Grade My Drawing

Minimum Viable Product Definition

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Revision History

Date	Author	Version	Description
08/28/2017	Mike Arnold	0.0.1	Initial Version
09/05/2017	Ben Flaiz	0.0.2	
09/07/2017	Mike Arnold	0.0.3	Added Payments Policy to the Subscription section, added technology for payment gateway and KYC, and rebuilt TOC
09/08/2017	Mike Arnold	0.1.0	Intermediate Release. Made layout changes, consolidated revisions from Ben and added a reference links in various sections of the document as needed.
09/08/2017	Ben Flaiz	0.2.0	Added detail to teacher accessibility Added preview rendering of Master STEP file to Assignment Definition
09/16/2017	Mike Arnold	0.2.1	Added CONFIDENTIAL watermark

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Product Concept

Fundamentally the purpose for this product is to provide a better way for teachers to teach and students to learn about CAD (Computer Aided Design). This product is suitable for teachers of middle school, high school and college age students. The product will provide a better way for teachers to communicate assignments, grading criteria and results. It will perform the grading of assignments accurately and in quantifiable detail in a much faster more transparent way than in the past with traditional grading methods. For students, the product will make it easier to submit assignments and to gain instant feedback on how the assignment was graded and where areas of improvement in skill levels exist. Future versions of the product will offer the ability for teachers to share assignments with other teachers and assign and administer multiple choice, matching, or fill in the blank quizzes coupled with 3D assignments. This product will introduce the methods of interaction between teachers and students that are becoming more common in colleges and universities across the country, specifically more on-line based individual learning.

Solution Overview

To achieve these goals, the product will provide the following basic capabilities, which are described in more detail later in this document:

1. Teacher Registration
2. Student Registration
3. Assignment Definition including Validation Criteria File (VCF)
4. Teacher STEP File Upload
5. Student STEP File Upload
6. STEP File Comparison and Evaluation Component

The solution will be built upon n-Tier Web and Service Oriented Architectures. It will be hosted on a public cloud provider (AWS, Azure, other) and will have the ability to scale both horizontally and vertically to support workload fluctuations in the most cost efficient manner possible. The pricing for this service will be subscription based and will be based on a tiered structure to economically support teachers with few or many classes and students.

Interaction with the product will consist of a teacher registration workflow that will enable the teacher to define their class structure and their students in each class, select pricing and complete their payment transaction via an ecommerce gateway provider that is fully integrated into the product.

Once the payment is accepted the teacher will have the ability to release welcome notifications to students so they can in turn register or the teacher may opt to manually register students anonymously. For more details on this, please refer to the Teacher Registration section of this document. The system will provide the teacher with reconciliation reporting so they can see which students have completed their registration.

A teacher will have the ability to upload a STEP file created with a CAD desktop software program like Inventor or AutoCAD as is normally done today. This uploaded STEP file becomes the Master STEP File and will be used to compare all Student STEP Files against. Additionally, the teacher will select the

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applicable criteria upon which the students STEP files will be graded, known as the Validation Criteria. The product will understand this list of known common criteria and use it to evaluate the accuracy of the student's drawing. Point values and concepts addressed will be assigned to the Validation Criteria and a numerical grade will be displayed upon successful upload and evaluation of the student file.

Students will have the ability to supply their STEP file for a given assignment that will be graded by the system. Once submitted the Student STEP file will be compared to the Master STEP file and a results file will be created. This Results file will be used to generate the students' grade and will also help the teacher provide better feedback to the student about their performance and achievement.

