 0.62; standard error [SE] = 0.08). Content quality was the highest mean (\pm SD) scoring category by a significant margin with a score of 5.4 (\pm 2.48; SE = 0.33). Marketing had a mean (\pm SD) score of 1.3 (\pm 0.48; SE = 0.06). The overall lowest performing category was technology, with a mean (\pm SD) score of 0.7 (\pm 0.09; SE = 0.01). General usability had a mean (\pm SD) score of 1.3 (\pm 0.39; SE = 0.05). Summary statistics of all categories are shown in Table 1. The overall rankings for the 55 assessed websites are presented in Table S2.

Leaders among ranking categories include the following: accessibility—Christiana Care Health Services (3.5); content quality—Christiana Care Health Services (11.7); marketing—seven-way tie between Stanford University, UCLA David Geffen School of Medicine, University of Arkansas for Medical Sciences, University of California (Irvine), University of Florida College of Medicine Jacksonville, Virginia Commonwealth University Health Systems, and Washington University (2.1); technology—five-way tie between

TABLE 1 EM residency websites: summary statistics from usability analysis

Category	Mean (SE)	Standard Deviation	Minimum	Maximum
Accessibility	1.9 (0.08)	0.62	0.6	3.5
Content quality	5.4 (0.33)	2.48	0.2	11.7
Marketing	1.3 (0.06)	0.48	0.5	2.1
Technology	0.7 (0.01)	0.09	0.6	0.9
General usability	1.3 (0.05)	0.39	0.5	2.4

Abbreviation: SE, standard error.

Brookdale University Hospital and Medical Center, Christiana Care Health Services, Tower Health, University of Arkansas for Medical Sciences, and the University of Florida College of Medicine Jacksonville (0.9); and general usability—Christiana Care Health Services Program (2.4). The top ranked website for overall usability was also Christiana Care Health Services Program (3.2). For the categories that ended in a tie, the websites had scores within a 100th of a decimal point. Table S2 does not reflect these as a tie.

DISCUSSION

After thorough investigation of usability, the general usability category was found to be low performing, indicating overall room for improvement amongst EM residency websites. Content quality was the overall highest scoring category by a significant margin and technology was the lowest performing category.

A low mean general usability score indicates that these EM residency programs do not have a complete understanding of usability metrics and what is necessary for overall website quality. This is resembled by the disproportionate scoring between the analyzed categories. On the surface, it is easy for programs to view the quality of their website simply based on their content. However, by utilizing usability analysis these websites can examine beyond what is on the surface and discover other aspects in which they can improve.

Regarding content quality, our data shows that EM residency websites have placed heavy emphasis on providing accurate and relevant information about their residency programs. This represents the notation that, from a logistical standpoint, EM residency websites are primarily concerned with their content. It is important to inform these programs, however, that content quality is only a partial contributor and other factors need to be addressed to improve general usability. In the event that a program was looking to improve their content, they could start by performing frequent audits, making sure their content is up to date. They could also address whether the information they are presenting is relevant to what applicants are looking for. Additionally, evaluating both the quality and the quantity of their multimedia and confirming that their websites do not contain spelling or grammatical errors will improve their overall content quality.

Technology being the lowest mean ranked category suggests a lack of importance placed on digital and information technology among these residency programs. A lack of investment may

be resembled by a lack of server capacity or infrequent website/social media audits. Increasing website speed is a method in which websites can instantly improve their technology score. Increasing speed can largely be achieved by minimizing the amount of conflicting technology on the back-end server. Additionally, efforts can be made to improve front-end design by enhancing ease of navigation and making websites scalable across different devices. By working with experts in user experience and user interface design, websites can address these areas.

Our results show that marketing also scored low among EM residency program websites. If looking for improvement, programs can work with experts in SEO to optimize their websites to become more discoverable via search engines. They can also increase efforts in promoting their websites via social media or other affiliated websites to increase their referral traffic. Promoting overall brand strength would also increase overall website traffic.

When comparing our research to similar studies performed on different residency programs, the results are fairly consistent regardless of specialty. Although studies evaluated websites based on tools and/or metrics that differed from our methodology, all similar studies across residencies indicated that there needs to be improvement to website presence from most institutions.¹⁹⁻³⁰ Our methods were a direct continuation of a study by Calvano et al.¹¹ that ranked the usability of digital health care center websites. Previous research allowed the authors to compare usability trends in health care, including digital health care centers, hospitals, and children's hospitals.¹¹⁻¹³ In previously published usability studies, content quality was also found to be the highest ranking category.¹¹⁻¹³ Health care organizations as a whole have placed emphasis on providing factual consumer scientific information. Overall, health care websites are primarily concerned with their content and, therefore, neglect other aspects of usability. Technology being our lowest mean ranked category was also consistent with previous research.¹¹⁻¹³ This suggests a lack of importance placed on digital and information technology in the field of health care.

