D O C U M E N T

K N O W L E D G E M A N A G E M E N T P L A N

R o s e t t a P r o j e c t

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TABLE OF CONTENTS

1 Objective 1
2 Scope 2
2.1 Knowledge Management in a Nutshell 2
2.2 Knowledge Management : the Rosetta case 4
3 Knowledge Management Implementation 5
3.1 Overall Description 5
3.2 Documentation 7
3.2.1 Documentation required 7
3.2.2 Implementation plan 7
3.3 Ground tools 8
3.3.1 Ground tools available 8
3.3.2 Implementation plan 9
3.4 Human resources 9
3.4.1 General approach 9
3.4.2 Implementation plan 10
3.5 Access network 11
Annex 1: 12
Annex 2: Experts directory template 13
Annex 3: Overall action plan summary 14

1 OBJECTIVE

The procurement process of the Rosetta mission was initiated in 1997. Although launch will take place in January 2003, the main scientific operations phase on Comet Wirtanen will only happen in the period 2012-2013. In view of such a long time frame from start of procurement process up to acquisition and treatment of the scientific results, the following risk items have to be duly considered :

- Non-availability of Rosetta experts,
- Limited overall design knowledge,
- Obsolescence of on-board technologies.

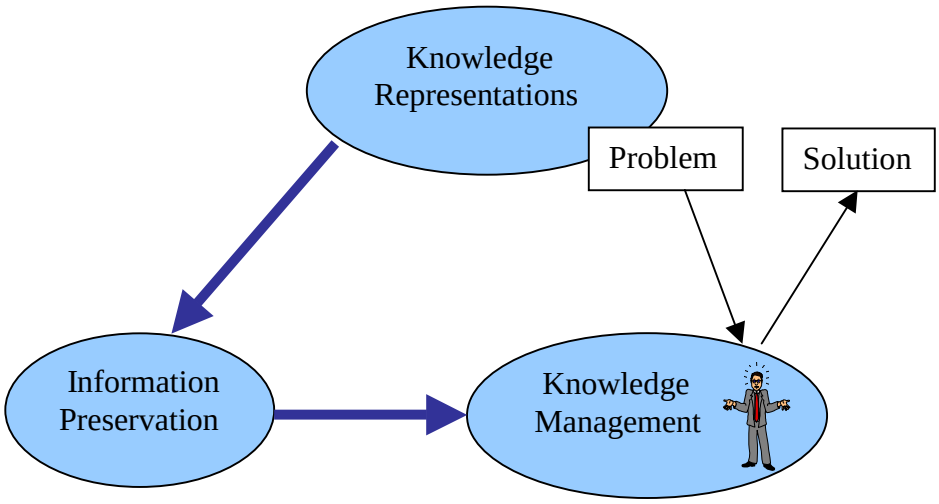
It is therefore of prime importance to be able to put in place means ensuring that the Rosetta technical and scientific expertise can be maintained for more than ten years after launch. The present document presents the main knowledge management requirements and implementation means necessary to achieve this objective.

2 SCOPE

2.1 Knowledge Management in a Nutshell

Knowledge can be defined as any information concerning the world that has come to a conscious human mind and has (or could have) been communicated to other human minds.
Knowledge Management can be defined as the function to provide the right information to the right people at the right time, so that they can make the best use of it.

Figure 1 : *Rosetta knowledge environment*:



In the areas of spacecraft, payload and ground-segment, we assume that a person can solve a problem with the available information, experience, links to other people and tools. The first step in the knowledge management process is to list the representations of the available knowledge. A decision has then to be done which ones of these we want to preserve. The information preserved will be available later as input for the knowledge management and allow a person to solve problems, as depicted in figure 1 above.

Knowledge Representations

The available knowledge representations for a given domain can be classified in three different categories as follows :

- First category : Basic or raw knowledge.
- Second category : Reduced information.
- Third category : Processed information with the aim to preserve knowledge.

