Session 3238

Enhancing Engineering Graphics Courses Through Animated, Sophisticated, Multi-Media, Graphical Presentations

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Abstract

Exploring new instructional methods that use technology tools adds an important aspect to the cognitive abilities and visualization skills of on-campus undergraduate students. This paper presents visual examples from an ongoing experiment that was started in 1998 at the School of Technology, Eastern Illinois University to study the effectiveness of the "show-and-tell-and-let-apply" (SATALA) approach adopted by the author for his Engineering Graphics lectures, using some features of Microsoft PowerPoint software.

Microsoft PowerPoint software capabilities can be used to create simple but effective, animated, multi-media, graphical presentations that enhance students' visualization skills and give them the know-how to hand-solve a variety of projection problems, geometric shapes drawings, and Descriptive Geometry concepts, in an easy and affordable way.

From hand-drawing geometric shapes such as ellipses, to hand-solving Descriptive Geometry problems such as piercing points, students' comprehension of subject matter as well as their problem solving ability are greatly enhanced through the "show-and-tell-and-let-apply" (SATALA) approach in lecturing. Students' better comprehension of the subject matter is reflected in surveys conducted, as well as in students' performance and superior grades. A balanced merging of hand drawing with computer drawing seems to give students the best of both worlds.

A recent market survey showed that using Microsoft PowerPoint software capabilities in this kind of application appears not to have been explored before in that particular way. Discussions with students, publishers, and colleagues in academia provide assertions of the potential effectiveness of using this kind of multimedia presentations in delivering Engineering Graphics courses.

Preparing SATALA PowerPoint slides for Engineering Graphics courses is a very time consuming process. However, any time and effort invested in it, pays high dividends in the many students who get a better understanding of the subject matter which, in turn, improves their performance during their college years, and later in the work place.

Introduction

Historically, Engineering Graphics courses have not been very user-friendly to many students. Inherently, those courses require superior visualization skills. Visualization is an essential tool for design, and the creation and/or the interpretation of drawings. As visualization is also a developed skill, students are often become frustrated by their inability to readily visualize objects presented in engineering drawings. Students not only vary in their natural abilities or visualization skills, but also they do have diverse backgrounds, learning styles, and career objectives.

Moreover, Engineering Graphics courses, most of the time, are introductory courses in many engineering or technology curricula, presented to freshmen students who most probably are not yet oriented enough, or certain about their abilities or even interest in those disciplines. Unfortunately, this could turn-off some students, making them to become less motivated or enthusiastic. If their stamina is not strong enough to help them survive this frustrating period, students may undergo painful experiences, or even quit the discipline altogether.

Engineering Graphics courses, however, need not be such an obstacle. Indeed, they can be made easy for many students through the innovative use of Microsoft PowerPoint software capabilities to create effective animated multimedia graphical presentations. In fact, preparing PowerPoint slides for Engineering Graphics courses was initiated, in the first place, to meet the individual needs of undergraduate students as they learn concepts that require special visualization skills.

Background

This paper presents selected visual examples from an ongoing experiment that was started in 1998 at the School of Technology, Eastern Illinois University to examine the (SATALA) approach adopted by the author for his Engineering Graphics lectures, using some of the features of Microsoft PowerPoint software. The paper also briefly presents preliminary results of surveys conducted to evaluate that experiment and to help explore the presentations' effectiveness in Engineering Graphics classroom.

Rationale

Since their infancy, this generation of on-campus undergraduate students grew up with different forms of multimedia from toys to video games, electronic gadgets, computers, Internet, radio, television, video, CD/DVD, and a long list of appliances. Reaching out to students, "in their own language," naturally calls for the use of multi-media presentations that enhance traditional lectures.

This becomes even more important, given other factors such as the variety of students' backgrounds, visualization natural abilities, the wide range of subject matter content, the relatively limited time for lecture, lab, or homework, and the teaching styles of instructors -- all of which require more insight, flexibility and careful planning to accommodate.

Multimedia is a powerful instructional, pedagogical tool for the teaching of Engineering Graphics. Lecturing on Engineering Graphics theories and concepts in a tangible way polishes the students' imaginative ability, which in turn helps them visualize objects more easily, and leads them to a better comprehension of the subject matter.

