International Space Systems, Inc.

RECIPE©
Collaborative Engineering Environment

Prepared for

MDA Panel Session

Thermal Fluids Analysis Workshop

September 12, 2001

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Agenda

- History of RECIPE© – What we set out to do
- Current Activities – ISSI and RECIPE©
- Requirements – What user needs in a system
- System Overview – Capabilities of RECIPE©

History of RECIPE©

Early History (Up to Spring 1999)

- Began with idea for RBCC vehicle design (coupled design)
- Phase-I STTR
  - All rocket TSTO
  - SSTO RBCC
- Thermal Analysis TestBed
  - Incorporated MINIVER and SINDA
  - Added robust database
  - User operated distributively

Recent History (Spring 1999 – Present)

- Demonstration of collaborative process for TGIR 2000 Conference
- Intercenter Systems Analysis Team (ISAT) technology assessments
  - September 2000
  - November 2000
  - March 2001
  - April 2001
  - June 2001
- Received several Phase III contracts

Current Activities

Recent History (Spring 1999 – Present)

- Continuing RECIPE© development
- Intercenter Systems Analysis Team (ISAT) participation
- Advanced Engineering Environment (AEE)

Requirements

RECIPE© Top Level Requirements

- System must be simple to use!
- Accommodate any model needing inputs from and/or providing outputs to other models
- Data to be easily retrieved and placed under configuration management
- Provide traceability of requirements/inputs and assumptions
- Provide a system that will work in Windows, Macintosh, and Unix environments
- Accommodate distributed computing via internet
- Provide reporting/summarization capabilities

System Overview

System Overview – System Goals

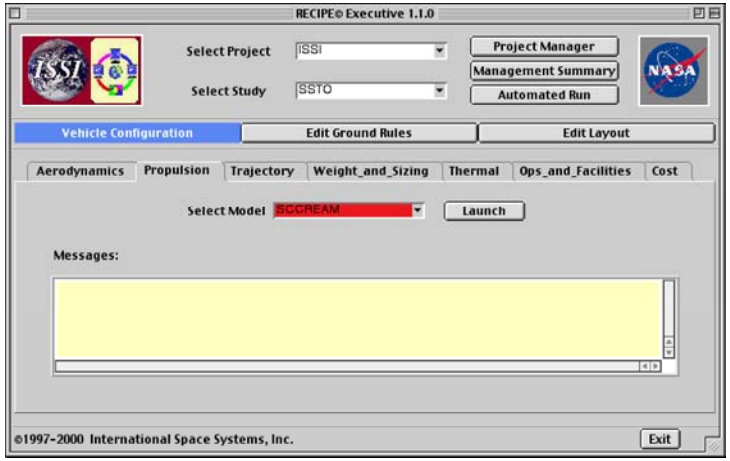
- Provide a system that can be used from preliminary design through production
- Provide a system that will permit data transfer between programs of any fidelity
- Provide a system that will allow engineers to work in parallel
- Provide a system that will allow engineers to work with their models in a familiar manner

System Overview – User Goals

- Make life easier for the manager
  - Provide security of mind about data
  - Provide method of tracking and recovering from problems
  - Provide progress tracking of projects
  - Provide method to view data transferred between models
  - Provide automated comparison report of important data which is portable to other presentations
- Make life easier for the engineer
  - Simplify process of exchanging data with other engineers
  - Simplify process of working with data
  - Simplify process of working with engineering tools