Technical Overview

As mentioned earlier the system will be built on n-Tier Web and Service Oriented Architectures. Because this solution will be deployed to a public cloud hosting provider, it will have to use the more standard web containers and technology stacks. Agile and Waterfall are supported project management methods, however, the product must have a fully implemented CI/CD process and associated technology stack. A potential listing is provided here:

Technology Domain	Description	Solution/Product
HTTP Server	Renders HTML to the browser	Apache HTTPD Server or NGINX
Application Server	Supports open frameworks, business logic components and data persistence	Apache Tomcat Server
Database Server	Data persistence	PostgreSQL
Visual Rendering (STEP)	Visual rendering of STEP files	Three.js
STEP File Comparison Component	Comparison of STEP Files, assigning critical validation attributes, providing assessment of Subject to Master	Currently evaluating CADExchange SDK
Web Framework	Basic web MVC framework	Spring MVC
Java Script Frameworks	Basic javascripting frameworks	Angular.js, Ajax.js, others as needed post design
Identity and Access Management	Only authenticated users can access the system. Assume that an IAM/IDP external provider will be used.	OAuth and SAML2 should be supported
Continuous Integration and Deployment	Tools and frameworks used to manage Code, perform builds and deploy versioned artifacts to the target environment	IDE – Eclipse Build – Maven POM and Bamboo or Concourse CI Deployment – Bamboo or Concourse CI Dependency Management – Nexus or Artifactory Code Management – GIT or GIT Hub
Language	Languages used to create the solution	Java 1.8 and C++ are permitted. Java should be the core

		component but C++ can be used if needed in special cases. Complete MAKE file, compile instructions and deployment for C++ must be supplied in the supporting documentation described in Requirement #16
Operating System	Development	Mac OS and Windows 10
	Runtime (Non-Prod and Prod environments)	Linux (CentOS 7)
Dashboard/Reporting/CRM	Provide both online/dashboard CRM and Reporting as well as batch/static reporting.	ZOHO CRM and Reporting
Payments and KYC	Support payments acceptance rules and KYC (Know Your Customer) standards and best practices	Subscribe to a payment gateway for credit card acceptance. Merchant agreement will be required. Set up CAPCHA, IDology and Threat Metrix integrations for KYC.

Business Component Overview

The following is an overview of each of the core business components or elements to the system. When the technical project is started, there should be traceability back to the business components and capabilities for each technical component to ensure that the entire solution is being delivered in the final product.

Subscription Service and Payments Policy

The revenue model for this product is a monthly or annual subscription based service. Initially, the focus will be on technology teachers across the country as they will be the primary beneficiaries of the use of this product. However, as we expand into colleges and universities, entities that do not rely on public tax based funding, the ability to provide a software licensing (named user) based revenue model should be supported.

A tiered subscription model will be supported so that different numbers of classes and levels of student enrollment can be more accurately reflected. This will enhance perceived equity in pricing and will solicit more subscriptions. Once the appropriate tier is selected, payment acceptance will be a function of the eCommerce Gateway provider we use. A merchant account will have to be obtained and the credit/debit or alternate payments (like PayPal) that will be accepted will be a function of the merchant agreement with the eCommerce Gateway provider. We understand that the provider will expose payment APIs that we will have to conform to. Also, we require that all security best practices like SSL and others (KYC, CAPCHA, IDology, ThreatMetrix for example) must be implemented.

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Teacher Registration

The enrollment process will start with Teacher Registration. During this process we will establish the identity of the teacher, the school district, the location and other relevant bits of information to establish the teacher and the institution they represent.

Following the registration process, the teacher will have the ability to define their classes and the students in each class. Once the appropriate metadata about these entities is captured the teacher will have the ability to send email/SMS notifications to students to start their enrollment and registration process or the teacher can manually register individual students or mass register an entire class. The program would automatically generate usernames and passwords. These usernames and passwords would be available for the teacher to export to a spreadsheet program.

The process to mass register an entire class will, in general terms, consist of the following steps or actions. In a dialog control on the UI, the teacher will enter a list of student names in the format (Last Name, First Name) with a CRLF at the end of each student name. The teacher will then submit this list for processing by clicking the correct button within the UI. The process will parse the list, insert the students into the data persistence layer (RDBMS) and generate either an Excel list of student name, User ID and Password or a formatted Access Card that can be handed to each student. The desired output format can be set by the teacher within Teacher Preferences.