When multimedia is used in a prudently designed manner to present the fundamentals of Engineering Graphics to students, it can motivate them to learn more of the topic without much difficulty. Later, it would help them to easily apply the knowledge they attain in the workplace. Furthermore, lectures and teaching materials in multimedia presentations are often already prepared before hand, for the most part. This allows faculty to concentrate during the lecture on direct and spontaneous student interaction, which is a crucial element in effective teaching.

The "Show-and-Tell-and-Let-Apply" (SATALA) Approach

It was found that students in general prefer to receive and apply small manageable amounts of information, that are released to them at successive increments over short intervals of time. The (SATALA) approach is kind of a "how-to" instruction that enables students to work independently and enhances their sense of achievement. It bridges students' visualization gap, eliminates their frustration, and makes the drawing process more fun and self-fulfilling.

The SATALA presentations typically walk the students through the various steps of a particular solution -- one step at a time -- and conclude with the correct results. Students are instructed to follow and apply each step in their notes as it appears in front of them. Students are also instructed to immediately comment or ask the instructor, should they have any question.

During the SATALA presentations, students indeed become fully engaged in the show -- using their eyes, ears, hands, and minds all at once. The SATALA approach appeared to effectively enhance the students' sensory and cognitive experience by using PowerPoint capabilities in presenting forms, shapes, animation, and color-coding to simply construct the drawings in front of them from simple to compound -- one step at a time. In some instances, the show would be repeated one more time without interruption as a review, to show the whole thing from start to end.

Following the show, students are generally expected to solve similar Engineering Graphics problems by pencil at a drawing board. At that time, students would still have access to the PowerPoint presentation in order to encourage their further interaction by replaying it, or any parts thereof, any number of times at their own pace, as need be. As students visualize Engineering Graphics concepts presented on the screen, they in fact exercise a developing skill that would otherwise be intimidating, tedious, and time consuming if done using a printed worksheet.

Indications of the success attained through using those presentations are monitored through the students' overwhelming positive response to exploratory presentations of this mode of delivery.

Discussion

The ability to visualize objects and situations in one's mind and to manipulate those images is a cognitive skill vital to many career fields, especially those that require work with graphical representations such as visual arts and engineering. Individuals vary widely in these skills. Some persons are naturally more gifted than others. However, those less gifted can, and should, enhance their visualization skills over time through regular practice and self-motivated serious training.

The PowerPoint presentations of various Engineering Graphics problems and concepts impart to students the know-how in a simple, attractive, even entertaining way. This SATALA approach would help students' arrive at a fast solution to a problem without the need to go through excessive verbal instruction, whether read or heard, that can easily become overwhelming.

The entertaining presentation through the capabilities of PowerPoint software generates students' enthusiasm for the course and builds up their self-confidence, making them feel good about themselves and what they are learning. The heartening sense of achievement which students attain, and their feeling of content and self-fulfillment would encourage them to achieve even more and to excel.

Indications of the success attained through using those presentations are monitored through the students' overwhelming positive response to exploratory presentations of this mode of delivery. Of course, this would eventually be reflected also in enrollment and retention statistics.

Preparing PowerPoint slides is a very time consuming, sometimes frustrating, process that also requires training and technical skills to effectively use the software. A single slide can have 80 to 100 animations and would easily require between 4 to 5 hours to prepare. Variables at play include the selection of line shape, thickness, color, and animation. More importantly, the sequence of steps and their timing must be so planned in such a way that would reach the students in a logical and smooth way.

However, any time and effort invested in preparing those PowerPoint slides, eventually pays high dividends in the many students who get a better understanding of the subject matter which, in turn, improves their performance during their college years, and later in the work place.

Software

The use of a multimedia instructional approach in Engineering Graphics allows for more individual, self-paced instruction, and leads to further development of visualization skills through use of the interactive PowerPoint presentations.
The features of Microsoft PowerPoint software (Office 97 or Office 2000) nicely fit the anticipated effectiveness of the SATALA approach adopted for lecturing, which significantly helped change the Engineering Graphics learning and teaching paradigm, and enhanced students' education. The interactive PowerPoint presentations give

immediate instruction to students, and have proven to effectively improve their visualization skills that are essential to generate and interpret complex multiview drawings and pictorials.

