PROGRESS REPORT

CONTRACT N° : IST-2000-29266

PROJECT N° : 29266

ACRONYM : VIRTUALFIRES

TITLE : Virtual Real Time Fire Emergency Simulator

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2 Executive publishable summary

A Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES) will be developed using techniques of virtual reality. In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular tunnel geometries with associated safety installations, particular fire hazard scenarios, etc.

It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD). Two systems are planned: one where the CFD simulation is pre-calculated, stored into a data base and then displayed another where it is carried out in parallel to the visualisation. In the first system the user will be able to move through the data but will not be able to change the characteristics of the simulation, for example the ventilation characteristics. In the second system the user may change the properties of the simulation while the data are displayed.

The VIRTUALFIRES system will be a unique system that can be used for assessing the fire safety of tunnels and aircraft, for training of rescue personnel and for planning rescue scenarios and will be able to replace or supplement real fire tests. The end users of this system will be rescue organisations such as the fire brigade and police, tunnel operators and government organisations concerned about tunnel safety. The system can be used for making an objective assessment of the fire safety of existing European tunnels. It can also be used for training drivers on how to behave in the case of a fire emergency in a tunnel.

3 Objectives and strategic aspects

We propose to apply the method of virtual reality to develop a simulator for assessing the fire safety of tunnels and for training rescue personnel. In a virtual computer-simulation-based environment all data about the structure, the safety equipment, ventilation, the fire and smoke development and vehicles/passengers exist in computer memory only. These data are displayed in such a way that the user has the possibility to study all the hazardous effects of a real fire emergency. The project therefore aims to contribute to efforts by the Community to increase the fire safety of European tunnels. It also aims to extend the range of application of virtual reality techniques.

The objective is to develop and implement a Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES). In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel.

By the end of this project a prototype of the VIRTUALFIRES simulator will have been developed which can be used by government authorities, tunnel operators and rescue personal. Currently the only method available to assess the fire safety of tunnels is to perform real fire tests. The advantages of virtual reality based simulations are that they offer virtually unlimited scope, are economical (the only expense being the computer time) and are environmentally friendly because no toxic waste is produced. As a result of the project's activity, through the availability of VIRTUALFIRES, the fire safety of tunnels will be increased because all European tunnels can be tested for fire safety and virtual fire tests can be made obligatory for new tunnels.

The work plan is to develop computer software, which together with specialised hardware can be used to display in a virtual reality environment the geometry of a tunnel with all its structural elements and safety installations together with the results of computer simulations of fires. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular geometries, hazard scenarios, etc. It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD) although emphasis will be placed on the development of the CAVE installation.

The applications on which we will concentrate the development include:

Training of rescue personnel. Currently this can be only done with real fire test, which are expensive and produce toxic material.

Objective assessment of the fire safety of tunnels. This is currently either done using a list of rather arbitrary rules or by performing real fire/smoke tests (i.e. Mont Blanc Tunnel).

The simulator can also be used for:

Training of drivers. Using the simulator truck and other drivers can be trained on how to behave in a case of a fire accident.

Intervention management. The tunnel operators will be able to train the intervention procedures in order to mitigate the effects of a fire emergency.

4 Scientific and technical performance

4.1 Objective summary

4.1.1 Work package 2

The objective is to continuously update the system specifications in response to decisions of the consortium.

4.1.2 Workpackage 3

For the remaining time of the project the objective is to optimise the data management especially in the face of the real time simulation and to add minor extensions. Finally, the documentation for this part of the VIRTUALFIRES Simulator will be written.

4.1.3 Workpackage 4

The objective is to implement the VIRTUALFIRES functionality specified in WP2 in the VR environment. The aim is that the same software will run both in the CAVE environment and in a Head Mounted Display (HMD) system with some modifications. The HMD-version of VIRTUALFIRES is designed to run on a well-equipped graphics workstation or PC. To display CFD data requires many optimisations because of the size of the data and is also demanding from a user interface perspective. The coupling of real-time generation of CFD-data to the VR-environment is highly innovative and raises many unsolved problems.

4.1.4 Workpackage 5

The objective is to develop advanced, efficient and user-friendly simulation tools for the computer aided analysis of tunnel fire hazards and embedding them into the VR environments (CAVE and HMD) of the other partners. Two approaches have been followed during the past period concerning the development of these tools. The first one was the a-priori generation of CFD data for various anticipated tunnel fire hazards (MontBlanc and Gleinalm tunnel) using the commercial CFD package FLUENT™, whose underlying numerical algorithms are based on implicit time integration schemes and body fitted computational meshes. The results of these computations have been stored in the central VIRTUALFIRES database and can now be accessed by the different VR systems for the visualisation of flame front and smoke movement.

Whilst the above approach represents a standard way to display data in a VR environment, the second solution strategy pursued is much more challenging and definitely contained some technical risk. Here it was envisaged to run the CFD simulations in real time embedded in the VR systems. The numerical methodology is based on the Lattice-Boltzmann method and utilizes explicit time integration schemes. Initial tests, which have been already performed, proved the feasibility of the proposed solution strategy. However, it is obvious that this approach requires significant computing resources and it will not be feasible to compute in a concurrent fashion the fire hazard taking place in the entire tunnel geometry. It is therefore planned to solve the full three dimensional conservation equations only in regions of interest (an extended area around the user). The remote areas of the tunnel will be treated using one dimensional transport equations for the hydrodynamic quantities. The boundary conditions at the interface between the 1D/3D areas are adopted continuously.

4.1.5 Workpackage 6

The objective of this workpackage is the assessment that the VIRTUALFIRES system developed in the previous workpackages meets the requirements of and specifications stated in WP2. To assess the accomplishment of these requirements, an evaluation of the accomplishments of different WPs (3, 4 and 5) will be done as a validation of the results of the project.

4.2 Technical progress

4.2.1 Workpackage 3

- **IRIX MipsPro CC 7.41 port of MySQL++ 1.7.9**

Trying to resolve the problems on IRIX, SiTu had to port the MySQL++ library for the MipsPro compiler, because Mysql AB confirmed that they support only the gcc compiler on this platform. The port is now officially available on the Mysql website.

- **IA64 gcc port of MySQL++ 1.7.9**

Getting the datamanager running on the linux cluster revealed stability problems and unpredictable behaviour of the MySQL++ library on the IA64 architecture. This was caused by data being misaligned due to different sizes of the datatypes in the 64bit environment.

A port for IA64/gcc was made including the fixes for the datatypes and is also available now on the Mysql website.

- **Datamanager on IRIX and IA64**

Having the MySQL++ library available on these platforms, getting the datamanager to run revealed no further problems.

- **ACE on IRIX and IA64**

The communication framework ACE was built on the IRIX and IA64 linux platform. This revealed no major problems.

- **porting of FIGDs HVR plugin for IRIX**

SiTu did the initial port of FIGDs cover plugin for the MipsPro CC 7.41 compiler. This port made the plugin compile on both platforms (Linux and IRIX) and was then used by FIGD to continue its development.

- **Architecture change from separate covise modules to a single cover plugin**

Regression testing of the system undisclosed a severe performance burden caused by the XML protocol between the UIC and DMC modules. Also performance penalties due to the architecture of the covise modules and their way of communicating with cover plugins led to the decision to collapse the UIC, DMC, ReadCGNS modules into one single cover plugin. KTH began the framework implementation of the UIC plugin and SiTu finished it.

This change greatly improved the stability and performance of the system.

- **GeomHandler plugin**

SiTu extended KTH's GeomHandler plugin to support reading multiple geometry files and placing them at arbitrary positions in the scene.

- **ICE on the linux IA64 cluster**

The CFD controller was adapted for parallelisation and handling multiple instances of ICE and the ICElib steering library was extended to support realtime changes of boundaries. Regression testing on the cluster was performed.

Due to linking with MPICE, the MPI version of ICE, ICElib had to be compiled with the Intel cc compiler on IA64, which also required to rebuild ACE with this compiler.