The following table gives an overview of these three categories:

Categ	Definition	Example: Chess Game	Example: Software Business	Example: Printed Board Design
1st	Knowledge or information which which has not been communicated	Player Players' experience Chess board	Programmer Programmers' experience Software code	Designer Designers' experience Layout
2nd	Information or knowledge which was reduced from the 1st category	beginners handbook	Requirement docs Design docs test reports review docs user manuals	Requirement docs design docs test reports pictures
3rd	Information processed with the aim to preserve knowledge	strategy book written by the chess champion	Booklet named 'Clever Guide to Usage of xyz software'	hands-on tutorial lectures at university

Information Preservation

When the information representations, deemed necessary to preserve knowledge, are selected, the question of how to preserve it (archive, storage, etc) needs to be addressed. While the way to archive some representations might be straightforward (e.g. *users' manual)*, it is necessary to check whether the condensed information is sufficient for the purpose of knowledge management.

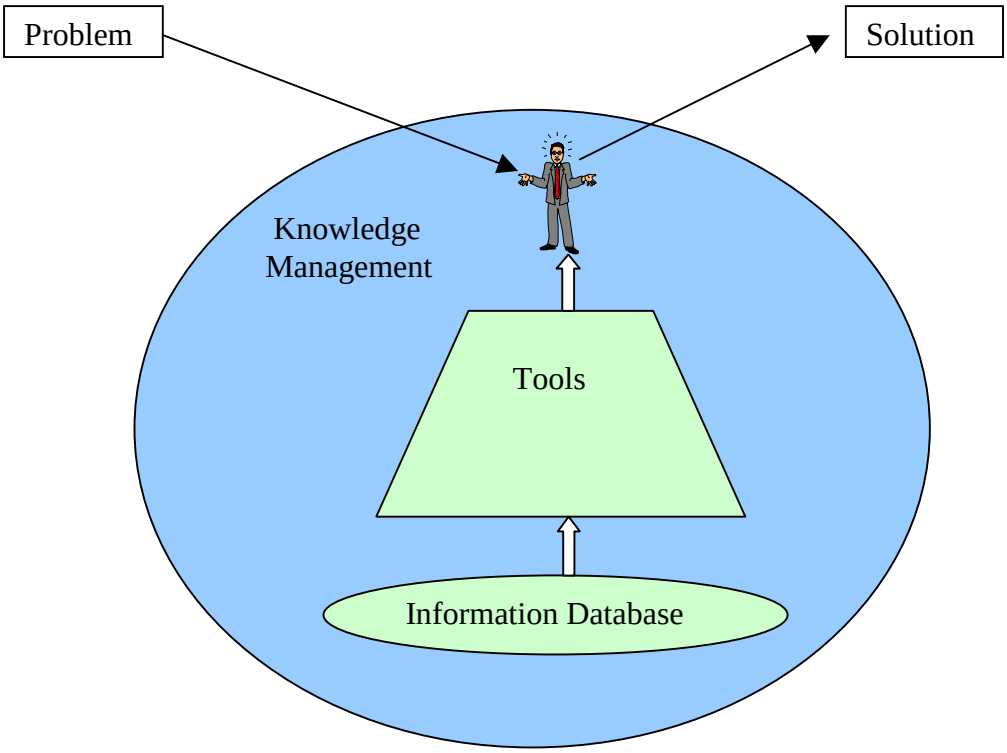
The question of the media to be used needs to be addressed too, as well as the need of reformating after 3-5 years (see section 3 hereafter).

Knowledge Management

The task of the knowledge management is to provide the *right* tools to the *right* people at the *right* time. It is clear that the goal is very subjective and at the time of writing this document, we do not know :

- What the problems might be when we arrive at the comet,
- How we can possibly measure the quality of a knowledge management database.

Figure 2 : Knowledge Management process



The Knowledge Management tool(s) shall provide quick and easy access to the electronic representations in a unique and defined way. The following major features shall be considered in the selection of the tool(s):

- Ability to access different kind of information representations, at least documents, images, drawings, audio sources, video sources.
- Possibility of cross indexing between the representations.
- Automatic/manual indexing, e.g. with semantic analysis of the textual information.

