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Sample Application MA-11-17-0155-17
Project Category: Learning Experiences
Funding Level: $0 - $25,000

Arboretum at Flagstaff

Amount awarded by IMLS: $24,963
Amount of cost share: $0

Attached are the following components excerpted from the original application.

- Abstract
- Narrative
- Schedule of Completion

Please note that the instructions for preparing applications for the FY2018 Museums for America grant program differ from those that guided the preparation of FY2017 applications. This year, the maximum that may be requested from IMLS is $250,000. Be sure to use the instructions in the FY2018 Notice of Funding Opportunity for the grant program and project category to which you are applying.

Transition Zone Horticultural Institute, Inc., dba The Arboretum at Flagstaff

Developing an Interactive Climate Change Center: Phase 3

The Arboretum at Flagstaff is applying for funding to complete a new, interactive outdoor Climate Change Center (CCC, formerly referred to as the I-STEM Learning Center), which will engage students and general audiences in the Science, Technology, Engineering, and Mathematics of real-time climate change research, interpretation, and mitigation. The CCC is being developed around a research theme based on the Southwest Experimental Garden Array (SEGA). SEGA's primary purpose is to integrate the study of climate change and genetics to help develop climate change mitigation strategies. SEGA is a research facility being developed by Northern Arizona University in partnership with The Arboretum, with funding from the National Science Foundation.

The Arboretum is charged with conservation efforts and providing scientific information on environmental issues. One of the biggest issues we are facing is climate change. Yet the issue is politicized and climate change education is often not place-based. We seek to raise awareness about climate change, connect people to on-the-ground scientific investigation, teach students and teachers, and demythologize a politicized issue using a Public Engagement with Science model. The completion of the CCC will accomplish a primary directive in The Arboretum's strategic plan—to become a major STEM education site in northern Arizona. The CCC will also provide a unique learning experience for students of all ages. Over 20,000 guests per year visit The Arboretum to learn about the flora and fauna of the Colorado Plateau and the environment in which they are found.

Specifically, over a two-year time frame, the proposed project will 1) add three additional kiosks making the total seven, 2) provide standards-based curriculum guides for educators to assist in on-site and in-classroom instruction, and 3) make datasets and curriculum guides readily available through the development of new webpage interfaces. Three new SEGA kiosks will complement the existing kiosks and emphasize the following ideas, a) temperature monitoring and the importance of microclimates for plant growth, b) solar power technology and renewable energies, and c) light detection and determining what light can and can not be used for photosynthesis. The curriculum guides will focus on three major themes: 1) climate change research can minimize impacts on the Earth and society, 2) making smarter choices in how we live our every-day lives will be made easier through improved climate literacy, and 3) building public trust and endorsement of scientific inquiry into climate change, can help bridge the void between what we already know and moving forward with developing national policies to protect our environment.

We expect project outcomes and results to be two-fold. First, formal and informal educators will have a place-based source for current, comprehensible climate change information that is both engaging and thought provoking. Second, general audiences will be able to witness and engage in the engineering and technology associated with modern climate change research – leading to a more informed public and improved science literacy within the population. The success of these outcomes will be measured through: 1) the number of participants visiting the kiosks, 2) the on-site learning experience, based on an exit surveys and polling, and 3) the administration of pre- and post-tests querying audiences' climate change knowledge. Public benefits will include a local resource for learning about climate change impacts and possible mitigation practices that are place-based, and therefore, more readily accepted and applicable, as well as connecting children and adults to scientific investigation and application.

Transition Zone Horticultural Institute, Inc., dba The Arboretum at Flagstaff

Developing an Interactive Climate Change Center: Phase 3

<u>Project Justification</u>
The southwestern USA is suffering one of highest levels of climate change impacts in North America. For example, the two record droughts of 1996 and 2002 resulted in widespread pinyon (*Pinus edulis*) mortality, with an estimated >12,000 km^2 of die-off (Breshears et al. 2005). If climate change in the Southwest continues as predicted (IPCC 2007), landscape-level changes in species distributions are certain to continue or even accelerate (e.g., Parmesan & Yohe 2003). The climate change models of Rehfeldt et al. (2006) predict the near extirpation of symbolic and widespread species such as pinyon pine, ponderosa pine (*Pinus ponderosa*), and saguaro cactus (*Carnegiea gigantea*) from Arizona by 2090. Although these recent drought events have left very visible scars on the landscape, not all of the effects of climate change are as easily identified.