Communication problems under heavy loads were solved.

4.2.2 Workpackage 4

- **Rewrite of UIC**

With an upgrade to the MIPSPro 7.41 C++ compiler a corresponding new build of COVISE, and a rewrite of some sections of code, we now are able to compile the UIC plug-in and link it with COVER on SGI machines. This means that the UIC now runs in the CAVE environment.

- **PDA wireless connection implemented and tested**

We have purchased a new PDA with built in Wi-Fi connection. The GUI program was updated to work on this system and with a new panel to change network parameters.

- **Software Quality Assurance Tests**

The UIC and GUI have been extensively tested and numerous bugs have been fixed.

- **GUI documentation**

A first version of the GUI documentations is available.

- **Navigation in the CAVE with the PDA**

A module in the PDA has been implemented to simulate the standard Wand in the CAVE environment. You can now navigate completely with the PDA and use the buttons on the PDA for selection instead of the Wand buttons.

- **Improvements in the geometry handler**

The geometry handler has been improved to be able to create new objects and move objects.

- **Implementation of realistically looking smoke & fire**

Adapting the visualization methods to capabilities of the CAVE environment

This technical report directly refers to the technical report 'Display of realistically looking smoke & fire' which describes the basic technology of the so called 'Direct Volume Rendering' for the visualization of semitransparent objects, the limitations the CAVE environment poses to this method and suggested a workaround to circumvent these limitations, from a perspective before the actual implementation started. This report now describes the current state of the implementation and the problems that were encountered up to this day.

Workarounds

As stated in the first report the basic limitations of the CAVE environment are:

- the unavailability of the 3D-texturing
- geometry could only be set up in an offline process

The first workaround tested was the one described in the report. This workaround circumvents both of the limitations mentioned above. 3D-Texturing is not needed and the geometry used to render the semitransparent objects is fixed, regardless of the position of the viewer. The planes were arranged in an axis-aligned fashion, which results in three sets of mutually parallel planes. With this method there is always a set of planes which lies at least close to perpendicular to the viewing direction. Furthermore a viewer inside the volume is always surrounded by at least six planes. But as expected, this method with fixes planes is not feasible for the rendering of semitransparent volumes, because the shifting of the viewing direction caused rendering artefacts which are not acceptable for a realistically depiction of fire.

The experiences with this prototype taught us, that there may be no way to circumvent the use of the billboarding-technique, which arranges the planes perpendicular to the users viewing direction. Consequently the second workaround focussed on the availability of this technique.

There is a big, yet subtle, difference between billboard-rendering and ‘standard’ rendering of geometry, which in general is not perceived by the common user:

Rendering is a serial process, which handles different image representations in different stages of the rendering process. The first representation is the geometry defined by vertices in different coordinate systems and a topology of these vertices. In the first stage all vertices of a scene must be transformed into the ‘world coordinate system’ of the scene, which usually means the application of linear transformations (rotations, translations, etc…) to every vertex.

The second stage is the mapping of the ‘world coordinate system’ onto the ‘screen coordinate system’. This projection (also a linear transformation in homogenous space) defines for every vertex a corresponding point within the screen coordinate system. At this stage the image is represented as ‘fragments’. The last stage (the so-called ‘rasterizer’) now defines the pixels, whose colour is affected by the colour of a given fragment.

The difference between the techniques mentioned above is that in ‘standard’ rendering the geometry does not change when the viewer moves. This means the transformation into world coordinates can be done once and the result of this step can be reused, as long as the geometry does not change for other reasons. In contrast to that, while rendering billboards, the geometry must change every time the viewer moves. So the geometry must be updated every frame.

Having no 3D-Texturing available further aggravates this problem, because the positions where the temperature and density field must be sampled change with the geometry.

In quantities the consequence of this is : We have a temperature and a density field consisting of 104-105 vertices, and a moving spectator. If the rendering speed should be at least 10 frames per second, there may be a number of 105-106 vertices to be sampled, transformed and rendered in one second in software (rather than in dedicated hardware).

Fortunately it soon turned out to be that billboarding as such is available as a feature of the performer scenegraph system, so the sampling and rendering performance remains the main problem. For this reason the Direct Volume Rendering can be parameterized by a ‘resolution’ value, which roughly defines the sampling distance between two neighbouring points within the volume. Using this value a trade off can be achieved between the rendering performance and the resulting image quality.

Implementation

The algorithm uses the viewing coordinate system of the spectator. At first the far corner of the data volume will be determined. From this point a set of parallel planes perpendicular to the viewing direction is generated, until either the plane crosses the near corner of the data volume or the spectator. The distance between two such planes is defined by the resolution value. The main problem of the implementation was to find an accurate intersection area between the plane and the actual volume and an algorithm to sample this intersection with the given resolution. An intersection between a parallelepiped and a plane might be a single point, a triangle, a quadrilateral, a pentagon or a hexagon. To cover those different cases, I decided to use the bounding box of this intersection instead and tile this bounding box with the resolution given. Because the bounding box is bigger than the intersection itself, some of the tiles may lie completely or partly outside the data volume.

In the first implementation of this method only the tiles lying completely outside the volume are discarded, because they will be invisible anyway. Since the colour of a pixel is determined via interpolation between the corners of a fragment, the colours may ‘bleed’ beyond the borders of the data volume, if there are corners inside and outside the volume. This results in a lack of image quality at the borders.

To eliminate this in a second implementation, the tiles lying partly outside the data volume are clipping against that volume. As a result all fragments created lie completely inside the volume.

To further enhance the performance of the rendering system, the sampling rate applied to a given plane is now dependent from the distance from the spectator. Apparently the near plane must be sampled with a higher accuracy than the far plane, which is seen from a distance, and generally occupies a smaller area of the screen if it can be seen at all (because of layers of high opacity between the viewer and the far plane). The number of vertices to be sampled and rendered can be decreased by up to 50-90 percent.

Turbulence on a sub-grid scale

One of the new features of the shader-based/3d-textured rendering of fire and smoke could not be implemented: The application of a stochastic distortion field to the visualization to model features of the fire and smoke which are of finer granularity than the original grid (See previous report : expected drawbacks). The reason for this is obvious : Shannons sampling theorem states that only features of half the frequency of the sampling rate can be represented accurately. Only to represent all features of the temperature field means to sample the field with twice the original frequency.As we have three dimensional data, this translates to the number of sampling vertices eight times the number of vertices in the original grid. This alone is enough to bring the renderer to its limits.

A 3D-texturing engine overcomes this problem by going the opposite way: The number of vertices sampled is not defined by the sampling rate a priori, rather than the number of pixels to be filled. Every pixel in screen space corresponds to a number of points in world coordinate space (depending on the number of planes which extend over this pixel). As the pixel is the smallest unit on the screen, their array define the highest sampling rate which makes sense for every plane given. A plane in front stretching over the full size of the screen is sampled at a higher rate than the far plane which only stretches over a few pixels. The distance dependent sampling rate mentioned above tries to emulate this approach but a sampling rate at pixel size still remains out of question.

Originally the distortion field was applied to amend to the original data at a higher frequency. To apply a distortion field with the same frequency as the original data is a dangerous thing, because it would falsify the original data, so this approach has been dropped.

Memory Management

Memory management is a always a big issue, when dealing with performance problems. Usually every memory allocation and deallocation process is very time consuming and can not be optimized, because the details of the memory management lie in the responsibility of the kernel. This applies to a multiprocessor system in particular. As the memory is a pool commonly shared by all processors available the memory management is a typical bottleneck in parallelized applications, because only a single processor can be served at a time.

In its former stage, the HereVR-Plugin created new scenegraph nodes whenever new geometry is to be displayed. Every new node created its own geometry buffers used for vertex or texture coordinates, which resulted in many allocation and deallocation procedures during visualization.

