##### APPENDIX A:

**Developing Digital Exhibits for the Science Museum**

**May 2017A guide to standard requirements and good practice**

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|  | DEVELOPMENT OF DIGITAL EXHIBITS |
|  | By ‘digital exhibit’ we mean any exhibit that involves writing digital code that runs on a computer or processor-based system.Please request a supplementary guide if your design led you to develop an electromechanical exhibit or a passive/time-based exhibit. |
|  | Touring |
|  | The Science Museum is keen to tour its exhibitions both nationally and internationally. This may influence the design and development of the digital exhibit. The Science Museum will make you aware of this at the beginning of the project. |
|  | SOFTWARE REQUIREMENTS |
|  | The Science Museum is keen to encourage developers to express their creativity in the design of their exhibits and welcomes innovative designs. However, there are a few requirements it is essential to comply with to ensure you develop a successful exhibit for the Science Museum. |
|  | Development platform |
|  | Digital exhibits in the Science Museum must run for at least 14 hours a day, 365 days a year. The platform chosen for developing the exhibit can play a key part in making this possible. Our experience has shown that good development platforms for exhibits display the following characteristics:   * Already in widespread use in similar types of installation. * Has a strong community or company support. * Uses an existing widely used language. * Is a stable official release of software, including any plug-ins and add-ons (beta releases or versions that have not undergone rigorous testing in a wider market will not be accepted unless formally agreed with the Science Museum).   In any case, choice of technology and release version need to be formally agreed with the Science Museum to ensure they meet the Museum’s standards and maintenance requirements. |
|  | It is your responsibility to make sure:   * No terms of any third party licence are breached. * Any open-source licence does not require the project to be released open source unless formally agreed with the Science Museum. * No third-party licence prevents the project and its associated source code being delivered to the Science Museum. |
|  | Exhibit launch |
|  | *Your exhibit will be running unstaffed, on a stand-alone basis, without any external signage. Therefore:* |
|  | All exhibit software must start up when the computer/computers are powered up. This should include the start-up of all required components and the caching/loading of any required data/assets. Power will be applied to the Windows/Mac computer running the exhibit at the same time as any peripherals, e.g. projectors, screens, etc. The exhibit should take this into account, and not require peripherals to be powered up first. The exhibit software must take over the whole screen and must not display any underlying operating system ‘furniture’ including window borders, scroll bars, title bars, control panels, etc.The software must not allow the visitor to access any of the underlying operating system functionality directly – including network services, the file system and printing system.The exhibit must be capable of running under a standard Windows/Mac user account that does not have administrator privileges. A copy of the lockdown guide will be provided and software should be tested in that mode. |
|  | The cursor should be switched off. You should also include an editable preferences file that allows the cursor to be switched on and off. This means that you will not have to make separate versions for development and delivery. |
|  | Networking |
|  | If you intend your exhibit to connect across the network to the ‘outside world’ you should discuss this with the New Media Department before starting development. The Museum has very tight network security and will need to establish a clear need for this type of operation before it can be allowed.  The exhibit must run even when the network fails, so it must have an offline mode to ensure that the visitor experience is not compromised in the event of a network failure, and/or must display an alternative screen that is suitable for visitors.  Assume that any computers associated with an exhibit will have dynamic IP addresses. Where fixed IP addresses are required Museum approval must be sought. |
|  | Usage logs and analytics |
|  | Except for the most trivial of exhibits, it should be possible to enable the creation of a log file:   * To track the progress of an exhibit while in use, to assist in identifying when problems occur. * To measure daily uses of the exhibit.   Access to analytics is not a mandatory requirement. However, if you have already developed expertise in creating usable analytics you should discuss the option with the Museum. |
|  | **Flagging dysfunctional exhibits** |
|  | If your exhibit intercepts a minor error, we expect the exhibit to carry on and to log the error. To ensure the error is brought to the attention of the Museum technician, the exhibit should check the log at start-up and generate a message that can only be dismissed manually. This message should *only* be displayed if the exhibit is started before 10.00 – so that if the exhibit is rebooted during the day, the message does not appear.  For example: ‘This exhibit has logged XX errors over the last 7 days. Please check log file for further diagnostics.’ There should also be a ‘touch to continue’ button.  The design of the message window needs to be elegant and be submitted for approval as part of the ‘look and feel’. |
|  | Updatability |