The growing attention to climate change effects, such as extreme weather events, has led to an overwhelming amount of information and uncertainty (Karl & Trenberth 2003) – some of it true and some of it false (NCPA 2013). A 2010 survey of 1,000 adults revealed that 46% either did not believe global warming was happening or did not know about it (Leiserowitz et al. 2010). Here in northern Arizona, where climate change impacts are highly visible, and potentially devastating to humans, the need to distinguish the truth from the falsehoods is critical to sustaining an ecologically viable landscape. Because there is so much conflicting information available on the World Wide Web and from other sources regarding climate change and what it will mean for humans, it is important to have an accurate and reliable source for information. For this reason, The Arboretum at Flagstaff has undertaken the development of our Climate Change Center (formerly the I-STEM Learning Center) to provide relevant and science-based climate change information to our northern Arizona audience, as well as to our visitors from throughout the state. *At this time, we are requesting funds for Phase 3, the final step in completing the Climate Change Center*.

In 2014, The Arboretum at Flagstaff was awarded a grant from the IMLS Museums for America program to partially fund Phase 2 of what we are now calling the Climate Change Center (CCC). The current CCC hosts four interactive-interpretive kiosks and is home to the Penstemon Phenology Garden (funded in part by the American Penstemon Society) (See figure 1). The garden provides hands-on opportunities for visitors and school groups to perform citizen science roles in collecting phenology data on selected species of *Penstemon*. The collected data are uploaded to Project BudBurst for all to access and use. The existing kiosk topics and themes are summarized below:

Kiosk 1 (3-sided): Welcome and introduction to SEGA, What is Climate Change? and What can be done to lessen climate change impacts?

Kiosk 2 (2-sided): How do SEGA scientists measure soil moisture and precipitation? What is the importance of soil moisture and precipitation, examples of annual rainfall from climates around the globe, and local precipitation trends. Visitors can push a button to simulate a watering event at a SEGA garden site. Data are displayed here and on kiosk #3.

Kiosk 3 (2-sided): The SEGA data center and how information gets from the soil sensor in the ground to the researcher far, far away using the WiSARD network, WiSARDS are explained, climate vs. weather definitions are provided, and weather station components are described. Visitors can push a button to toggle through descriptive images and explanations of the data capture, transfer and storage system shown on a large monitor.