After a major refactoring process in the current stage every visualization method is changed in a way that the memory buffers are not attached to the scenegraph node rather than to the visualization method. The memory buffers will now be created once for each probe, and will be reused as long as this visualization is active. The same applies to the scenegraph node, which will not be destroyed after use. Instead it will be reused and simply be filled with new geometry data.

Avoiding Flickering

After a few tests the Direct Volume Rendering seemed to have a problem with changing datasets. Everytime the data is changed, the corresponding visualization went blank for a moment and displayed the image after a few milliseconds. This flickering is a very common phenomenon in graphics systems. The standard solution to this is to use a double buffering scheme. The reason why this is only noticeable with Direct Volume Rendering might be the complexity of the visualization, but this applies to all visualization methods. Therefore the current version of the HereVR-Plugin uses two sets of geometry buffers and geometry nodes for every visualization. That way the geometry can be stored even if the corresponding data has been unloaded until the new data has been loaded and the new geometry has been set up. The geometry set actually rendered can be updated by exchanging the geometry nodes within the scenegraph, which is a operation fast enough to avoid flickering.

Conclusion

This algorithm works on all systems available for testing. The performance could up to now only be tested under Linux on a 1.4 Mhz Pentium PC. It should be noted that the actual time needed to set up the geometry and sample the data volume lies at about 3M – 4M Vertices /sec. The time to render that data, however is bigger and difficult to assess, because it is done by the scenegraph system. At 105 vertices per frame, the frame rate on this system lies by about 10 frames per second. How the performance will be in the CAVE with the current version of the system is subject to optimization and fine-tuning to be done in Stockholm.

It should be noted that every rendering system has its limits. The system the algorithm was developed on, fails to render correctly at a rate of around 400.000 vertices per frame due to synchronization faults. A corresponding value has to be found for the CAVE engine – with respect to any geometry to be rendered additionally. According to my experience this value might be smaller. Even if the CAVE engine is a 12-processor computer, it has to be taken into account that (in theory) only two of them render a single image (one for each side of the CAVE). In such a case the resolution value mentioned above can be adapted to the capabilities of the system.

Using rendering with semitransparent planes, the visual environment of a fire burning in the tunnel can be remodelled. As planned the temperature is mapped onto the colour and the density is mapped onto the opacity of a given sampling vertex, using an appropriate 2D-Texture. Using Direct Volume Rendering the blending mechanism between the different planes models the light absorption of a given volume on the path from the light source to the viewer. So regions were smoke poses severe restrictions to the visibility conditions can be easily identified as well as the regions of fire and regions where the line of sight is clear. The granularity of the features of the fire, however, will depend on the sampling rate which in turn must be traded off with the performance of the system. Summarizing the effort I state, that the problems related to 'qualitative' aspects could all be solved (overall feasibility of the method, feasibility of the workaround, usability of results). Problems related to 'quantitative' aspects naturally depend on the resources available on the given rendering system (sampling rates, trade off performance and realism), but the algorithm presented is flexible enough to adapt to these resources.

4.2.3 Workpackage 5

- **Release of ICE 2.0**

ICE 2.0 was released according to the Deliverables and Milestone list in PM 26. The software performs according to the specifications given in the Work Programme

- **Software Documentation**

Software User Guide 2.0 was completed and sent to the Co-ordinator in time.

- **Software Quality Assurance Tests**

Intensive software testing before the official release of ICE 2.0 was performed to insure proper functionality.

- **Validation Case Studies**

A number of case studies have been done to assess the predictive capabilities and the performance of ICE 2.0 on CD's Compaq ES40 and Linux Cluster computing systems.

- **Reference Calculation**

A geometrical model of a Dortmund Subway Station was generated and flow and smoke spread was calculated according to the specifications given by FDDo. Results have been transferred to the VIRTUALFIRES Database.

- **ICE 2.0 Installation on Lucidor**

All software was transferred to KTH and installed on the VIRTUALFIRES computing platform Lucidor. Currently the communication between the VIRTUALFIRES Datamanager and ICE 2.0 is tested.

- **Updates Concerning Fire Suppression Modelling**

Before ICE 2.0 was officially released an extended version of the thermal energy equation was implemented to include the effect of fire suppression systems on flame and smoke spread.

- Updates to Obtain Integral Values across Boundaries

On request of SiTU at the moment extensions within the development version of ICE 2.0 are made to enable the computation of integral values of flow quantities and temperature across boundaries.

- Parallelisation Efficiency Studies

An on-going activity is concerned with the assessment of the parallelisation efficiency of ICE 2.0 on Lucidor and on CD's Linux Cluster system. At the moment scale up studies are made to figure out the minimum number of processors necessary to perform real time CFD-simulations. The development work is hindered by limited and slow access to Lucidor for software testing.

Scale up studies on CD's Linux Cluster system consisting of computing nodes which are about twice as powerful as the nodes of Lucidor indicate that with a minimum number of 10 nodes real time CFD-simulations are feasible. Hence, about 20 nodes of Lucidor must be allocated at the forthcoming Review Meeting to demonstrate such type of calculations on KTH's Lucidor. During the Review Meeting it has to be ensured, that exclusive use of this system partition is given and interaction with other users is avoided.

- 3D/1D Coupling - Version 1.0

The first version of the 3D/1D coupling code has been completed. Since the last review meeting the following modifications have been done:

- reduction of the grid is implemented,
- automatic boundary switch between 1D and 3D at the ends of the computational domain is implemented,
- time dependent boundary conditions are included,
- restart of the code is implemented,
- gravity is included in the 1D model and
- the friction model has been improved such that the setup procedure, which was needed to
- compute necessary constants at the beginning of the simulation, is avoided.

Several tests have been performed where the 3D/1D model was compared to the 3D model. The results are very good.

In the Figure 2 the coupled model is compared to the 3D model. The tunnel is 100 m long and contains a heat source near the center. The initial size of the 3D area in the coupled model is 30 m (30-60m). Under the simulation run the 3D area is expanded to the right four times. The isosurfaces at t=20,10,2 are shown after 1000 time steps (max value of t is 100).

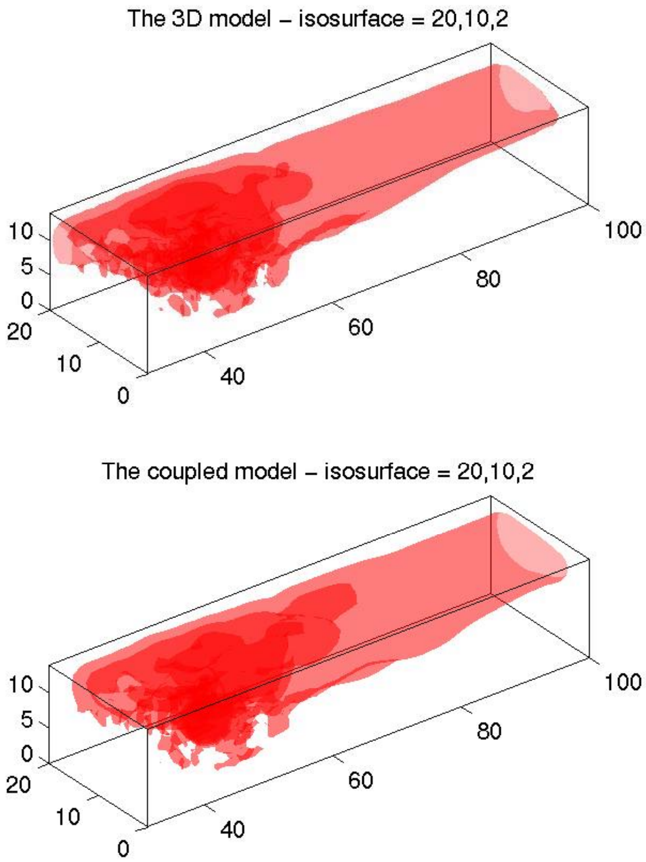


Figure 2: Comparison of 3-D and coupled 1D-3D model.