Students rightfully expect that the computer is the natural medium for the presentation of information in Engineering Graphics. It should be noted, however, that the capabilities of Microsoft PowerPoint software and its potential usefulness in improving the teaching/ learning of Engineering Graphics must be discretionary introduced to the students. To safeguard against overwhelming the students, only the features of PowerPoint that serve a purpose should be used, and in small increments as need be -- starting from simple Engineering Graphics concepts and procedures, and building up to the compound.

Four Selected Typical Engineering Graphics Case studies

This paper presents four selected typical Engineering Graphics case studies. These are:

1) Multiview Orthographic Projection - The Loop Principle.
2) Drawing an Ellipse - The Four Point Approximate Method.
3) Drawing an Ellipse - The Revolution Method.
4) Line & Plane Piercing Point - The Auxiliary Method.

Case No. 1: Multiview Orthographic Projection - The "Loop" Principle (Wahby, 2001).

A simple and basic concept in multiview orthographic projection is that the three views of any point are connected through what can be called a "closed loop" of projection lines (Fig. 1).

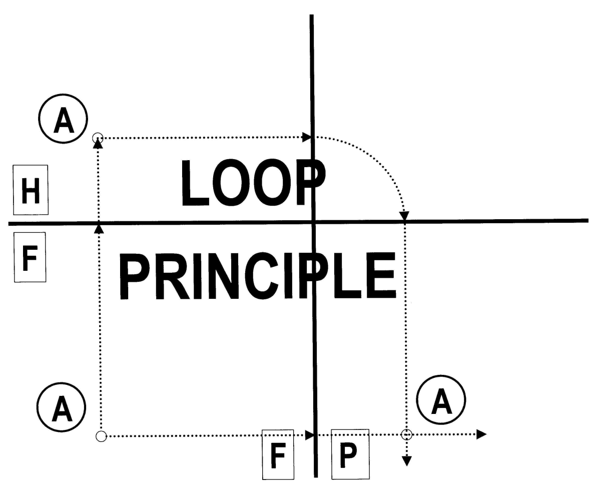


Fig. 1: The Loop Principle

A horizontal projection line connects the frontal and the profile views, a vertical projection line connects the frontal and the top views, and the top and the profile views are to be connected in such a way that "closes" the loop. No matter how many points are there in an object, the three views of each single point are connected through their own unique loop (Fig. 2).

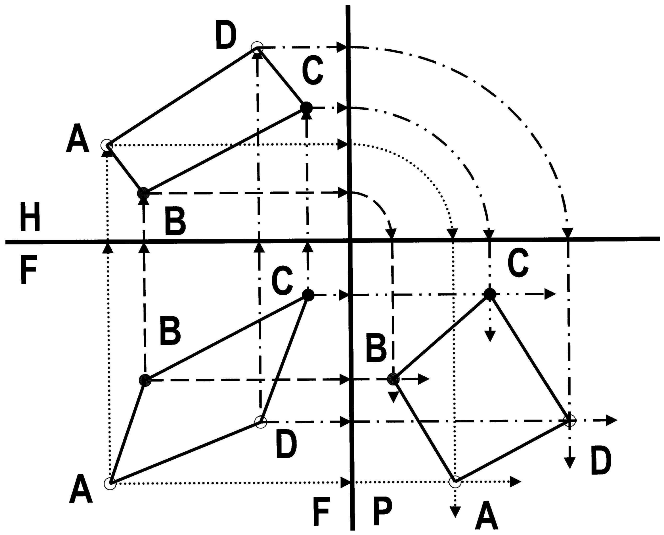


Fig. 2: The Loop Principal: Points, Lines, and Planes

Surprisingly, quite a few students (15%) needed some time to realize the simple and basic fact that what we have in multiview orthographic projection is: *three views of a single point, and NOT three points -- three views of a single line, and NOT three lines -- three views of a single plane, and NOT three planes!* The PowerPoint presentation makes it easy for those students to immediately visualize the Loop Principle and how it works. From there, they can easily solve most any assigned multiview orthographic projection problems.