2.2 Knowledge Management : the Rosetta case

The present document covers all aspects of the mission that are of vital importance until the end of the scientific operations, i.e. on Spacecraft, Payload and Ground Segment areas. The approach taken to maintain the Rosetta technical and scientific expertise at a high level are spelled out in the following sections around three main domains:

1. Documentation,
2. Ground tools,
3. Human resources.

3 KNOWLEDGE MANAGEMENT IMPLEMENTATION

3.1 Overall Description

The overall Rosetta Knowledge Management Plan relies on the following resources:

- a set of various available information, covering all aspects of the spacecraft and instruments design, as well as Ground operations,
- ground tools allowing to either simulate or replicate predefined scenarios,
- the human expertise accrued on the Rosetta mission during several years of development phase.

In the aim of consolidating to the maximum possible extent the above resources, a Knowledge Management Database (KMDB) installed and maintained at ESOC will serve as the core repository of any Rosetta related knowledge which may be useful in case of technical questions. This database shall allow to refer any query to the relevant documentation, ground tool check or expert as necessary. The overall principle is shown in the figure 3 attached hereto.

The design process of the KMDB has been initiated already. It follows the steps listed hereafter:

- Identify the necessary documentation and its media, ground tools and configurations, available human expertise (see sections 3.2, 3.3 and 3.4 herebelow),

- Index the above mentioned resources according to technical domains to be defined (propulsion, AOCMS etc.),

- Define the allowed formats for any information feeding the KMDB,

- Select the appropriate environment (database, operating systems, and search enquire etc.) allowing to properly organise the Rosetta information and manage queries,

- Migrate the identified information into the KMDB, after implementation of the appropriate prerequisite actions (scanning, file conversions etc.).