4.2.4 Workpackage 6

A work plan of work package 6 „Evaluation and Validation“ was drafted according to the request made by the reviewers at the review meeting held in Stockholm on Nov. 24th. The approval of this plan was a necessary condition for the undertaking of further work in this work package.

Reviewers comments are reproduced in the following:

„The presentation outlined the work that will be conducted in WP6a. Although WP6 is not due to commence until January 2004 the reviewers were concerned that ***sufficient thought had yet to be given to the selection of metrics and methods to be used during validation****. The reviewers were also concerned that the consortium did not appear to be aware of the existence of an up to date and appropriate user specification (D2.4 had last been updated in February 2003 but many of the items in the specification appear to have been dropped from the current implementation plans – i.e. modeling of fire hoses)...*

The review, together with appropriate documentation provided prior to the review must show:...

- *The validation process. How will the validation be conducted, who will conduct the validation, where and on what systems will the validation take place, what criteria will be used, and what test cases will be used in the validation.“*

In accordance with the reviewers' comments the evaluation and evaluation plan was extended to include the following items:

- Test cases to be used
- Selection of methods and metrics
- Roles of participants
- Evaluation resources

A clear connection with D2.4

4.3 *Comparison planned activities and actual work*

4.3.1 Reports

At the 4th review meeting in November 2003 at KTH Stockholm the project was off schedule due to technical problems, mainly related to the IRIX platform, the then available MipsPro 7.3 compiler and the rendering capabilities of the chosen scenegraph OpenPerformer.

Due to the actions taken after this review meeting up to the 5th (In-Depth) review meeting at the end of March 2004 at KTH Stockholm these technical issues could be solved and a functional prototype was demonstrated in the CAVE and on the HMD.

Deliverable	Title	Planned Closing date	Achieved closing date	Reason for delay
D3.6	Release version of data management	26	29	see above
D4.6	VR implementation with full functionality optimised for speed	25	29	see above
D4.7	VR integration with real-time CFD data generation	25	29	see above
D4.8	VIRTUALFIRES users manual	26	30	see above
D6.1	Report on CAVE/ HMD installation	26	postponed	WP 6 was postponed until the success of the 5th review
D6.2	VIRTUALFIRES results report	28	postponed	WP 6 was postponed until the success of the 5th review
D7.1	Definition of Testcases	8	29	rejected at 4th review
M4.1	Beta testing of software completing successfully	27	27	see above
M5.3	Software release V2.0	26	29	see above
M6.1	Requirements accomplishment	27	postponed	WP 6 was postponed until the success of the 5th review

Table 2: Planned activities and actual work done

4.4 *State of the art review*

There are many tools on the market for displaying CFD datasets. However, at present they are not able to perform simultaneously the CFD simulation and the display of data in real time. The main advance of VIRTUALFIRES over existing methods is the complete interaction of the user with the simulation and real time display of data in a realistic way. For that reason a development of massive parallel visualization methods was initiated. These methods, which utilize partly sophisticated hardware capabilities of new graphic cards available on the market, are integrated in a state of the art visualization system (parallel visualization kernel / Covise).

4.5 Planned activities for the next period

4.5.1 Workpackage 3

- Detailed specification and creation of the required modelling data for the testcases used for the evaluation.

- Adaptation of the datamanager and its related components to handle the required changes for 1D3D-coupling.

4.5.2 Workpackage 5

- 3D/1D Coupling - Further Research

The research aimed to divide the one-dimensional area into two separate zones - hot flow zone and cold flow zone - has been started recently. According to the first investigations the classical zone model is inappropriate here. Instead the development of the hybrid model, where ideas from both the zone model and the field model are used, is under investigation.

4.5.3 Workpackage 6

According to the description of work, the evaluation process will go on for about two months and it will comprise the following taks:

- Evaluation of CAVE and HMD installation

- General validation

The plan presented at the last review is considered a draft produced at the request of the reviewers. It is clear that defining the final evaluation plan is a task that requires the participation of the whole consortium.

4.5.3.1 Resource allocation for the validation and evaluation

Each evaluation session will be carried out in the presence of an evaluator.

The PC system will also demand the participation of a technical facilitator who will carry out the commands of users and will collaborate with them to get the most out of the system capabilities.

In the case of the CAVE system two technical facilitators will be needed: one cotrolling the system out of the CAVE and the other inside the CAVE to carry out the commands of users and to collaborate with them to get the most out of the system capabilities

In addition, the hardware and software necessary for the CAVE version and the HMD version should be available for each session.

At least eight users from the end users and fire brigade groups will take part in each scenario.

However, a lower number of end users from the authorities/operators/designers group will be used because of their limited availability.

All the CAVE tests will take place in Stockholm because of the particular incidences that have affected this setup.

The PC tests will take place at the partners locations depending on the availability of users to validate the system.

5 List of deliverables (Month 25 – 30)

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Del. type*	Delivery (proj. month)	Delivered (proj. month)
D3.6	Release version of data management	3	SITU	Serial	26	29
D4.6	VR implementation with full functionality optimised for speed	4	KTH	Prototype	25	29
D4.7	VR integration with real-time CFD data generation	4	KTH	Prototype	25	29
D4.8	VIRTUALFIRES users manual	4	KTH	Report	26	30
D6.1	Report on CAVE/ HMD installation	6	EUVE	Report	26	postponed
D6.2	VIRTUALFIRES results report	6	EUVE	Report	28	postponed
D7.1	Definition of Testcases	7	METL	Report	8	29
D7.2	Journal articles	7	METL	Report	28	
D7.3	Conference papers and exhibition at conferences	7	METL	Report	28	
M4.1	Beta testing of software completing successfully	4	KTH	Demonstration	27	27
M5.3	Software release V2.0	5	CD	Demonstration	26	29
M6.1	Requirements accomplishment	6	EUVE	Demonstration	27	27

Note: D3.6, D4.6, D4.7, M4.1, M5.3 have been demonstrated at the 5th (In-Depth) Review in Stockholm, 31 March - 1 April 2004, but were not formally submitted then. WP 6 has been postponed to start in June 2004.

6 Exploitation and dissemination of results

6.1 Exploitation

Using the e-tip software supplied on CORDIS a draft Technological Implementation plan was prepared and submitted. COVISE was invited to input data in view of a possibility of becoming a distributor of VIRTUALFIRES.

6.2 Dissemination

VIRTUALFIRES was demonstrated at the conference on Safe and Reliable Tunnels in Prague (February 4-6, 2004) and at the international conference on Tunnel Safety and Ventilation, held form April 19-21, 2004 in Graz. A main lecture about VIRTUALFIRES was presented at the international conference on Tunnel Safety and Ventilation [3].

7 Management and coordination aspects

A project coordination meeting was held on November 25, 2003 after the review. A summary of this meeting was already sent to the PO and the reviewers on December 23, 2003. The main outcome was that a technical coordinator (Gunther Lenz) was appointed whose duties were to provide a tight control over the development activities leading up to the in depth review. The first action of the technical coordinator was to develop a detailed road map and to assign work responsibilities to each partner. In the lead up to the review a detailed report was requested every 2 weeks by the responsible consortium members so that progress could be checked and any required remedial action taken. These periodic reports were forwarded to the reviewers in order to keep them informed of developments. It appears that this procedure has been successful since we believe that all items of concern to the reviewers could be resolved. A more detailed report of the activities is given later (for more details refer to documentation for in depth review).