Teacher Accessibility and Analysis

Teachers will have access to their classes not the classes of other teachers. Once an assignment is created the master STEP file will be uploaded and an assignment window can be given. When the window is open students will be able to view the assignment and any instructions associated with it. The students will then be able to upload their STEP file for evaluation. The evaluation will be done instantly and student feedback will be given based on the teacher's input and settings. The teacher will be able to input what feedback should be displayed for various criteria when setting up the assignment. When the assignment window is open the teacher will be able to access the class and see the student grades. In this view the teacher will be able to select individual students to see the submitted work and view the assigned grade. At this point the teacher will be able to manually modify the grade assigned by the software or delete the submission allowing the student to resubmit.

Teachers will have the ability to set up the number of times a student can resubmit their work for a given assignment as well as the rule for determining the maximum grade given the number of submissions. The default settings for these constructs will be maintained by the teacher within Teacher Preferences but the teacher can override them on each assignment if desired. An example of the rule for calculating maximum grade would be to average the scores for each submission or to deduct a certain point value or percentage for each submission or to just set a tier value for each submission.

Teachers will be able to view statistics by class by selecting a drop down and viewing the percentage of students losing credit in each of the various validation criteria. This will allow the teacher to modify future instruction to increase student proficiency in the CAD discipline being targeted by the assignment.

In the future, Teachers will have the ability to discuss and share assignments with other users through the use of an online discussion forum.

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Teachers will be able to assign and administer multiple choice, fill in the blank, or matching quizzes.

Student Registration

The student will be able to login to the site with the randomly generated username and password. Once registered the student will have access to video tutorials, on-line help and other resources to get them familiar with the use of the product.

In general terms each student will only see their assignments given to them by their teachers. Additionally, they will only be able to see those assignment submissions that they have made. They will also be able to see the feedback generated by the STEP Comparison and Evaluation Component as well as the additional comments made by the teacher.

Assignment Definition

To establish an assignment:

1. Assign a description
2. Select an assignment window or due date, number of submissions allowed, grading rule for multiple submissions and other parameters to be defined.
3. Upload a STEP file that will act as the Master for all student submissions to be compared to
4. Render the image on screen
5. Select from the master list of criteria the criteria that are relevant to the given assignment.
6. Select the Student(s) and/or Class(es) that the assignment applies to

Once this is completed the impacted students could opt to get an email notification letting them know to go onto the product, review the assignment and begin their work. Metadata about the assignment will include things like start and end dates, due dates, notes/descriptions, resources for help or instruction and other relevant bits of information for the students to be successful.

Students will have limited preferences; receive notifications by email, text or both. As other preferences at the student level are identified they will be added to this part of the product.

Teacher STEP File

The teacher will have to provide a STEP file for each assignment. This STEP file will be produced in a traditional CAD tool which is outside the scope of this product. This product will only grade and evaluate the student submitted STEP files to the teachers' STEP file for the purpose of providing better student evaluations and learning opportunities.

The teacher STEP file is used as the Master STEP file in all grading processing. However, grading cannot be performed unless a STEP Criteria file is also submitted as part of the assignment. Please refer to the Assignment Definition section of this document for further details.

Student Step File

The student will provide and upload a STEP file for each assignment. This STEP file will be produced in a traditional CAD tool that is outside the scope of this product. The student will be able upload STEP files, according to the number of uploads permitted in the assignment definition, between the assignment

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start and end dates. However, on the due date, the last STEP file uploaded will be the one used for grading.

STEP File Comparison and Evaluation Component

Component Overview

The STEP File Comparison and Evaluation Component is at the center of an application being built to support technology teachers in the US teaching students about Computer Aided Design (CAD). This component will help improve speed and accuracy of grading student assignments. This will be accomplished by comparing the teachers CAD STEP file to the students, based on a Validation Criteria File (VCF). The VCF will contain a subset of all known validation criteria. This subset will be those criteria that are applicable to the given assignment. Using the VCF data, the student and teacher STEP files will be compared and the results of the comparison will be tabulated in a response file.