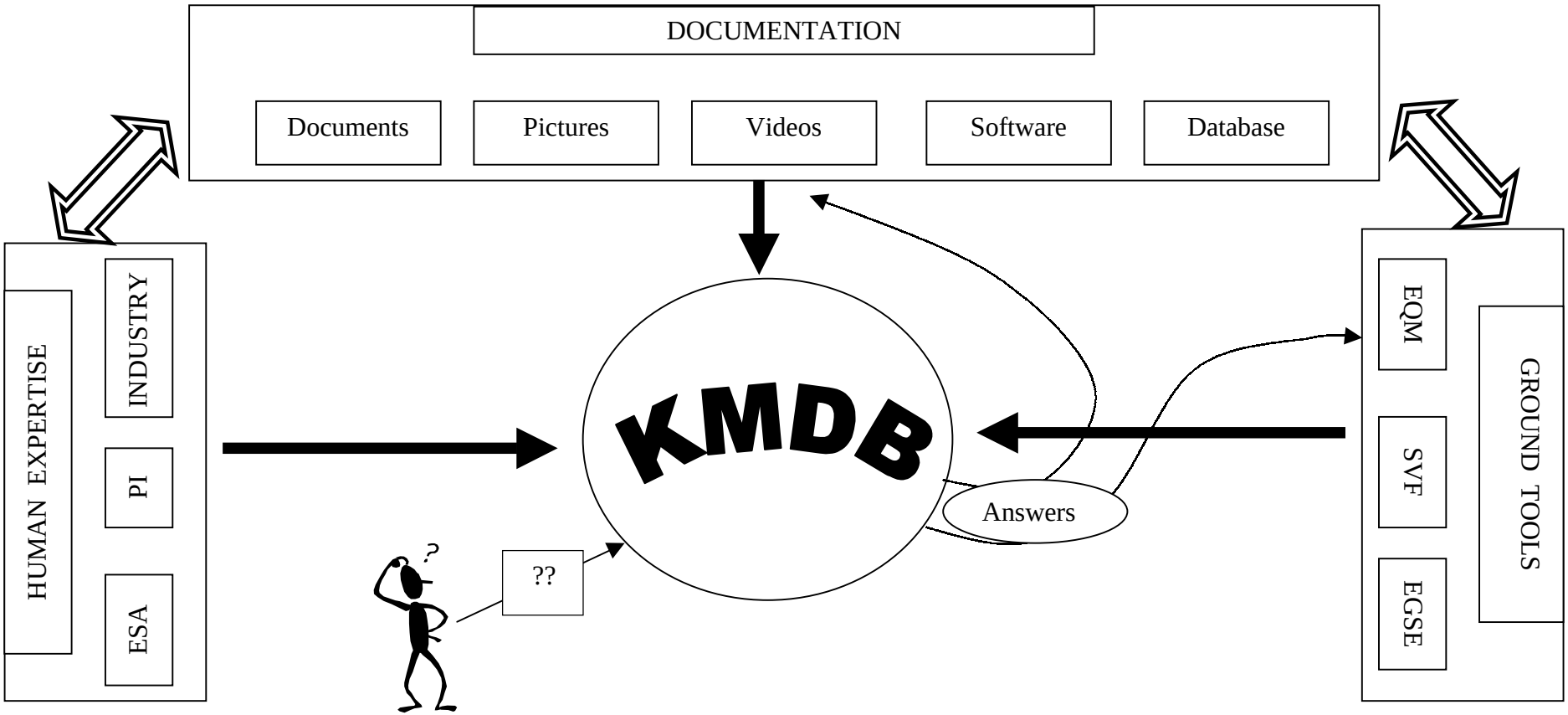


Figure 3: Knowledge Management Plan

In view of the long time frame of the Rosetta scientific mission, it is anticipated that the KMDB environment (operating systems, hardware, software and search engine) will have to be replaced (at least once over the mission) by new resources, thus ensuring reliable maintenance capabilities.

3.2 Documentation

3.2.1 Documentation required

"Documentation" is not meant here to be restricted to paper and/or electronic documents, but includes also any other type of media allowing to acquire valuable knowledge on any aspect of the Rosetta mission.

Among the whole volume of documentation generated during the development phase of any space mission, some of it becomes of no technical added value once launch has taken place. A critical review has been performed on Rosetta which led to define a selection of documentation representing necessary inputs to the KMDB. This can be summarised as follows (see annex 1 for the complete detailed list):

- existing documentation to be kept as is,
- existing documentation, however requiring updates,
- non-existing documentation which has to be produced.

3.2.2 Implementation plan

Documentation includes a variety of different media supports, which, for the sake of the Rosetta programme, can be as wide as:

- documents (paper and electronic format),
- pictures (mainly digital),
- videos,
- software (Rosetta specific),
- databases (Rosetta specific),
- etc.

For all the above mentioned Rosetta documentation, the following implementation steps shall be followed:

- convert the selected documentation into formats compatible with the KMDB,
- index the documentation according to selected technical domains and key-words (as needed, depending on the search engine capabilities),
- migrate the documentation into the KMDB,
- archive at ESOC a hardcopy of all the available documents, as a back-up solution.

The **pictures archive** gathers the results of a systematic photographic survey already initiated on the Rosetta units/subsystems as well as on the AIV integration flow. The pictures made will be stored following the Rosetta product tree. The detailed procedure is described in RO-DSS-CN-1065.

The **videos archive** is mainly aimed at gathering key information on the various Rosetta experiments, through the means of systematic interviews of key persons selected for each experiment. A proper indexing of the video tracks through appropriate key words shall be performed and hence allow to access quickly the track relevant to the query.

3.3 Ground tools

3.3.1 Ground tools available

Because of the Rosetta mission profile, extending more than ten years after launch, it is imperative to be able to either simulate forthcoming operations or replicate in-flight anomalies. To do so, the following existing ground tools have been identified:

- EQM spacecraft, including all its Ground Segment Equipment,
- Flight Spare (FS) units, when available,
- EQM/FS (as appropriate) of each Rosetta experiment,
- Software Validation Facility (SVF) specifically developed for Rosetta,
- Avionics Test Bench (ATB).