|  | It is likely the Museum will need to amend or update the content over the life span of the exhibit. It is your responsibility to make the exhibit’s content dynamic and ensure text and images are stored in external files and folders. If your choice of development platform does not allow for dynamic content, you must bring this to the New Media Department’s attention. |
|  | If your design relies on specific word counts for text fields or specific dimensions for images, please share this information with the New Media Department and include it in your software documentation to facilitate the update process. |
|  | Database and CMS |
|  | You may want to rely on an existing or bespoke CMS to make your exhibit dynamic.  Please discuss any proposed use of a database and CMS with the New Media Department before work commences to ensure this can be accommodated within the specific attributes of your project. |
|  | Video and other third-party assets |
|  | Please discuss any proposed use of video or other third-party assets with the New Media Department before work commences to ensure that the formats and codecs are acceptable to the Museum. |
|  | HARDWARE REQUIREMENTS |
|  | Standard hardware platforms |
|  | The Museum has two standard hardware platforms: MacMini for Apple Mac applications and PC running Windows 7 for PC applications. Particular hardware specifications vary from project to project, but are set by the Museum at the start of a project. |
|  | Current standard hardware specifications are:  Apple MacMini 7.2 November 2014   * CPU Intel i5 2.6 GHz * 8 GB RAM * Integrated graphics Intel IRIS * Hard drive 256 GB Flash SSD * Apple OSX Yosemite or later   PC   * CPU Fast Intel CPU (Intel i5) * 8 GB RAM * Hard drive: 256 GB Flash SSD * Sound Blaster compatible soundcard * DirectX 11 supported video adapter * Four USB ports * 10/100/1000 network card * Windows 7 |
|  | For certain exhibits it may be necessary to add additional hardware (e.g. extra in/out ports) to the base-build computer or make changes to system settings.  Please ensure that the Museum has been fully informed of any changes you plan to make before you start building your exhibit, as any additional hardware must be approved and purchased by the Science Museum. |
|  | **Alternative hardware systems** |
|  | For certain exhibits it may be necessary to choose an entirely different platform. Please ensure that the Museum has been fully informed of your plan before you start building your exhibit, as any additional hardware must be approved and purchased by the Science Museum.  Note that if the commissioned work becomes part of a touring exhibition, the hardware must be available internationally. It is likely that your exhibit will be linked to a gallery- or exhibition-wide show control system. If you choose to develop your exhibit with an alternative platform it will be your responsibility to ensure your exhibit responds to different show control calls (e.g. muting the exhibit). |
|  | **Tablets**  While tablet computers can appear to be a convenient method of delivering interactivity and touch-screen exhibits into a gallery, they do present certain challenges when considering integration with the exhibition control system.  If you wish to develop for tablets, please ensure that the Museum has been fully informed before you start building your exhibit, as this may not be a viable solution for your project. In addition, any hardware must be approved and purchased by the Science Museum. |
|  | **Single-board computers**  For low-power, low-resource-intensive applications it may be appropriate to use a single-board computer.  The current standard for this is the Raspberry Pi 3 Model B running an up-to-date build of the Raspbian Linux distribution. |
|  | Interfaces |
|  | **Touch screens**  Visitors are not very accurate when using touch screens, so active areas on the screen should be at least 25 mm (1 inch) wide and at least 25 mm apart. Accuracy is even lower towards the edges of the screen.  Touch screens simulate a mouse by sending the exhibit a mouse click when the screen is touched. The normal standard for mouse operations is to have them execute on ‘mouse up’ – when the mouse key is released. Touch-screen exhibit software should be written in the same way and action should be triggered on ‘mouse up’ – with a visual and/or audio change on ‘mouse down’ to provide feedback to visitors and ensure they do not keep their fingers on the screen and push harder.  Following the wide adoption of smartphones, most visitors expect multi-touch and smooth-gesture control. However, because of the Museum’s robustness requirements, current touch screens specified for exhibits do not always offer the same level of gesture control. Please perform hardware tests before integrating gesture control into your exhibit. |
|  | **Other interfaces**  The Science Museum will support the development of exhibits that rely on alternative interfaces if the interaction is appropriate and particularly suited to the objectives of the exhibit.  However, here are a few things to bear in mind:   * Incorporate and document an option to operate the exhibit without using the novel interface (i.e. using a keyboard and mouse). * Provide a way of testing the interface without using the main exhibit software. * It is essential that you deal with the cursor in an appropriate way.   Please note:  Evaluation has shown that exhibits with non-touch-screen interfaces work better if the call for action demonstrates the type of interaction that is required from the visitor.  The Science Museum will request that the user experience and functionalities of the ‘novel’ interface should represent the main evaluation objectives of the first prototype, and therefore should be pushed forward in your development programme. |