8 Glossary

SiTu	Institute for structural analysis, Graz University of Technology, Austria
CD	Christian-Doppler-Laboratory for Applied Computational Thermofluiddynamics, Austria
FIGD	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Germany
KTH	Kungl. Tekniska Högskolan, Sweden
LTF	Lyon-Turin Ferroviaire, France
METL	Ministere del'Equipment des Transport et du Logement, Centre d'Etudes de Tunnel, France
FDDO	Stadt Dortmund, Feuerwehr (fire brigade), Germany
EUVE	European virtual engineering, Spain

9 Annexes

9.1 Deliverable and major milestone list

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D2.1	Report on available developer tools	2	FIGD	1,5	Report	Int.	2
D2.2	Selection of developer tools	2	FIGD	1,4	Spec.	Int.	2,5
D2.3	Report on available system capabilities (hardware)	2	FIGD	1,8	Report	Int.	2
D2.4	Specification of planed system capabilities (software)	2	FIGD	7,5	Spec.	Int.	2,5
D2.4a	Update System Specification	2	FIGD		Spec.	Int.	
D2.5	Report on existing VR-systems, Adaptability to VIRTUALFIRES	2	FIGD	1,1	Report	Int.	3,5
D2.6	Specification of selected VR System & required extensions	2	FIGD	2,2	Spec.	Int.	4
D1	Project presentation	1	SITU		Publicity	Ext.	3
D2	Dissemination and use plan	7	METL		Report	IST	6
Total		**WP2**		**15,5**			
D3.1	Report on geometrical data base	3	SITU	3	Report	Rest.	5
D3.2	Report on CFD data base	3	SITU	2,5	Report	Rest.	5
M1	CFD computation of fire reference simulations completed	1-5	CD		Demonstration	IST	6
D3.3	Report on compression/ optimisation	3	SITU	3,5	Report	Rest.	6
M5.1	Release of VIRTUALFIRES a-priori results database	5	CD		Dem.	IST	11
D3.4	Beta version of data management for first prototype	3	SITU	6	Prototype	Rest.	15
D3.5	Beta version of data management for second prototype	3	SITU	5	Prototype	Rest.	20
M3.1	Beta testing of software completed successfully	3	SITU		Demonstration	Rest.	16
D3.6	Release version of data management	3	SITU	4	Serial	Rest.	26
Total		**WP3**		**24**			
D4.1	Specification on methods of displaying CFD data	4	KTH	4	Report	Rest.	12
D4.2	Specification of user interface in VR-environment	4	KTH	4	Report	Rest.	12
D4.3	Report on hardware HMD specification	4	KTH	2	Report	Rest.	13
D4.4	Integration of HMD system completed	4	KTH	6	Prototype	Rest.	16
M5.2	Software release V1.0	5	CD		Dem.	IST	17
D4.5	VR implementation with limited functionality and speed	4	KTH	13	Prototype	Int.	18

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D4.6	VR implementation with full functionality optimised for speed	4	KTH	8	Prototype	Int	25
D4.7	VR integration with real-time CFD data generation	4	KTH	8	Prototype	Int	25
D4.8	VIRTUALFIRES users manual	4	KTH	4	Report	Int.	26
Total		**WP4**		**49**			
D5.1	CFD database containing results of 6 computational studies	5	CD	30	Database	Int.	11
D5.2	Report: Interactive Field Simulation Techniques; Solver and Data Flow Parallelization	5	CD	37	Report	Int.	11
D5.3	Parallelisation efficiency report	5	CD	1,5	Report	Int.	24
D5.4	Software User Guide V1.0	5	CD	5,5	User guide	Int.	14
M5.3	Software release V2.0	5	CD		Demonstration	IST	26
D5.5	Software User Guide V2.0	5	CD	5,5	User guide	Int.	26
Total		**WP5**		**79,5**			
D6.1	Report on CAVE/ HMD installation	6	EUVE	12	Report	Int.	26
M4.1	Beta testing of software completing successfully	4	KTH		Demonstration	Rest.	27
M6.1	Requirements accomplishment	6	EUVE		Demonstration	IST	27
D6.2	VIRTUALFIRES results report	6	EUVE	6,5	Report	Int.	28
Total		**WP6**		**18,5**			
D7.1	Definition of cases	7	METL	2	Report	Int.	8
D7.2	Journal articles	7	METL	2	Report	Ext.	28
D7.3	Conference papers and exhibition at conferences	7	METL	2	Report	Ext.	28
D7.4	Webpage	7	METL	3	Website	Ext.	6
Total		**WP7**		**9**			

* *A short, self-evident description e.g. report, demonstration, conference, specification.*

** *Int.* *Internal circulation within project (and Commission Project Officer if requested)*

Rest. *Restricted circulation list (specify in footnote) and Commission PO only*

IST *Circulation within IST Programme participants*

FP5 *Circulation within Framework Programme participants*

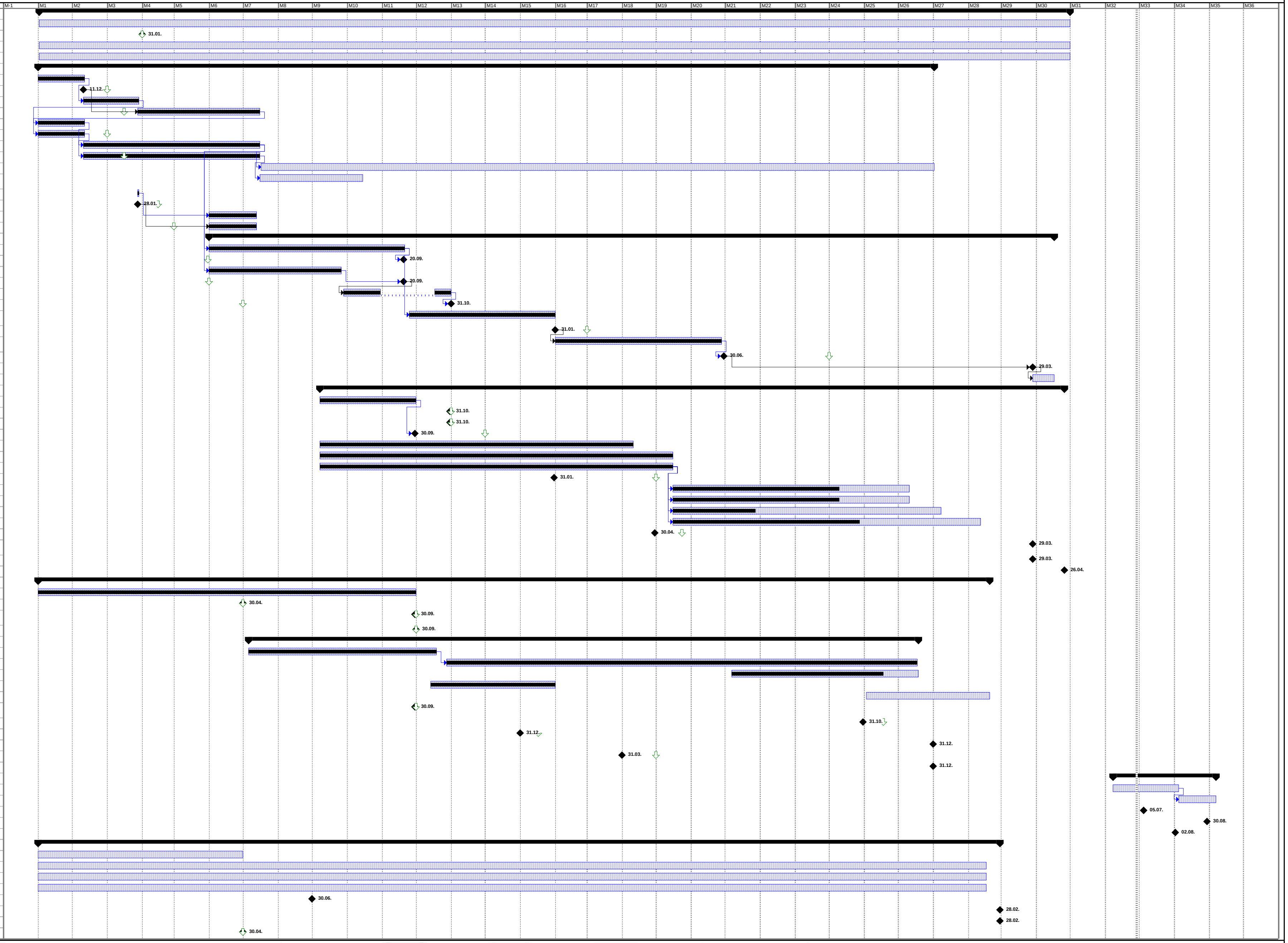
Table 1 : Man Power and Progress Follow-up Table