3.3.2 Implementation plan

The overall approach consists in building at the Operations Control Centre facilities (ESOC) a model as much as possible representative of the spacecraft in orbit. To do so the following steps have been/shall be initiated:

- Build a detailed inventory of EQM/FS units available, at Spacecraft and Experiments level.
- Build a detailed inventory of all available GSE, at Spacecraft and Experiments level.
- Procure the ad-hoc hardware allowing to operate the EQM in a de-mated configuration.
- Build the EQM with all its experiments, using to the maximum possible extent Flight Spare (FS) units (the use of flight spares for Spacecraft units is unlikely, since all available FS units will be delivered to Mars-Express as soon as launch has taken place).
- Organise before launch installation and full set-up of the EQM and its GSE at ESOC.
- Organise before launch installation and full set-up at ESOC of the Rosetta SVF and ATB, together with all available software and databases, as appropriate.

The above implementation plan assumes full and active cooperation from all experimenters, hence ensuring that their EQM/FS models can be given on loan at ESOC for long periods.

3.4 Human resources

3.4.1 General approach

Human resources are the most sensitive aspect of any knowledge management plan, simply because most of the knowledge resides with the engineers, scientists and operators which have contributed to the development of the Rosetta mission! All documents produced throughout a project lifetime aim at recording all the knowledge gained at all levels. They can nevertheless not possibly record the human expertise gained, which allows to assess and identify quickly the solution to a given technical problem or question.

The approach taken for the sake of the Rosetta mission is threefold:

a) Create a directory as complete as possible, including all identified key players from Industry, Scientific Community and the Agency, together with the fields of expertise for each individual.

b) Gather as much information as possible concerning the design of spacecraft and its instruments, on top of the usual data-packages, through interviews of key persons contributing to the project development.

c) Maintain a high level of expertise among the community involved in the Rosetta mission operations by means of training and/or active participation in spacecraft manoeuvres.

3.4.2 Implementation plan

- Rosetta directory

- Identify various domains of expertise applicable for the Rosetta mission (AOCMS, Experiment A, etc.).

- Identify key persons for each of the identified domains and gather for each key person a set of necessary information (as per template in Annex 2), including the applicable domain(s) of expertise.

- Recording of human expertise

- Develop standard script(s) and select the key persons to be interviewed.

- Perform interview and edit the interviews in such a way they can be reached by key words.

- Develop and maintain an “Experience” database during the mission lifetime, to be set up and maintained by the Operations team.

- Maintaining a high level of expertise

- Organise regular training sessions on Rosetta flight operations (including presentations on S/C design), and/or participate in flight manoeuvres.

- Organise regular sessions to the operations team giving general guidelines on system design and operations procedure of the spacecraft and the various experiments.

As part of the Flight Operations Team at ESOC taking responsibility for the proper conduct of the Rosetta mission, it is anticipated to require support from Industry during the first year of the launch, thus ensuring a smooth hand-over to the ESOC Operations team.

3.5 Access network

In view of the diversity of Rosetta key persons, the KMDB shall be hosted on an internet based environment, accessible from outside ESA, however based on a selection of identified users and access rights.

The selection process of such an access network has been initiated and is still ongoing.

ANNEX 1:

DOCUMENTATION MATRIX : NECESSARY INPUTS TO THE KNOWLEDGE MANAGEMENT DATABASE (KMDB)

DOCUMENTATION	TYPE	SPACECRAFT	PAYLOAD	GD SEGMENT
Acceptance Data Packages	Document	✓	✓	✓
Users manual	Document	Updates to include prediction/ in-flight result comparison		✓
NCR /RFW /SPR lists	Document	✓	✓	✓
Reports (test reports etc.)	Document	✓	✓	✓
Requirements /Specifications	Document	✓	✓	✓
ICD	Document	✓	✓	✓
Drawings	Document	✓	✓	✓
Technical notes	Document	✓	✓	✓
Source codes	Software	✓	✓	✓
Development environments	Software	✓	✓	✓
Test cases /Scripts	Software	✓	✓	✓
Spacecraft database	Database	✓	✓	✓
Flight Dynamics database	Database	✓	✓	✓
S/C and P/L units and integration process	Picture	Photographic survey initiated. Shall be pursued until S/C encapsulation		✓
Experts interviews	Video	To be initiated asap		✓
Plans	Document	Not applicable	Not applicable	Not applicable
Minutes of meeting	Document	Not applicable	Not applicable	Not applicable
E-mails	Document	Not applicable	Not applicable	Not applicable
Procedures	Document	Not applicable	Not applicable	✓
ABCL /CIDL	Document	Not applicable	Not applicable	Not applicable
Schedules	Document	Not applicable	Not applicable	Not applicable