Kiosk 4 (2-sided): SEGA research and its application to sand management, local collaborations that are working together to solve climate change impact issues, focus on Babbitt Ranches partnership, and student research and volunteer involvement in SEGA, focus on Grand Canyon Trust partnership. (See supporting document 2 as an example for text, layout, and the design themes; empty boxes are for handouts).
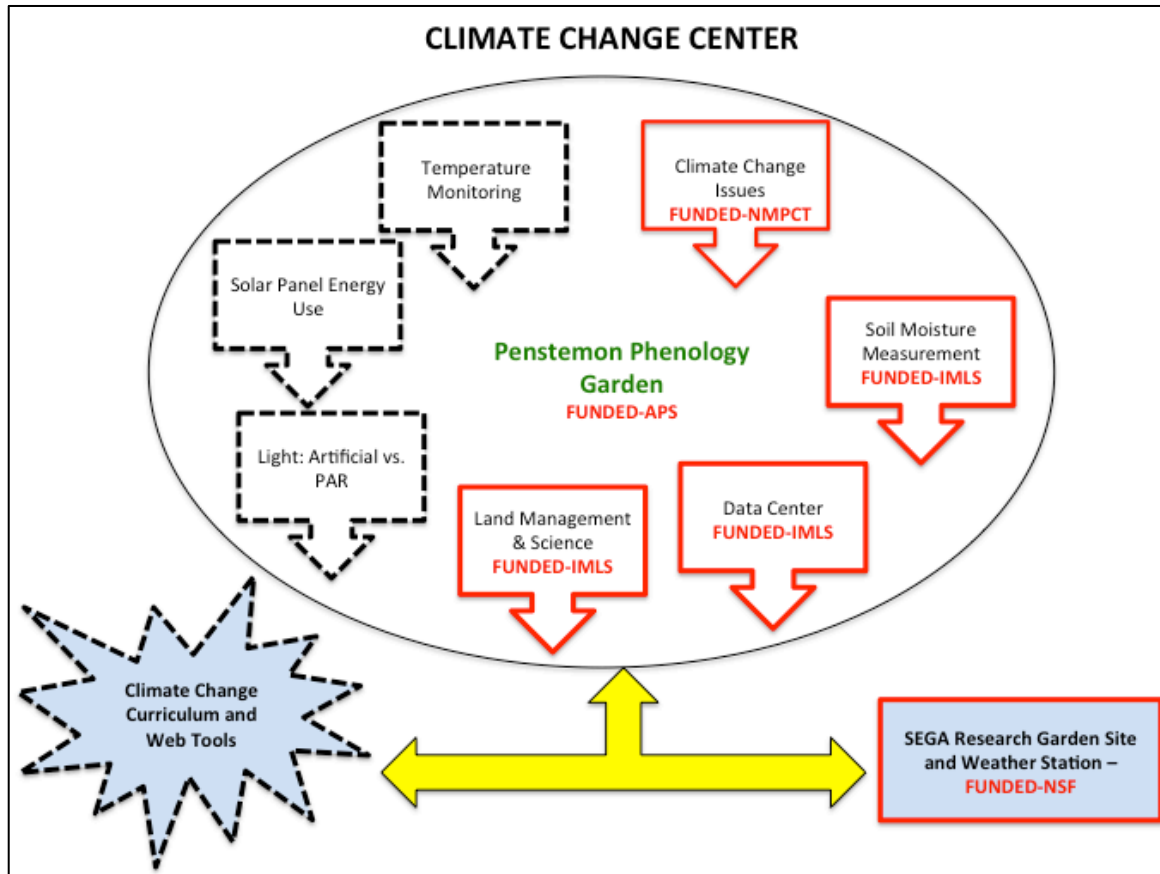

Figure 1. A diagram of the existing and proposed development of The Arboretum at Flagstaff's Climate Change Center is shown.

Earlier funding to support this project also came from both the National Science Foundation (NSF) and the Nina Mason Pulliam Charitable Trust. The NSF funded Northern Arizona University in 2011 to develop the Southwest Experimental Garden Array (SEGA), a research instrument that allows scientists to examine the effect of climate on the genetic traits of plants and plant dependent communities. Since temperature decreases and moisture increases with increasing altitude, elevation can be used to simulate changes in climate. The SEGA instrument uses gardens at multiple elevations to control the temperature to which plants are exposed and computer controlled irrigation to control soil moisture. In this way, SEGA allows scientists to expose plants to both warmer / drier and cooler / wetter simulated climates. The theme of The Arboretum's CCC focuses on the Science, Technology, Engineering and Mathematics (STEM) aspects of SEGA with an emphasis on how climate change science is being implemented. The proposed work for Phase 3 of the CCC has three objectives: 1) expanding the number of SEGA-based

interactive kiosks from four to seven, 2) developing new web pages to establish web-based communication formats for distributing CCC information, and 3) creating standards-based curriculum guides for grades 6-8 to detail how the CCC can be used in classroom and during field-trip instruction.

The proposed project will enhance climate change science learning and education opportunities for The Arboretum's existing 20,000+ annual visitors, supporting The Arboretum's mission "to develop educational programs that promote conservation and use of native plants" and vision "to become an outstanding Arboretum recognized for scientific research and educational programs on conservation and environmental issues…" Specifically, completion of this project will allow The Arboretum to obtain one of its 5-year goals, which is to gain recognition as a STEM site in northern Arizona. Although we encourage on-site visitation, by providing standards-based teaching curricula and tools for CCC use via the Web, we will expand the user audience by making lessons readily available and easy to access for off-site use. The activities proposed here address the IMLS Strategic Plan by placing learners at the center of the issue and offering them an engaging learning experience that will provide connection to the greater northern Arizona community through the use of tangible, local examples.