Task/Subtask (N°/title)	Partner (Name/ abbrev.)	- - - - - - - - - Man-Month - - - - - - - - - - - Planned efforts - at start of period (MM)				Actual effort (MM)			Forecast effort (MM)		Devia-tion (MM)	- - - - - - Technical Progress % - - - - - - Planned (%)	Assessed* (%)	Devia-tion (%)	Comments on major deviations and/or modifications of planned efforts.
		Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Year 3	Total	*Totals*	Year 1+2+3	Year 1+2+3	*Year (now)*	
		a	b	c	d	a1	b1		c1	d1	d1-d				
1. Management	SiTu	9	7	4	**20**	9,28	7,54	2,47	2	**21,29**	***1,29***	80%	79%	*-1%*	
	CD	0		1	**1**			1	0	**1**	***0***	0%	0%	*0%*	
	FIGD	0,34	0,33	0,33	**1**	0,34	0,33	0,33		**1**	***0***	67%	67%	*0%*	
	KTH	0,4	0,4	0,2	**1**	0,44	0,31	0,4	0,1	**1,25**	***0,25***	80%	60%	*-20%*	
	ALPE/LTF	0,4	0,4	0,2	**1**	0,37	0,37	0,26		**1**	***0***	80%	74%	*-6%*	
	METL	0,5	0,3	0,2	**1**	0,53	0,34	0	0,2	**1,07**	***0,07***	80%	81%	*1%*	
	FDDo	0,1	0,2	0,2	**0,5**	0,28	0,2	0,25	0,25	**0,98**	***0,48***	60%	49%	*-11%*	
	EUVE	0,4	0,4	0,2	**1**	0,4	0,4	0,1	0,1	**1**	***0***	80%	80%	*0%*	
	Total	**11,14**	**9,03**	**6,33**	**26,5**	**11,64**	**9,49**	**4,81**	**2,65**	**28,59**	***2,09***	76%	74%	*-2%*	
2. System Specification	SiTu	3	0	0	**3**	5,08	0	0		**5,08**	***2,08***	100%	100%	*0%*	
	CD	1,5			**1,5**	1,5				**1,5**	***0***	100%	100%	*0%*	
	FIGD	3			**3**	6				**6**	***3***	100%	100%	*0%*	
	KTH	2,5			**2,5**	2,36				**2,36**	***-0,14***	100%	100%	*0%*	
	ALPE/LTF	1,5			**1,5**	0,17				**0,17**	***-1,33***	100%	100%	*0%*	
	METL	1			**1**	0,48	0,02	0		**0,5**	***-0,5***	100%	100%	*0%*	
	FDDo	3,5			**3,5**	2,93	0,4	0	0	**3,33**	***-0,17***	100%	100%	*0%*	
	EUVE	1,5	0	0	**1,5**	0,75				**0,75**	***-0,75***	100%	100%	*0%*	
	Total	**17,5**	**0**	**0**	**17,5**	**19,27**	**0,42**	**0**	**0**	**19,69**	***2,19***	100%	100%	*0%*	
3. Data Processing	SiTu	11	5		**16**	9,79	10,89	1,31	1	**22,99**	***6,99***	100%	90%	*-10%*	
	CD	1,5			**1,5**	1,5				**1,5**	***0***	100%	100%	*0%*	
	FIGD		1,5		**1,5**		1,5			**1,5**	***0***	100%	100%	*0%*	
	KTH	0,3	1	0,2	**1,5**	0,08	0	0	0	**0,08**	***-1,42***	87%	100%	*13%*	
	ALPE/LTF	0,2	0,8	0,5	**1,5**	0,17	0,06		0,5	**0,73**	***-0,77***	67%	32%	*-35%*	
	METL	0,25	0,25		**0,5**	0,25	0,24	0,09		**0,58**	***0,08***	100%	84%	*-16%*	
	FDDo	0,5	4		**4,5**	0,13	4	0	0,5	**4,63**	***0,13***	100%	89%	*-11%*	
	EUVE	0,8	0,2	0	**1**	0,8	0,2			**1**	***0***	100%	100%		
	Total	**14,55**	**12,75**	**0,7**	**28**	**12,72**	**16,89**	**1,4**	**2**	**33,01**	***5,01***	98%	90%	*-8%*	
4. VR Implementation	SiTu	1	15	4	**20**	1,04	11,88	9,02	1	**22,94**	***2,94***	80%	56%	*-24%*	
	CD	1	1		**2**	1	1			**2**	***0***	100%	100%	*0%*	
	FIGD	3	7,5	1	**11,5**	5	6	0,5	0,5	**12**	***0,5***	91%	92%	*0%*	
	KTH	4	5	2,5	**11,5**	4,89	12,39	6,6	0,5	**24,38**	***12,88***	78%	71%	*-7%*	
	ALPE/LTF		0,8	0,7	**1,5**	0	0	0,42		**0,42**	***-1,08***	53%	0%	*-53%*	
	METL	0	0,8	0,2	**1**		0,02		0,2	**0,22**	***-0,78***	80%	9%	*-71%*	
	FDDo	1	2		**3**	0	4	0		**4**	***1***	100%	100%	*0%*	
	EUVE	0,5	1,3	0,2	**2**	0,5	1,3	0,2	0	**2**	***0***	90%	90%	*0%*	
	Total	**10,5**	**33,4**	**8,6**	**52,5**	**12,43**	**36,59**	**16,74**	**2,2**	**67,96**	***15,46***	84%	72%	*-11%*	
5. CFD Data Generation	SiTu	0	10	2	**12**	0	1,36	1,99	0	**3,35**	***-8,65***	83%	41%	*-43%*	
	CD	12,5	18	18	**48,5**	15,5	15	15	0	**45,5**	***0***	63%	67%	*4%*	
	FIGD				**0**					**0**	***0***	0%	0%	*0%*	
	KTH	3	7	4	**14**	0,86	9,29	4,7	3	**17,85**	***3,85***	71%	57%	*-15%*	
	ALPE/LTF	0,2	0,4	0,4	**1**	0,11	0		0,4	**0,51**	***-0,49***	60%	22%	*-38%*	
	METL	0,2	0,8	0,5	**1,5**	0,11	0,35	0,27		**0,73**	***-0,77***	67%	63%	*-4%*	
	FDDo		0,5	0,5	**1**		0	0,8	0	**0,8**	***-0,2***	50%	0%	*-50%*	
	EUVE	0	1,5	0,5	**2**	0	1,5	0,5	0	**2**	***0***	75%	75%	*0%*	
	Total	**15,9**	**38,2**	**25,9**	**80**	**16,58**	**27,5**	**23,26**	**3,4**	**70,74**	***-9,26***	68%	62%	*-5%*	
6. Evaluation/Validation	SiTu			3	**3**				0,5	**0,5**	***-2,5***	0%	0%	*0%*	
	CD			2	**2**			1	0	**1**	***-1***	0%	0%	*0%*	
	FIGD			1,5	**1,5**		0,25	1,25		**1,5**	***0***	0%	17%	*17%*	
	KTH			1,5	**1,5**				1	**1**	***-0,5***	0%	0%	*0%*	
	ALPE/LTF			2	**2**				2	**2**	***0***	0%	0%	*0%*	
	METL			1,5	**1,5**		0,06	1,66		**1,72**	***0,22***	0%	3%	*3%*	
	FDDo		0	3,5	**3,5**		0,25	1,25	1,3	**2,8**	***-0,7***	0%	9%	*9%*	
	EUVE	0	0	5	**5**	0	0,75	1,5	3,5	**5,75**	***0,75***	0%	13%	*13%*	
	Total	**0**	**0**	**20**	**20**	**0**	**1,31**	**6,66**	**8,3**	**16,27**	***-3,73***	0%	8%	*8%*	
7. Dissemination	SiTu	0,5			**0,5**	0,7	0			**0,7**	***0,2***	100%	100%	*0%*	
	CD			0,5	**0,5**			0,5	0	**0,5**	***0***	0%	0%	*0%*	
	FIGD			0,5	**0,5**	0,11		0,39		**0,5**	***0***	0%	22%	*22%*	
	KTH	0,1	0,1	0,3	**0,5**	0,15	0,4	0,1	0,3	**0,95**	***0,45***	40%	58%	*25%*	
	ALPE/LTF	0,2	0,4	0,4	**1**	0,17	0,17		0,4	**0,74**	***-0,26***	60%	46%	*-14%*	
	METL	1,5	0,9	0,6	**3**	1,37	0,81	1,26		**3,44**	***0,44***	80%	63%	*-17%*	
	FDDo		1	1	**2**	0,05	0,5	0	1,2	**1,75**	***-0,25***	50%	31%	*-19%*	
	EUVE	0,7	0,9	0,4	**2**	0,2	0,9	0	0,9	**2**	***0***	80%	55%	*-25%*	
	Total	**3**	**3,3**	**3,7**	**10**	**2,75**	**2,78**	**2,25**	**2,8**	**10,58**	***0,58***	63%	52%	*-11%*	
TOTALS	SiTu	24,5	37	13	**74,5**	25,89	31,67	14,79	4,5	**76,85**	***2,35***	83%	75%	*-8%*	
	CD	16,5	19	21,5	**57**	19,5	16	17,5	0	**53**	***-1***	62%	67%	*5%*	
	FIGD	6,34	9,33	3,33	**19**	11,45	8,08	2,47	0,5	**22,5**	***3,5***	82%	87%	*4%*	
	KTH	10,3	13,5	8,7	**32,5**	8,78	22,39	11,8	4,9	**47,87**	***15,37***	73%	65%	*-8%*	
	ALPE/LTF	2,5	2,8	4,2	**9,5**	0,99	0,6	0,68	3,3	**5,57**	***-3,93***	56%	29%	*-27%*	
	METL	3,45	3,05	3	**9,5**	2,74	1,84	3,28	0,4	**8,26**	***-1,24***	68%	55%	*-13%*	
	FDDo	5,1	7,7	5,2	**18**	3,39	9,35	2,3	3,25	**18,29**	***0,29***	71%	70%	*-1%*	
	EUVE	3,9	4,3	6,3	**14,5**	2,65	5,05	2,3	4,5	**14,5**	***0***	57%	53%	*-3%*	
	TOTAL	**72,59**	**96,68**	**65,23**	**234,5**	**75,39**	**94,98**	**55,12**	**21,35**	**246,84**	***12,34***	72%	69%	*-3%*	