Case No. 2: Drawing an Ellipse - The Four Point Approximate Method

The systematic steps to draw an ellipse by the Four Point Approximate Method (Fig. 3) can be found in most engineering graphics textbooks. "*Given the axes AB and CD, connect points A and D with a diagonal line. With AO as the radius, draw the arc AA' using O as the center. With DA' as the radius, draw the arc FA' using D as the center. Bisect line AF with a perpendicular bisector as shown in (Fig. 3); this locates points G and H, which become the centers for the required arcs. Points G' and H' are located equidistant from O as points G and H, respectively. The distance GO equals OG', and HO equals OH'. Draw the radius AG arc from points G and G' and the radius HD arc from points H and H' to complete the ellipse.* (Muller, et al, 2002)

One of the main problems here is that students see the figure accompanying a text "all at once." Figures are usually, and rightfully, supplied to help students visualize and understand a certain problem or a concept. Unfortunately, however, they sometimes intimidate and even turn off a good number of the students as they try to read the drawing, not knowing exactly from where to start and how exactly to arrive at the end product.

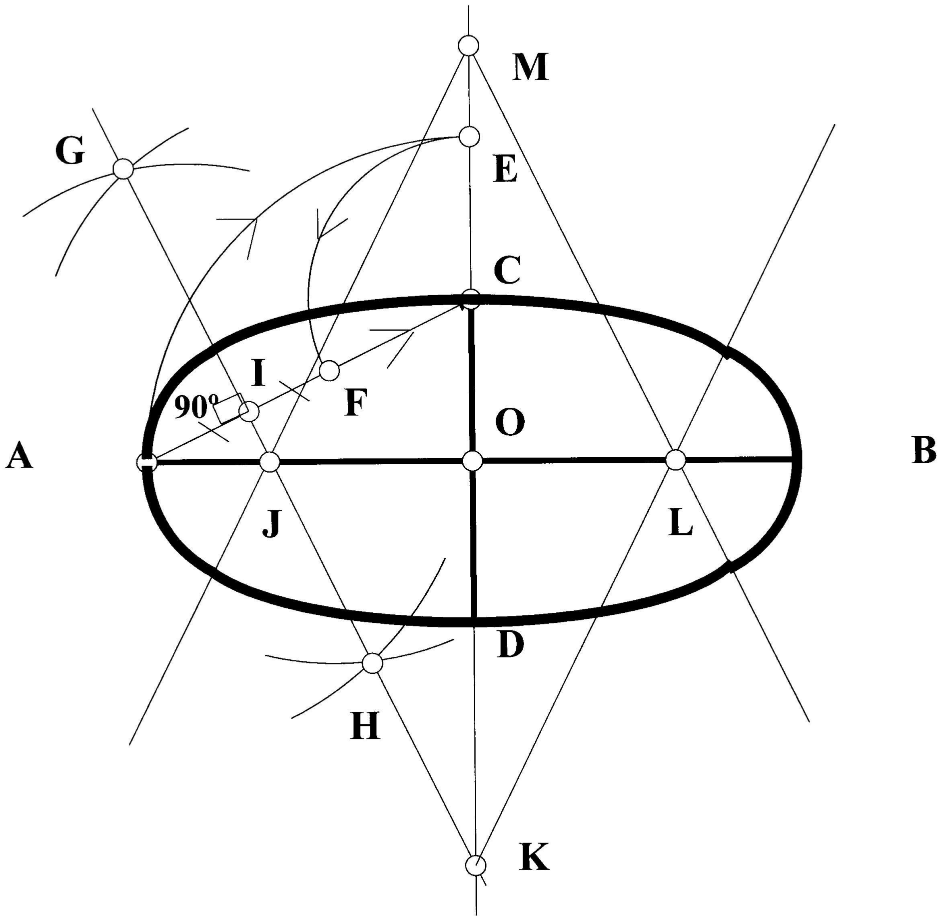


Fig. 3: Drawing an Ellipse - The Four Point Approximate Method

It was observed that about 22% of the students could draw the ellipse following those instructions -- and with much assistance from the instructor! The PowerPoint presentation shows those same steps, but animated and revealed one step at a time. After a single showing, 80% of the students were able to draw the ellipse without further help from the instructor, 9% needed a second showing, and 11% needed three or more shows, in addition to the instructor's help.