Project Work Plan

This project aims to accomplish three primary objectives: 1) to expand on the SEGA-based CCC series of interactive kiosks by three, 2) to develop web-based communication formats, and 3) to introduce new standards-based curriculum for teachers that focuses on how to use the CCC both on-site and remotely in the classroom. Lynne Nemeth, The Arboretum's Executive Director, will serve as the overall project director. Dr. Haskins will be responsible for project management, reporting and invoicing, and curriculum development. Below is a description of the new kiosks, web-based communications, and curriculum to be built and developed.

The Arboretum's Facilities Manager will complete kiosk installation. Technical hardware will be designed and implemented by a technician hired from NAU's School of Informatics, Computing, and Cyber Systems. Dr. Haskins will develop kiosk text with assistance from NAU-SEGA partners and colleagues. Mr. Paul Heinrich will supervise the technician and development of products to make the kiosk designs interactive. Ms. Andi Kleinman will provide graphical design work. Her work on the Phase 2 kiosks will be continued in Phase 3, providing consistency in appearance across the Climate Change Center.

Kiosk 5. *Temperature Monitoring: How is temperature measured in the SEGA garden?*
This kiosk will focus on the importance of microclimates in plant growth. It will feature multiple thermocouples that send data through WiSARD nodes and are displayed at the kiosk using a modified version of a Google Maps tool. The viewer will be able to toggle through maps showing different points for data origin, as well as graphs of the data.

Kiosk 6. *Solar Panel Monitoring: How is the SEGA technology powered?*
The theme of this kiosk is renewable energy and how photovoltaic solar panels are utilized at remote SEGA gardens. Using a solar panel on a gimbaled mount, students will be able to monitor the amount of power converted vs. the position of the solar panel, and see the

effects of angle to the sun and shadowing. This will require a special WiSARD SP board capable of monitoring the range of currents and voltages produced by solar panels.

Kiosk 7. *Photosynthetically Active Radiation (PAR): What is PAR to a plant?*
This kiosk will make use of Li-Cor PAR sensors to demonstrate that there is a specific spectrum of light utilized for photosynthesis and plant growth and that not all light spectrums are beneficial to plant growth. This display will use two sensors (one for PAR, one for all light) outside the kiosk in the sunlight and an additional pair inside the kiosk that is under a florescent light. Both will be able to be activated through a push button or capacitive touch interface. The display will compare the percentage of light from each sensor that can be utilized for photosynthesis.

The development of CCC Web pages will serve as a gateway to the outdoor exhibit, preparing visitors for what they will experience, and will also provide links to visualization of and access to SEGA data and curriculum guides. Providing the information in a web-based format will allow us to reach global audiences. The curriculum guides for grades 6-8 will correspond with NGSS and Common Core standards. Educators will be able to access these webpages and download real SEGA datasets that will provide students with a local connection to their environment. The datasets can then be used for science and mathematical instruction and to prepare for field trips to The Arboretum.

    Curriculum guides will provide instruction to educators and examples on how the information found in the CCC can be incorporated into science and math classes for grades 6-8. Major themes that will be emphasized include: 1) climate change research can minimize impacts on the Earth and on society, 2) making smarter choices in how we live our every-day lives will be made easier through improved climate literacy, and 3) building public trust and endorsement of scientific inquiry into climate change, can help bridge the void between what we already know and moving forward with developing national policies to protect our environment (Drummond et al. 2016).
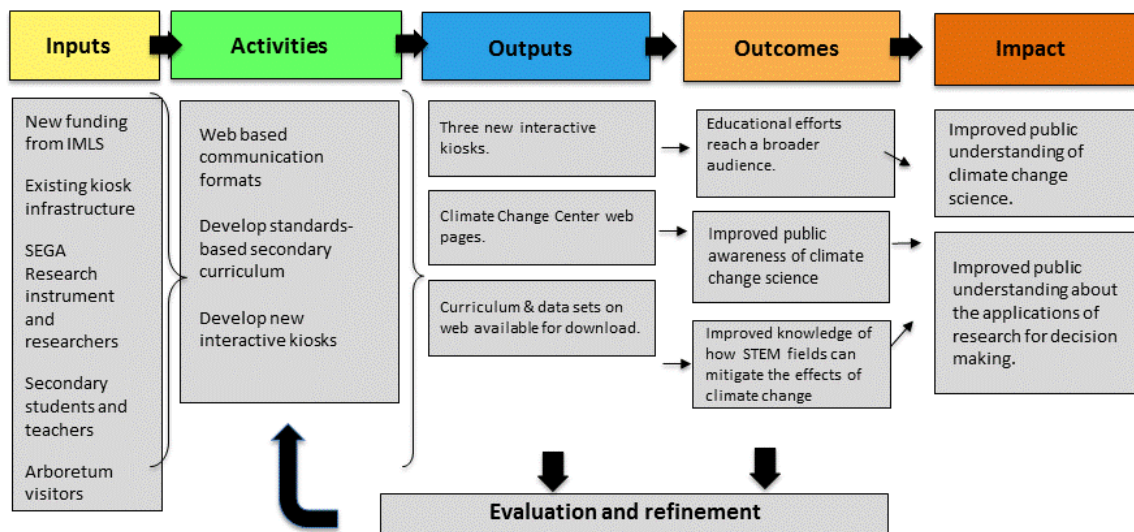
Evaluation Plan