|  | **Video and image recognition interface**  If the exhibit has a video camera, the camera should display ‘mirror’ images. |
|  | **Bespoke interfaces** |
|  | Where the exhibit contractor is designing, specifying or supplying additional bespoke hardware, e.g. for a physical interface, this must be agreed and signed off by the Museum before fabrication commences.  The exhibit contractor will have to issue detailed documentation and an operation and maintenance (O&M) manual for any bespoke hardware supplied as part of the contract – see section below. |
|  | USER EXPERIENCE |
|  | DDA compliance |
|  | All exhibits developed for the Science Museum must meet current DDA legislation. Areas of note to computer software developers include the legibility of text (font, colours/contrast and size) and that all videos must be subtitled. Please see APPENDIX\_Accessible Text and Design Guidelines.pdf for further information. |
|  | **Time-outs and attractor sequence** |
|  | When not in use, your exhibit should default to an ‘attractor’ mode or attractor screen. As well as providing an engaging incentive and clear call to action for the exhibit, this screen should work as a screensaver to prevent any possibility of image ‘burn in’ to the screen. |
|  | If no-one interacts with the exhibit, it should reset itself to the attractor sequence. Visitors should receive some warning of this, so after a set period without activity the exhibit should bring up a message saying something like:  Are you still there?  Touch the screen or this exhibit will restart in 10 seconds.  The exhibit code should ensure the time-out is not triggered if the exhibit has passive sequences without calls for action such as narrated animation, video, etc.  The countdown and the period of time before the exhibit resets should be stored in an editable preferences file so that it can be changed by Museum staff if necessary. |
|  | **Screen design** |
|  | The visual style of an exhibit will usually be informed by the design of the exhibition. In some cases you will be required to use graphic styles, typefaces and colour palettes already selected by the Museum. If this is not the case and you are designing everything yourself, typefaces and colours should be chosen carefully to ensure the exhibit meets current DDA legislation (see above). |
|  | Be particularly careful to design your graphics to the correct resolution. |
|  | The word count per screen should not normally exceed 50–70 words. |
|  | Icons should be used sparingly and should be clear and meaningful and never ambiguous.  Where possible use internationally accepted icons – for example ‘i’ for information.  For language selection, use the name of the language in that language rather than a flag.  All iconography must be thoroughly evaluated to ensure that it works for our visitors. Please also refer to the Accessible Text and Design Guidelines. |
|  | **Sound** |
|  | Good sound effects can significantly enhance an exhibit and facilitate engagement and understanding.  We cannot predict the sound levels in any Museum gallery, so you should *never* make the soundtrack essential for the visitor’s understanding of an exhibit. Therefore, exhibit instructions should always be accompanied by the equivalent text. Any video which carries spoken dialogue should also have subtitles. |
|  | Your exhibit should also be silent during its attractor sequence, as repetitive sounds quickly become irritating and can adversely affect the ambience of the gallery. |
|  | **APPROACH** |
|  | The Museum uses a development process with eight stages. Please refer to your brief or to your Invitation to Tender for a detailed description of the stages and their associated deliverables. |
|  | Stages of work:   1. Creative concept (including detailed/revised concept) 2. Concept proof (including prototype 1) 3. Initial development (including prototype 2) 4. Advanced development (including prototype 3) 5. Final development (including beta software) 6. Robustness testing (including final software) 7. Installation and handover (including installed exhibit and final deliverables) 8. Warranty |
|  | **Evaluation** |
|  | The Science Museum development process is articulated around a thorough user-centred approach and iterative evaluation process.  To ensure the quality of its exhibits the Science Museum runs evaluation, audience advocacy and visitor testing to assess their appeal to visitors and their ability to communicate the content messages and learning outcomes.  This process also gives you, the exhibit designer, a chance to experiment with new and different designs and to perfect the exhibit before it is finalised. |
|  | The Science Museum will undertake formative evaluation of the initial concept and of three working prototypes. Formal feedback from the Museum will be organised within 10 days after each step of delivery. We will expect a formal response and action plan in order to approve completion of a development stage. |
|  | The evaluation objectives are specific to your exhibit and to its challenges. Broadly, they focus on evaluating the creative response with the aim of removing barriers to engagement and comprehension.  The objectives and requirements will be specified after the concept design and after each development stage.  Prototypes will need be tailored to answer the evaluation objectives. As a result prototypes can be partially finished, partially functional versions of the exhibit, but each must be developed to a standard that allows it to be tested by the Science Museum on visitors.  The Science Museum team will decide on the suitability of the prototype for testing on the day of its delivery. |