ANNEX 2: EXPERTS DIRECTORY TEMPLATE

Last update : __/__/____

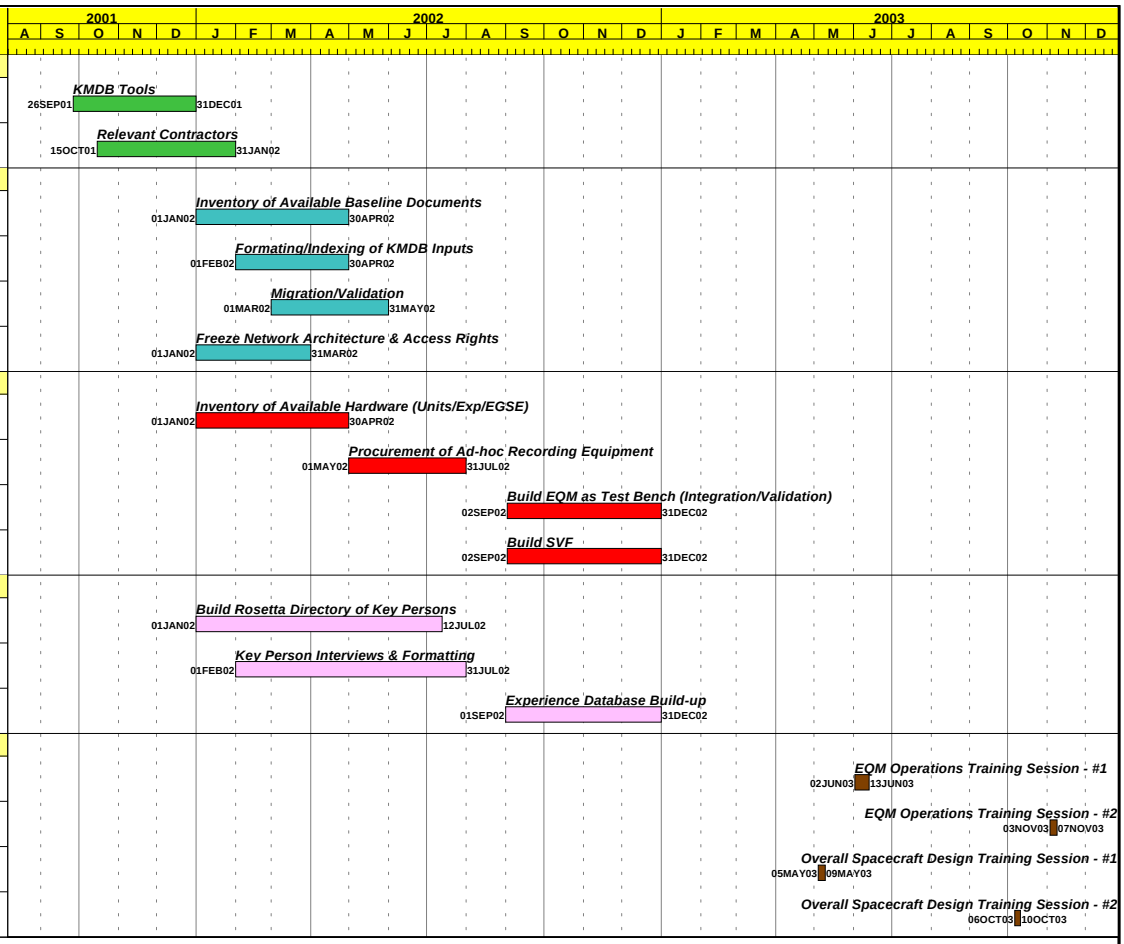
Name	Surname	Company	Domain of expertise	Period of involvmt	Company address	Private address	Phone / Fax Work	Mob	Private	Fax