Table 1: Assessment Plan

How engaging and comprehensible are the interactive kiosks?		
Outcomes	**Indicators**	**Method and data source**
Interactive kiosks provide engaging and comprehensible messages about SEGA and climate change content.	Interpretive materials are engaging, clear, relevant and content-focused.	Formative review by evaluation team; Pilot testing with a sub-sample of the target audience. Observations at opening event.
To what extent are the target audiences using the Climate Change Center Web pages?		
Outcomes	**Indicators**	**Method and data source**
A broader audience is reached through educational efforts.	Number and geographic location of users; content selection of users.	Google Analytics
To what extent does participation improve knowledge of climate change effects and mitigation strategies?		
Outcomes	**Indicators**	**Method and data source**
Increased knowledge of climate change effects and mitigation strategies.	Correct answers to questions.	Exhibit exit survey/ interviews Retrospective questionnaires with student groups Teacher questionnaires
To what extent does participation improve awareness and interest in STEM careers?		
Outcomes	**Indicators**	**Method and data source**
Increased awareness of and interest in STEM fields and climate change science in middle school students.	Questionnaire responses	Retrospective questionnaires with student groups Teacher questionnaires

Goal: The goal of the CCC is to raise awareness and knowledge of climate change through climate change education presented in conjunction with and utilizing real-time scientific investigation or, through climate change learning opportunities that utilize hand-on real-time scientific investigation.

The evaluation will examine the activities, processes and overall effectiveness of the educational resources available through the Climate Change Center. The Assessment Plan, Table 1, provides evaluation questions, outcomes, measureable indicators, and assessment methods and data sources. Formative evaluation will determine if the project is being

implemented as planned and identify strengths and weaknesses of the draft educational materials to allow for revision.

Formative (Process) Evaluation: Pilot testing will be used to determine if exhibit messages are clear and in line with the goal of the project. Written and verbal feedback from middle school students, Arboretum visitors and staff will be used to determine if the target audience is being reached and if the messages of the exhibit are being clearly communicated, engaging and relevant. Frequency counts of use of the kiosks and through Google Analytics will further inform these findings. The program team will communicate about findings regularly, and barriers to success will be examined and used to refine program components as is necessary.

Outcome Evaluation: Evaluation questions form the basis of the outcome evaluation, described in Table 1, and will be used to answer the summative question: *how effective is the Climate Change Learning Center Exhibit at increasing public awareness and knowledge of climate change science?*

Data Analysis: Quantitative data will be analyzed using descriptive statistics (such as means and frequency counts). Qualitative analysis of pilot testing interviews, and open-ended responses on exit survey and follow-up survey will be conducted using content analysis.

Year One Objectives in sequence (November 1 2017 – October 31 2018)
* Build and install 3 kiosk structures
* Design and build interactive kiosk components
* Develop text for kiosks
* Assess and revise kiosk text
* Develop standards-based curriculum guides

Year Two Objectives in sequence (November 1 2018 – October 31 2019)
* Develop web pages
* Continue work on standards-based curriculum guides
* Conduct assessments on web pages and curriculum and revise
* Upload web pages/curriculum
* Plan grand opening event to coincide with The Arboretum's Fall Open House (Sept. 2019)

Progress towards the project's goals will be monitored regularly through routine staff meetings run by The Arboretum's Executive Director, Lynne Nemeth, and through annual reporting to the IMLS. Deadlines for project tasks will be established early on in the planning process. Should the project begin to lag in meeting these deadlines, a special project-planning meeting will be held to re-evaluate the timeline and make plans to move forward.