|  | Prototypes should be delivered to and collected from the Science Museum on the days specified. The developer will be required to install the prototype or to provide clear instruction and supervision.  The developer is expected to provide the Science Museum with suitable risk assessment for evaluation and/or visitor testing. |
|  | **Robustness** |
|  | Science Museum exhibits are set to start up automatically at 08.00 and must then run completely unattended until (sometimes) after midnight. |
|  | Although the Museum team will undertake a final round of beta testing, core robustness testing is the responsibility of the exhibit producer. |
|  | Interactives designed for one-off events, attended installation and short-term marketing installations do not need to be robust in the same way as permanent interactive exhibits. You may be unused to dealing with these issues.  Robustness problems are very difficult to diagnose and fix because:   * Sometimes they only turn up after many hours of continuous use and it is very difficult to monitor exhibits once they have been installed on gallery. * Most robustness problems are caused by inherent problems with the tools used to create the exhibit – so the only way to fix the problem is to change the tool. |
|  | Robustness problems generally happen because:   * Memory leaks can occur – one of the biggest causes of unreliable exhibits in the Science Museum. Some pieces of software have a built-in problem whereby every time they perform some action they reserve a new bit of memory on the computer. Eventually the computer runs out of memory and crashes. This is known as a ‘memory leak’. For typical office use this is not a big problem, as the program is usually restarted several times a day, so the computer never runs out of memory. However, memory leaks cause big problems for computer exhibits because the program must run continually for over 14 hours a day. * Exhibits generally have a number of options, and if the exhibit has been insufficiently tested a visitor may find a particular combination of options which either make the exhibit crash or become unusable. |
|  | To keep robustness problems to a minimum, we recommend that you do the following:  Make sure the tools you use to make your exhibit are well established and from a reputable source. In particular, be very wary of the latest ‘X.0’ versions of software. Non-commercial software such as that produced by research institutions should be treated with particular caution.  If you are planning to use any software that you are unsure about, we strongly recommend you do some robustness testing on it *before* you finalise which technologies you are going to use for your exhibit. In particular we recommend testing for memory leaks (see above).  Be sure to test your exhibit thoroughly before final delivery. |
|  | We recommend that you do two main types of testing:   * Get someone who is not directly involved in developing the exhibit to sit down and test it for an hour or two to make sure that none of the options produce unexpected results. * Create a version of the program which will automatically run through the entire content, selecting options at random, and leave it running for a long time, such as over a weekend. |
|  | **Warranty** |
|  | The Science Museum requires a warranty period between 6 and 12 months – sufficient time to ensure the exhibit can be fully operated and maintained by our internal teams.  The Science Museum has a team of technicians and developers that attend exhibits who will carry out repairs of the exhibit during the life span of the gallery or exhibition.  The Museum will act upon the warranty and ask for producer involvement if:   * The exhibit is frequently faulty and requires above-average attendance from our technicians. * The O&M manual does not contain necessary information to carry out required repairs (see below for our O&M manual requirements). * The exhibition source files are incomplete and prevent our internal development team from dealing with problems (see below for our software deliverable requirements). * The technicians are unable to diagnose or resolve the problems. |
|  | To facilitate the implementation of the warranty agreement:   * Please provide clear contact details. * We expect the producer to keep a log of calls from the Science Museum to facilitate diagnosis and resolution of problems. |
|  | Response times must be in accordance with the scale and importance of the project and should be agreed at the end of stage 2, when the concept is approved. |
|  | **Loan computers for development stages** |
|  | Under certain circumstances the Science Museum will lend computers to exhibit producers. We lend these computers for two reasons:   * So you can carry out technical tests on your exhibit to make sure it is compatible with the standard hardware and system spec. * So we can evaluate your exhibit in the Science Museum. Contractors who have been lent a computer should bring this computer in with their exhibit pre-loaded on it for evaluation. The computer will be returned as soon as evaluation is over. |
|  | The Science Museum’s policy is that it expects computer exhibit contractors to have their own computers for development work. We *strongly* recommend that you do not rely on using the loan computer as your primary development platform because:   * It is likely we will recall all loan equipment at each stage of the development to carry exhibit evaluation. * These are generally exhibit computers which will later be installed on gallery. * We will recall all loan equipment for installation before the exhibit is due to go live. Please refer to the exhibit schedule for installation dates.   After it has been returned the computer disk will then be completely reformatted ready for use on gallery (if you need to make any changes to the system setup for your exhibit, be sure to document them thoroughly – otherwise we will install your exhibit on a standard system setup). |