Component Description

The STEP File Comparison and Evaluation Component will perform two primary functions. These functions will be called independently and individually by the other elements of the overall solution based on user stories and workflow. The two functions are:

1. Comparison and Evaluation
2. Image Rendering

Comparison and Evaluation:

The Comparison and Evaluation function will be exposed as a REST based API that other aspects of the system can call in a synchronous (Request/Reply) pattern or can be called as part of a batch process (the evaluation of all student assignments in a class) based on use case. The mechanisms to call this API in these manners is outside the scope of this requirement. The STEP File Comparison and Evaluation Component only needs to expose the API. The API will have three inputs:

1. Teacher STEP File
2. Student STEP File
3. Validation Criteria File – an XML document that will have Node/Value/Attribute. Node will be the criteria name, Value will be the value that must be present and Attribute will be Criteria Type (Boolean, Numeric, String, etc…).

The API will return an overall operation status, status message and if successful the Validation Criteria File with a SCORE Attribute added to the XML signifying the results for each criteria that was evaluated.

Image Rendering:

The Image Rendering function will be called from Java Script and will render the teacher and student STEP Files for a given assignment side by side in an iFrame on the web page. THREE.js and other technologies are capable of providing this functionality. This function will be chosen by the teacher and/or student based on user stories to visually inspect the results of the comparison and perform teaching and coaching.

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The Image Rendering function will receive the keys necessary to retrieve the Teacher and Student STEP Files as well as the Validation Criteria Results File from the database so they can be correctly rendered. Those parameters will be passed as JSON/application types in a HTTP POST operation.

Minimum Viable Product Requirements

The following is a bullet list of minimal requirements for this initial phase of product release.

1. The STEP File Comparison and Evaluation Component must be stateless. It should only process the inputs it is provided. This way we can horizontally scale out as many of these components as is needed to meet system demand.
2. The Image Rendering component may access the database to access the Teacher and Student STEP files as well as the Validation Criteria Results File in order to correctly render the images and show where students failed to complete the assignment correctly.
3. The STEP File Comparison and Evaluation Component AND the Image Rendering Component must be deployed as individual archives to a web application server container. JEE containers are not required but can be used.
4. Image alignment is critical for the comparison utility to work. It is acceptable for the MVP release to say that those images that are not aligned cannot be automatically graded. However, the ability for the system to match the student STEP with the orientation of the teacher STEP will be needed in subsequent releases. Please provide a separate sizing and estimate for this functionality.

Validation Criteria

1. Outside/Inside dimensional features. Must gauge how much of the object matches then it could be assessed with a percent difference calculation.
2. Surface area – evaluated with a percent difference calculation
3. Volume – evaluated with a percent difference calculation
4. Hole(s) center location – Simple Boolean, either it matches or it does not.
5. Hole(s) diameter – Simple Boolean, either it matches or it does not.
6. Fillet – Simple Boolean, either it matches or it does not.
7. Fillet radius – Simple Boolean, either it matches or it does not.
8. Chamfer – Simple Boolean, either it matches or it does not.
9. Chamfer angle – Simple Boolean, either it matches or it does not.

It should be noted that this list of criteria will grow over time. We need the ability to work with you in the future to add criteria as more are identified. This sample was derived by a~~n~~ review of over 100 past CAD assignments. However, we reserve the right to define more.

Also, for any given assignment the list of applicable criteria and any values that may be needed will be at the discretion of the teacher. Therefore, the Validation Criteria File that is input to the STEP File Comparison and Evaluation Component will be a sub-set of the known criteria.

Reporting

For this system there will be three basic categories of reports (Operational, Teacher and Student). For each of these categories there will be a dashboard with simple drill down capabilities and there will be standard nightly static report generation.

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Operational Dashboard will focus on the health of the system, system utilization, performance and response times as well as CRM data like open tickets, email requests for help or other customer support matters.

Operational nightly static reporting will consist of financial information (new subscriptions, monthly revenue and the numbers of teachers/students by demographic dimensions).

Teacher Dashboards will consist of students without STEP file submission by class by assignment by due date so that the teacher can remind the students of the work they need to complete. There are additional reporting requirements mentioned in the Teacher Accessibility and Analysis section of this document.

Teacher nightly static reporting will focus on students' grades, missing assignments and other general student/class performance metrics.

Student Dashboards will focus on new assignments, late assignments, near due assignments and overall academic standing.

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