**) Please note that the actual technical progress percentage and the updated remaining efforts must reflect the physically assessed status of the work.*

Table 2: Project Plan

Nr.	Task
1	**WP1: Management**
2	WP 1.1: Coordination of activities
3	D 1: Project presentation
4	WP 1.2: Steering committee meetings
5	WP 1.1: Web page maintenance
6	**WP2: System Specification/Development Tools**
7	WP 2.1: Report on available developer tools
8	D 2.1: Report on available developer tools
9	WP 2.2: Selection of developer tools
10	D 2.2: Report of selected developer tools
11	WP 2.3: Report on available system capabilties
12	D 2.3: Report on available system capabilities (Hardware)
13	WP 2.4: Specification of planned system capabilities
14	D 2.4: Report of planned system capabilities (Software)
15	WP 2.4a Update specification
16	D 2.4a: Report of planned system capabilities (D 2.4 update according reviewer comments)
17	WP 2.5: Report of existing VR systems
18	D 2.5: Report of existing VR systems
19	WP 2.6: Specification of selected VR system
20	D 2.6: Report of selected VR system and required extensions
21	**WP3: Data processing / compression**
22	WP 3.1: Specification of geometrical data base
23	D 3.1: Specification of geometrical database
24	WP 3.2: Specification of CFD data base
25	D 3.2: Specification of CFD database
26	WP 3.3: Data compression/optimisation techniques
27	D 3.3: Report on available compression/optimisation techniques
28	WP 3.4: Implementation of datamanagement for first prototype of VFS
29	D 3.4: Beta version of datamanagement for first prototype
30	WP 3.5: Implementation of datamanagement for second prototype of VFS
31	D 3.5: Beta version of datamanagement for second prototype
32	D 3.6: Release of datamanagement
33	WP 3.6: Documentation
34	**WP4: VR Implementation**
35	WP 4.1: Selection and integration of hardware for HMD system
36	D 4.1: Specification of methods of displaying CFD data
37	D 4.2: Specification of user interface in the VR-environment
38	D 4.3: Specification of hardware requirements for HMD system
39	WP 4.2: Implementation display of geometric data
40	WP 4.3: Implementation display of CFD data
41	WP 4.4: Implementation of user interactions
42	D 4.4: Integration of HMD system completed
43	WP 4.5: Optimisation of CAVE version
44	WP 4.6: Integration of real-time CFD data generation
45	WP 4.7: Documentation
46	WP 4.8: Testing of system with real data
47	D 4.5: VR implementation with limited funktionality and speed
48	D 4.6: VR implementation with full functionality. Optimised for full speed
49	D 4.7: VR integration with real-time CFD data generation
50	D 4.8: VR system user manual
51	**WP5: CFD Data Genertion**
52	WP 5.1: A-priori generation of CFD Data
53	M 1: CFD computation of fire reference simulations completed
54	D 5.1: CFD database containing results of 6 computational studies
55	M 5.1: Release of VIRTUALFIRES a-priori results database
56	**WP 5.2: CFD Simulations in real time**
57	WP 5.2.1: Feasibilty study
58	WP 5.2.2: Solver Parallelisation
59	WP 5.2.3: Parallelisation of data flow
60	WP 5.3a Software Release 1
61	WP 5.3b Software Release 2
62	D 5.2: Interactive Field Simulation Techniques; Solver and Data Flow Parallelization
63	D 5.3: Parallelisation efficiency report
64	D 5.4: Software User Guide V1.0
65	D 5.5: Software User Guide V2.0
66	M 5.2: Software release V1.0
67	M 5.3: Software release V2.0
68	**WP6: Evaluation / Validation**
69	WP 6.1: Evaluation of CAVE
70	WP 6.2: General Validation
71	D 6.1: Report on CAVE installation
72	D 6.2: VIRTUALFIRES results report
73	M 6.1: Requirements accomplishment
74	**WP7: Dissemination**
75	WP 7.1: Selection of cases that may be treated in VIRTUALFIRE
76	WP 7.2: Connection with journals
77	WP 7.3: Connection with national and international institutions.
78	WP 7.4: Project Web site.
79	D 7.1: Accurate definitions of cases
80	D 7.2: Journal articles
81	D 7.3: Conference papers and exhibition at conferences
82	D 7.4: Web pages



Projekt: VirtualFires_aktuell
Datum: Mon 28.06.04

Vorgang | Unterbrechung | In Arbeit | Meilenstein | Sammelvorgang | Projektsammelvorgang | Externe Vorgänge | Externer Meilenstein | Stichtag