Upon completion of the kiosks, a Climate Change Center Opening event will be scheduled to coincide with The Arboretum's Fall Open House event in the fall of 2019. The Fall Open House is a free-entrance event that occurs annually during Flagstaff's Festival of Science. Furthermore, completion of the web pages and curriculum guides will be promoted on-line through The Arboretum and SEGA's websites. Dr. Haskins will contact the local newspaper and Flagstaff's STEM City (http://www.flagstaffstemcity.com/) organization to promote the Climate Change Center.

Project Results

The proposed project falls under the IMLS Learning goal and has a specific performance goal of *developing and providing inclusive and accessible learning opportunities*. Phases 1 and 2 of this project have established a solid foundation for introducing visiting students and Arboretum guests to climate change, the impacts associated with a warming planet, and how SEGA is incorporating STEM resources to find long-term solutions to developing climate change impacts. Phase 3 of this project will not only support existing infrastructure and learning opportunities but, will greatly contribute to the inclusivity and accessibility of the Climate Change Center through web-based communication and access to instructional tools. Methods to collect data supporting this claim are described above, but will include the use of Google Analytics and professional formative assessment.

The need for increased climate literacy is supported by federal agencies, including the National Oceanic and Atmospheric Administration (NOAA 2009). According to a 2016 Pew Research Center Report "Roughly half of adults (48%) say climate change is mostly due to human activity; roughly three-in-ten say it is due to natural causes (31%) and another fifth say there is no solid evidence of warming (20%)". Thus, supporting the need for more climate change learning opportunities. The Arboretum's approach to this issue is to utilize a local climate change research instrument (SEGA) to illustrate the use of STEM in achieving positive outcomes that can mitigate climate change impacts. Through working with well respected and established local land management agencies and emphasizing regional examples and impacts we aim to more strongly and clearly engage our audience using a Public Engagement with Science model (McCallie et al. 2009) to improve understanding of climate change issues. We feel that this can be accomplished through expanding The Arboretum's Climate Change Center kiosk-series and web-based educational outreach tools.

This project will result in several tangible products including three additional interactive kiosks. Each kiosk will connect STEM with actual, local climate change research associated with SEGA. Kiosk messages will focus on positive outcomes and improving science literacy accessibility. The new kiosks will physically complete the Climate Change Center "loop" (see Fig. 1). Additionally, we will design and develop web pages centered on the Climate Change Center and the educational lessons it has to offer. These pages will be linked to The Arboretum and to SEGA's existing websites and will greatly expand the audience that we can reach as not every school group can afford or arrange a visit to The Arboretum. Through these new web pages we will also offer downloadable standards-based curriculum guides for grades 6-8, our target school group audiences. The guides will provide lesson plans and local/regional examples of how STEM activities and resources are helping to mitigate climate change impacts.

Project maintenance and sustainability after the duration of the grant will be made a top priority for two primary reasons. First, the educational message and public outreach components of the proposed project are integral to The Arboretum's mission "to develop educational programs that promote conservation and use of native plants" and vision "to become an outstanding Arboretum recognized for scientific research and educational programs on conservation and environmental issues..." Second, the Southwest Experimental Garden Array is a designated long-term research tool that is supported by not only by Northern Arizona University but, by the National Science Foundation. Both institutions highly regard educational outreach and are committed to its success.

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Schedule of Completion

2017-2018	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18
Objective 1: **Build 3 new interactive kiosks**												
Construct and install												
Design and build components												
Develop text												
Assess, revise, print text												
Objective 2: **Prepare curriculum guides**												
Identify data sets/find local examples												

2018-2019	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19
Objective 2: **Prepare curriculum guides**												
Identify data sets/find local examples												
Compose lessons/align with standards												
Assess and revise												
Objective 3: **Design web pages**												
Request permissions (logos)												
Build links and downloads												
Complete graphical design												
Assess, revise and release												