ANNEX 3: OVERALL ACTION PLAN SUMMARY AND CORRESPONDING TIMELINE

Domain	Implementation Action	Who?	By when?	Comments
Documentation	Select the appropriate KMDB tool, together with allowable file formats	ESA	End 2001	
Documentation	Convert the selected documentation into formats compatible with the KMDB	Industry / PIs	Apr 2002	"Industry" = selected contractor(s)
Documentation	Index the documentation according to selected technical domains and key-words (as needed, depending on the search engine capabilities	Industry / PIs	Apr 2002	
Documentation	Migrate /Validate the documentation into the KMDB	Industry	May 2002	
Documentation	Archive at ESOC a hardcopy of all the available documents, as a back-up solution	ESA	Launch (L)	
Gd tools	Build a detailed inventory of EQM/FS units available, at Spacecraft and Experiments level	Industry	L-3 months	
Gd tools	Build a detailed inventory of all available GSE, at Spacecraft and Experiments level	Industry	Apr 2002	
Gd tools	Procure the ad-hoc hardware allowing to operate the EQM in a de-mated configuration	Industry	Jul 2002	
Gd tools	Build the EQM with all its experiments, using to the maximum possible extent Flight Spare (FS) units	Industry	Launch (L)	
Gd tools	Organise installation and full set-up of the EQM and its GSE at ESOC	Industry	Launch (L)	
Gd tools	Organise installation and full set-up at ESOC of the Rosetta SVF and ATB, together with the available software and databases, as appropriate	Industry	Launch (L)	
Human resources	Identify various domains of expertise applicable for the Rosetta mission (AOCMS, Experiment A, etc.).	Industry / ESA	ASAP	Common Industry / ESA investigation
Human resources	Identify key persons for each of the identified domains and gather for each key person a set of necessary information (as per template in Annex 2), including the applicable domain(s) of expertise	Industry / ESA	FAR	ESA for Experimenters
Human resources	Develop standard script(s) and select the key persons to be interviewed	Industry / ESA	Feb 2002	ESA for Experimenters
Human resources	Perform interview and edit the interviews in such a way they can be reached by key word	Industry / ESA	FAR	ESA for Experimenters **????**

Human resources	Develop and maintain an “Experience” database during the mission lifetime, to be set up and maintained by the Ops team	ESA	As of launch	
Human resources	Organise regular training sessions on Rosetta flight operations (including presentations on S/C design), and/or participate in flight manoeuvres	Industry /ESA	After Launch	
Human resources	Organise regular sessions to the operations team giving general guidelines on system design and operations procedure of the spacecraft and the various experiments	ESA	Every 6 months	
Network	Define access network and associated access rights	ESA	Mar 2002	

Activity ID	Activity Description
Selection Process	
0010	KMDB Tools
0020	Relevant Contractors
Migration of Inputs to KMDB (Baseline Doct'n)	
0030	Inventory of Available Baseline Documents
0040	Formating/Indexing of KMDB Inputs
0050	Migration/Validation
0060	Freeze Network Architecture & Access Rights
EQM Set-up and Installation	
0070	Inventory of Available Hardware (Units/Exp/EGSE)
0080	Procurement of Ad-hoc Recording Equipment
0090	Build EQM as Test Bench (Integration/Validation)
0100	Build SVF
Human Resources	
0110	Build Rosetta Directory of Key Persons
0120	Key Person Interviews & Formatting
0130	Experience Database Build-up
Training	
0140	EQM Operations Training Session - #1
0150	EQM Operations Training Session - #2
0160	Overall Spacecraft Design Training Session - #1
0170	Overall Spacecraft Design Training Session - #2



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Rosetta Project
Knowledge Management Implementation Timeline