Case No. 3: Drawing an Ellipse - The Revolution Method

The systematic steps to draw an ellipse by the Revolution Method (Fig. 4) can be found in most engineering graphics textbook. *"Step 1: When the edge view of a circle is perpendicular to the projectors between its adjacent view, it appears as a circle. Mark equally spaced points around the circle's circumference and project them to the edge. Step 2: Revolve the edge view of the circle and project the points to the circular view. Project the point vertically downward to obtain the elliptical view."* (Earle, 2001)

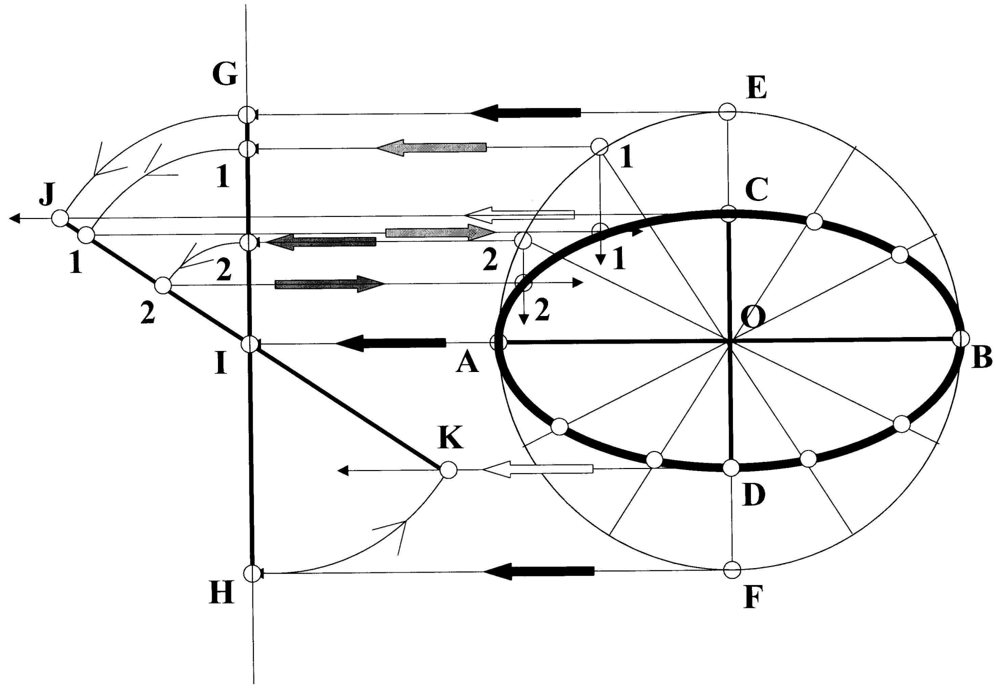


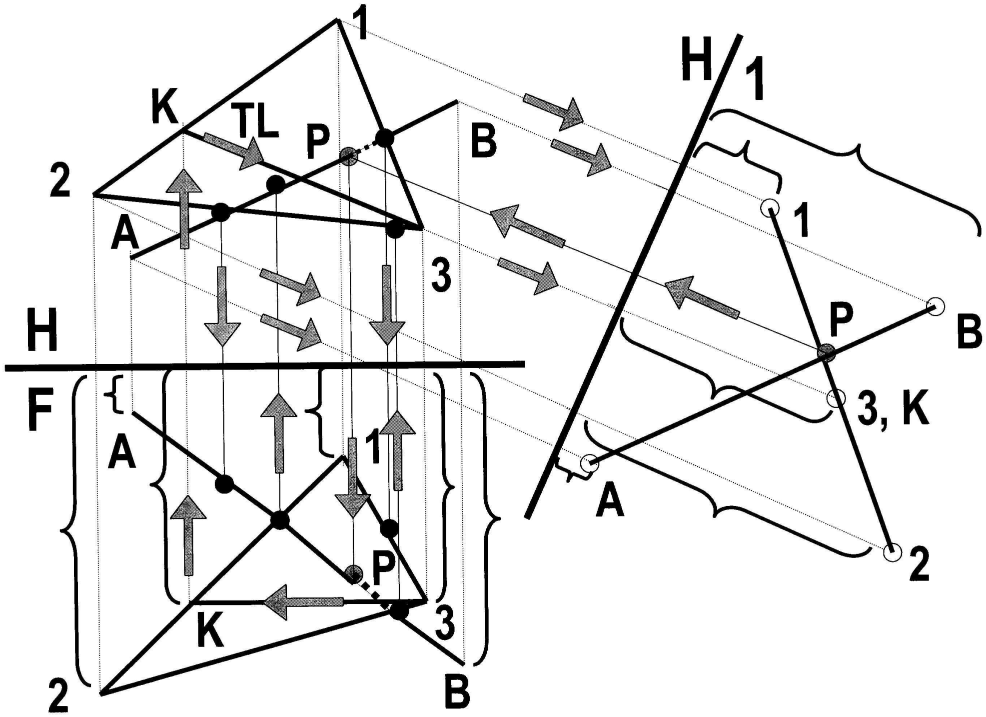
Fig. 4: Drawing an Ellipse - The Revolution Method