|  | **Problem-solving with loan computers**  If you have a technical problem with one of our loan computers, please contact the Science Museum and we will arrange for it either to be repaired or replaced. Do not try and repair the computer yourselves. |
|  | **DELIVERABLES FOR DIGITAL EXHIBITS** |
|  | **Software deliverables** |
|  | The following software deliverables should be supplied, as appropriate, on a memory stick or as a download. |
|  | * Final exhibit installation folder, containing: * The main software program or executable file * A configuration file (allowing us to turn cursor on and off, and to amend time-out timings, etc.) * A complete set of *all* external files needed to run the exhibit software * Third-party add-ons and software needed to run the main exhibit software * Exhibit and system documentation in Word or other editable format (see below) * Additionally, and depending on the exhibit platform, the producer is expected to provide either: * A fully automatic install version of the exhibit which installs everything required to make the exhibit work (the installer should be flexible enough to allow the software to be installed in any directory or drive) * A well-documented install process * A complete set of all the source files, add-ons and dependencies needed to author the software – we will also need a full specification of the software used to author the exhibit, including full version number and a list of third-party add-ons and other dependencies. We also need a complete set of the intermediate files used for producing graphics and sounds (this includes unflattened Photoshop files, vector files and the meshes used for producing 3D graphics, and source code). * O&M manual in Word or other editable format. |
|  | **Exhibit and system documentation** |
|  | Please include the following:Installation instructions for a clean install.A brief description of the exhibit aim and main sequences.A list of settings that the Museum can manipulate via the external setting files – time-outs, cursor visibility, etc.A list of external and updateable assets used by the exhibits (including any page-layout information such as word counts for text fields, dimensions or ratios of assets).If a novel interface has been used, you should document how to operate the exhibit using only the keyboard and mouse, and also how to test the hardware without having to run the whole exhibit (you may have to write a small test program to do this). For the system documentation it is particularly important that you highlight any changes made to the standard Science Museum specification. Please specify:   * The full version name of the system software required by the exhibit. * Hardware specification: * Processor, memory and hard-disk specification * Graphics-card specification * Input device(s) used * Any additional ports used by the exhibit * Display settings, i.e. resolution and number of colours needed. * Any external fonts needed. * Any other specific system settings needed, such as control-panel settings. * Any registry settings which need to be present – ideally, please write a shell script which implements these settings automatically. * The fully documented list of add-ons and files which must be installed and the appropriate directories, including information such as version number, codecs used, shareware licensing information, the supplier and any serial numbers or authorisation codes. |
|  | Source files documentation |
|  | Please include the following:A brief description of all supplied files, including purpose, file type, creator program and where the file should be installed.A description of the software and hardware required to compile and export the exhibit software.The full set of third-party add-ons used to create the exhibit.A description of the uncompiled source files, including a brief description of main routines (e.g. scripts) within the program (this should be at a level that allows experienced programmers in the Science Museum to maintain and update the software).Assignment of copyright, where applicable. |
|  | **Hardware and fit-out deliverables** |
|  | This includes any hardware, interfaces or other parts of the exhibit that have been procured by the software contractor as part of their contract.  Any loan equipment supplied by the Science Museum, including all leads, must be returned (in the same condition as received). |
|  | Hardware documentation |
|  | If any hardware has been procured by the software contractor, the software contractor should also provide hardware documentation. This should include:   * Circuit diagrams and schematics for any non-standard hardware. * Any additional non-standard hardware components – third-party components should be very clearly specified with part number, manufacturer and supplier. |
|  | **Additional operation and maintenance information** |
|  | In addition to the documentation listed above, your O&M manual should also include:Any routine checks and regular actions required over the life span of the exhibit.A simple diagnostic chart for troubleshooting.A clear point of contact.  * Agreed response times for the duration of the warranty period. * Any specific cleaning requirements for visitor-facing elements that have been supplied by the contractor as part of their contract. |