Table 3 : Budget Follow-up Table

PARTNER	Cost Category	BUDGET (EUR)	ACTUAL COSTS (EUR)					Total Pct. Spent (%)				Remaining Budget (EUR)	*Comments on major deviations from budget.*
			Year 1	M13-18	M19-24	M25-30	Total	Year 1	M13-18	M19-24	M25-30		
		e	a1	b1	c1	d1	e1	a1/e	a1+b1/e	a1+b1+c1/e	a1+b1+ c1+d1/e	e-e1	
Partner 1 SiTu	Labour	332443	111267,67	70884,37	67249,89	68680,03	318081,96	33%	55%	75%	96%	14361,04	
	Overheads	83658	26123,82	16134,61	16468,5	16846,13	75573,06	31%	51%	70%	90%	8084,94	
	Labour+Overheads	416101	137391,49	87018,98	83718,39	85526,16	393655,02	33%	54%	74%	95%	22445,98	
	Travel	25000	13122,11	7044,13	12130,03	12588,66	44884,93	52%	81%	129%	180%	-19884,93	redistribution of budget
	Durable Eqmt.	57501	4470,86	2903,57	2947,59	2947,59	13269,61	8%	13%	18%	23%	44231,39	redistribution of budget
	Consumables	3340	5358,49	-158,99	14,98	14,34	5228,82	160%	156%	156%	157%	-1888,82	redistribution of budget
	External Assistance	4766	200,00				200,00	4%	4%	4%	4%	4566,00	
	Other												
	..												
	Total	506708	160542,95	96807,69	98810,99	101076,75	457238,38	32%	51%	70%	90%	49469,62	
Partner 2 CD	Labour	206126	91339,17	24900,66	60360,66	43319,56	219920,05	44%	56%	86%	107%	-13794,05	
	Overheads	56109	24757,95	8736,81	17632	10655,72	61782,48	44%	60%	91%	110%	-5673,48	
	Labour+Overheads	262235	116097,12	33637,47	77992,66	53975,28	281702,53	44%	57%	87%	107%	-19467,53	
	Travel	10000	8989,07	2888,52	6521,33	5867,09	24266,01	90%	119%	184%	243%	-14266,01	
	Durable Eqmt.	50421	19641,24	15894,85	21278,01	4091,95	60906,05	39%	70%	113%	121%	-10485,05	
	Consumables	14000	3820,28				3820,28	27%	27%	27%	27%	10179,72	
	External Assistance												
	Other												
	..												
	Total	336656	148547,71	52420,84	105792	63934,32	370694,87	44%	60%	91%	110%	-34038,87	
Partner 3 FIGD	Labour	160334	95612,62	14179,95	2307,4	16496,41	128596,38	60%	68%	70%	80%	31737,62	
	Overheads	153976	112689,89	64420,74	3661,81	26248,07	207020,51	73%	115%	117%	134%	-53044,51	
	Labour+Overheads	314310	208302,51	78600,69	5969,21	42744,48	335616,89	66%	91%	93%	107%	-21306,89	
	Travel	15000	5218,39	3084,29	434,66	1020,81	9758,15	35%	55%	58%	65%	5241,85	
	Durable Eqmt.												
	Consumables	5000	1600,00	450,18			2050,18	32%	41%	41%	41%	2949,82	
	External Assistance												
	Other					-1959,75	-1959,75					1959,75	Adjustment to previously reports
	...												
	Total	334310	215120,90	82135,16	6403,87	41805,54	345465,47	64%	89%	91%	103%	-11155,47	
Partner 4 KTH	Labour	163065	32983,86	28056,18	51415	42693	155148,04	20%	37%	69%	95%	7916,96	
	Overheads	44240	8450,37	6276,66	12609	13070	40406,03	19%	33%	62%	91%	3833,97	
	Labour+Overheads	207305	41434,23	34332,84	64024	55763	195554,07	20%	37%	67%	94%	11750,93	
	Travel	24138	6308,64	3327,09	9853	3683	23171,73	26%	40%	81%	96%	966,27	
	Durable Eqmt.	5000										5000,00	
	Consumables	4000	1636,17			2110	3746,17	41%	41%	41%	94%	253,83	
	External Assistance												
	Other												
	Computing	25000	1321,09		1775	16866	19962,09	5%	5%	12%	80%	5037,91	
	Total	265443	50700,13	37659,93	75652	78422	242434,06	19%	33%	62%	91%	23008,94	
Partner 5 ALPE/LTF	Labour	48713	5313,00	1214,40	1062,6	3643,2	11233,20	11%	13%	16%	23%	37479,80	
	Overheads	9742	1062,60	242,88	212,52	728,64	2246,64	11%	13%	16%	23%	7495,36	
	Labour+Overheads	58455	6375,60	1457,28	1275,12	4371,84	13479,84	11%	13%	16%	23%	44975,16	
	Travel	15000	1565,92	1928,65	1961	2656	8111,57	10%	23%	36%	54%	6888,43	
	Durable Eqmt.												
	Consumables												
	External Assistance												
	Other												
	..												
	Total	73455	7941,52	3385,93	3236,12	7027,84	21591,41	11%	15%	20%	29%	51863,59	
Partner 6 METL	Labour	48713	14041,40	4605,80	5464,8	17381,1	41493,10	29%	38%	49%	85%	7219,90	
	Overheads	9742	2808,28	912,20	1092,96	3476,22	8289,66	29%	38%	49%	85%	1452,34	
	Labour+Overheads	58455	16849,68	5518,00	6557,76	20857,32	49782,76	29%	38%	49%	85%	8672,24	
	Travel	15000	2761,20	1656,00	1052	3623	9092,20	18%	29%	36%	61%	5907,80	
	Durable Eqmt.												
	Consumables												
	External Assistance												
	Other												
	..												
	Total	73455	19610,88	7174,00	7609,76	24480,32	58874,96	27%	36%	47%	80%	14580,04	
Partner 7 FDDo	Labour	45021	12388,40	1501,20	8927,9	12411,7	35229,20	28%	31%	51%	78%	9791,80	
	Overheads	12004	2669,58	593,04	1785,58	2482,34	7530,54	22%	27%	42%	63%	4473,46	
	Labour+Overheads	57025	15057,98	2094,24	10713,48	14894,04	42759,74	26%	30%	49%	75%	14265,26	
	Travel		1685,76	1464,00	230	7253,62	10633,38					-10633,38	
	Durable Eqmt.												
	Consumables												
	External Assistance	52500			25000		25000,00			48%	48%	27500,00	
	Other												
	Computing	15000										15000,00	
	Total	124525	16743,74	3558,24	35943,48	22147,66	78393,12	13%	16%	45%	63%	46131,88	
Partner 8 EUVE	Labour	54648	11187,36	8774,40	13819,68	6580,8	40362,24	20%	37%	62%	74%	14285,76	
	Overheads		8949,89	7019,52	11055,74	5264,64	32289,79					-32289,79	
	Labour+Overheads	54648	20137,25	15793,92	24875,42	11845,44	72652,03	37%	66%	111%	133%	-18004,03	
	Travel	15000	4827,88	2749,06	3992,62	1590,38	13159,94	32%	51%	77%	88%	1840,06	
	Durable Eqmt.												
	Consumables	2000										2000,00	
	External Assistance												
	Other												
	..												
	Total	71648	24965,13	18542,98	28868,04	13435,82	85811,97	35%	61%	101%	120%	-14163,97	
TOTAL	Labour	1059063	374133,48	154116,96	210607,93	211205,8	950064,17	35%	50%	70%	90%	108998,83	
	Overheads	369471	187512,38	104336,46	64518,11	78771,76	435138,71	51%	79%	96%	118%	-65667,71	
	Labour+Overheads	1428534	561645,86	258453,42	275126,04	289977,56	1385202,88	39%	57%	77%	97%	43331,12	
	Travel	119138	44478,97	24141,74	36174,64	38282,56	143077,91	37%	58%	88%	120%	-23939,91	
	Durable Eqmt.	112922	24112,10	18798,42	24225,6	7039,54	74175,66	21%	38%	59%	66%	38746,34	
	Consumables	28340	12414,94	291,19	14,98	2124,34	14845,45	44%	45%	45%	52%	13494,55	
	External Assistance	57266	200,00		25000		25200,00	0%	0%	44%	44%	32066,00	
	Other					-1959,75	-1959,75					1959,75	
	Computing	40000	1321,09				1321,09	3%	3%	3%	3%	38678,91	
	Total	1786200	644172,96	301684,77	360541,26	335464,25	1641863,24	36%	53%	73%	92%	144336,76	