It was observed that less than 2 % of the students could draw the ellipse following those instructions -- and with much assistance from the instructor. The PowerPoint presentation shows those same steps, but animated and revealed one step at a time. After a single showing, 85% of the students were able to draw the ellipse without further help from the instructor, 12% needed a second showing, and 3% needed three or more shows, in addition to the instructor's help.

Case No. 4: Line & Plane Piercing Point - The Auxiliary Method

The systematic steps to solve for a Line & Plane Piercing Point - The Auxiliary Method can be found in most engineering graphics textbook. "*Step 1: Draw a horizontal line on the plane in the front view (Fig. 5) and project it to the top view where it is true length on the plane. Step 2: Find the edge view of the plane in an auxiliary view and project AB to this view. P is the piercing point. Step 3: Project point P to line AB in the top view. Line AP is nearest the H1 reference line, so it is the highest end of the line and is visible in the top view. Step 4: Project P to line AB in the front view. AP is visible in the front view because line AP is in front of 1-2.* (Earle, 2001)

Fig. 5: Piercing Point - The Auxiliary Method



It was observed that 18 % of the students could completely solve the problem following those instructions -- and with much assistance from the instructor, while 22% could arrive at only a partial solution. The PowerPoint presentation shows those same steps, but animated and revealed one step at a time. After a single showing, 78 % of the students were able to solve the problem without further help from the instructor, 16 % needed a second showing, and 6% needed three or more shows, in addition to the instructor's help.

Future Work

This experiment opened the door for other possibilities to explore and expand to in the area of multimedia instructional technology and curriculum such as:

1. Expanding the topics presented in this mode of delivery and revitalizing traditional teaching methods to improve the teaching/learning process.

2. Providing continuity between lecture presentations and lab/home work and turning lab assignments and homework problems into a self-teaching instructional tool in stead of confining it to a mere testing tool. This may be done through incorporating interactive software that would provide immediate feedback after the students submit answers. The feedback would indicate the score for each problem and how long students take to finish it, with the correct solution provided when students fail to reach it on their own.

3. Preparing short course tutorials for distance learning and self-paced instruction using other software.

4. Introducing selected PowerPoint/multimedia presentations into K-12 instruction to increase Engineering Graphics awareness among students at an early stage in their education. This can also help in marketing and recruitment efforts into engineering and technology education.

Conclusion

The traditional Engineering Graphics lecture is substantially upgraded through adopting innovative mediated teaching methods that provide the students with the opportunity to electronically construct – step by step – complicated geometric shapes, and apply engineering graphics concepts.

The use of "show-and-tell-and-let-apply" (SATALA) multi-media presentations in the delivery of Engineering Graphics courses ignites students' imagination and stimulates their visualization abilities, both of which being basic elements in mastering Engineering Graphics theories and applications.

The SATALA PowerPoint presentations have significantly assisted the development of students' visualization skills, making them better equipped to understand and use engineering graphics effectively. Students' better comprehension of the subject matter is reflected in their improved performance and superior grades in assignments and exams, as well as in their positive feedback on surveys.

Developing the SATALA PowerPoint presentations for use in engineering graphics applications is a time consuming process that also requires training and technical skills to effectively use the software. However, the development of such presentations has been a constructive experience as they have been positively received by students.

With the success that SATALA PowerPoint presentations achieved so far, a great part of that must be rightfully accredited to the face-to-face delivery element in the lecture. Most students still seem to have the need to "listen," "see," and interact with a "physically present instructor." Students' ability to express ideas and personally communicate with the instructor keeps many students interested and active in a course. It appears that technology is still unable to completely replace the human factor in the teaching/learning process.

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