The biggest difference between our findings and previous findings was that an evaluation of children's hospital websites found accessibility to be the lowest score category as opposed to technology.¹³ Accessibility also ranked low in other previous studies.^{11,12} In our study, accessibility was found to be the second highest scoring category. It appears that EM residency programs have an increased understanding of the importance of accessibility compared to other health care organizations, indicating that they may be focused on

creating content that can be easily accessed and comprehended by a diverse population. However, if EM residency websites are looking to improve their accessibility, they could focus on making their platforms easy to navigate, publish content that is easy to read for those with low literacy levels, and confirm compatibility with screen readers and magnifiers. An assumption could be made that individuals accessing residency websites likely have sufficient levels of education/literacy necessary for appropriate comprehension, and therefore this measure is unnecessary. However, one goal of this research was to promote a consistent standard of evaluation across websites, regardless of the website type. Standardization of website analysis in the health care sector has been neglected in many areas and this is an important practice in other industries.¹⁵⁻¹⁷ Additionally, it is key to have a standardized framework for understanding equity for users such as applicants who speak English as a second language (i.e., international applicants) and the family members of applicants.

These data would benefit from future analysis comparing website usability between EM residency programs that were established pre-Web (pre-1990) and post-Web. This would address if pre-Web programs are underperforming in usability metrics compared to later established programs and provide additional insight on the groups of residency programs that would benefit the most from improving their website usability.

Health care is evolving through technology to improve quality of care while decreasing costs.³⁵ For these reasons, usability has become an important method for analyzing website presence throughout the health care sector, including education and medical training. With additional pressures that COVID-19 is placing on this year's application cycle and interview season, EM residency Web presence has become more important than ever.

LIMITATIONS

The authors recognize that this study includes limitations. Perhaps the largest being the amount of EM residency websites that the authors were able to accurately analyze. Out of the 251 ACGME-accredited EM residencies, only 55 met the inclusion criteria. This was primarily due to a limitation in the methods. The website analysis tools evaluate a website's entire primary domain or subdomain while many EM residencies use a subpage of a larger domain (i.e., hospital or university). If these websites were included, data would have been generated based on the entire hospital/university's domain, most of which is not residency related. For example, a primary domain may have an estimated domain age of 30+ years, but the EM residency subpage may have only been added 10 years ago. This would have misrepresented the data and given these subpages ranking advantages and thus were excluded.

Additionally, our sample of EM residency program websites only included each program's official, public website. Certain programs use separate websites/blogs that allow them to circumvent institutional IT blocks. Other programs have private/password-protected

websites that they only make available to applicants they plan to interview. Because there is not a standardized list containing these secondary websites, they would be tenuous to find and therefore we did not include them in our analysis. Due to this limitation, we believe that it would be beneficial to include these websites into future studies.

A minor limitation was in the assessment of a website's social media presence. Some websites did not have direct links to their social media profiles. In these cases, Facebook and Twitter's self-hosted search engines were used. Oftentimes the desired page was distant from the top results. This created uncertainty as to whether all of the official social media pages were discovered and emphasizes the necessity of embedding social media links to improve user experience.

An additional limitation included the measurement of website speed. This measurement can be variable with dependence on the time of data collection. Depending on the time, there may be differences in the Internet connectivity or changes to the website servers or computer hardware. This bias was minimized using the same computer and network to run all of the tools. Finally, data were collected over a span of 12 days meaning that some of the information may have changed since the initial evaluation.

CONCLUSION

In the 2020 to 2021 residency application cycle, the majority of medical students pursuing emergency medicine will make residency selection decisions without physically meeting program members or seeing facilities in person. Many potential residents will be looking to a program's website and social media presence to gain a better understanding of their compatibility with the program. Our results provide EM residencies with areas upon which to focus improvement in website usability efforts. The need for overall refinement is highlighted by the mean general usability score of 1.3. Our data have identified that content quality is the highest rated usability category and technology is the lowest. We recommend that EM residency programs include periodic usability audits of their websites to make sure they are adequately performing in all categories.

CONFLICT OF INTEREST

The authors have no potential conflicts to disclose.

AUTHOR CONTRIBUTIONS

Study concept and design: Joshua Calvano, Shuhan He, Deborah Lai. Acquisition of data: Edwin Fundingsland, Joseph Fike. Analysis and interpretation of data: Edwin Fundingsland, Joseph Fike, Joshua Calvano, Ali Raja, Deborah Lai, Sara Silacci, Mary Haas, Teresa Chan, Shuhan He. Drafting of the manuscript: Edwin Fundingsland, Joseph Fike, Joshua Calvano, Ali Raja, Deborah Lai, Sara Silacci, Mary Haas, Teresa Chan, Shuhan He. Critical revision of the manuscript for important intellectual content: Edwin Fundingsland, Joseph Fike,

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ORCID

Edwin Fundingsland  <https://orcid.org/0000-0002-7100-7555>

Joseph Fike  <https://orcid.org/0000-0003-4043-2185>

Joshua Calvano  <https://orcid.org/0000-0003-3938-2336>

Ali Raja  <https://orcid.org/0000-0002-8909-3586>

Deborah Lai  <https://orcid.org/0000-0003-2542-4793>

Sara Silacci  <https://orcid.org/0000-0002-7271-7145>

Mary Haas  <https://orcid.org/0000-0002-9506-5928>

Teresa Chan  <https://orcid.org/0000-0001-6104-462X>

Shuhan He  <https://orcid.org/0000-0002-9902-5077>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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