Example

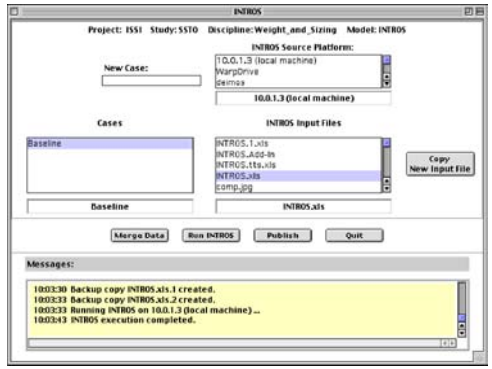
RECIPE© Main Screen



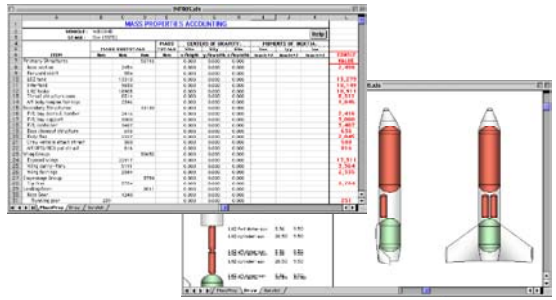
Engineer selects INTROS

System Weights And Sizing

INTROS Manager

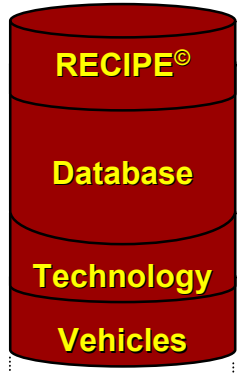


Engineer uses Technology Inputs In Model



Next Engineer(s) uses Results for their analysis
+
Technology Inputs

All results are stored in and recalled from RECIPE© Database



RECIPE© Server Saves Results

RECIPE© Database seamless to User

Trajectory

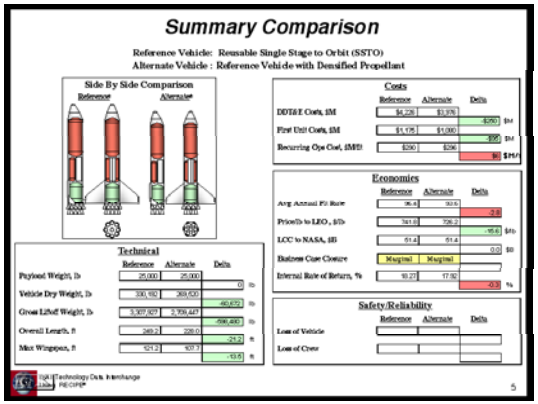
Facilities & Operations Costs

Development & Unit Costs

Economics

Quantitative Assessment

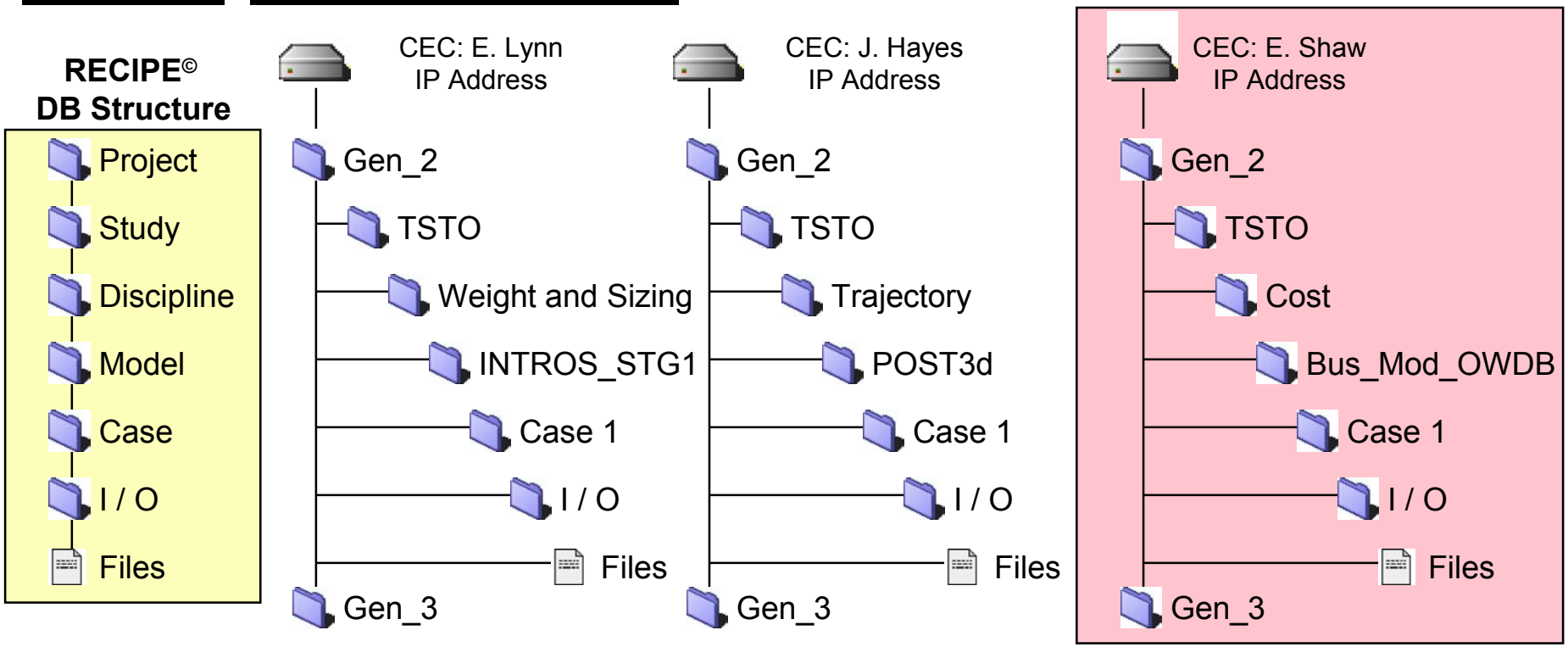
Management Summary



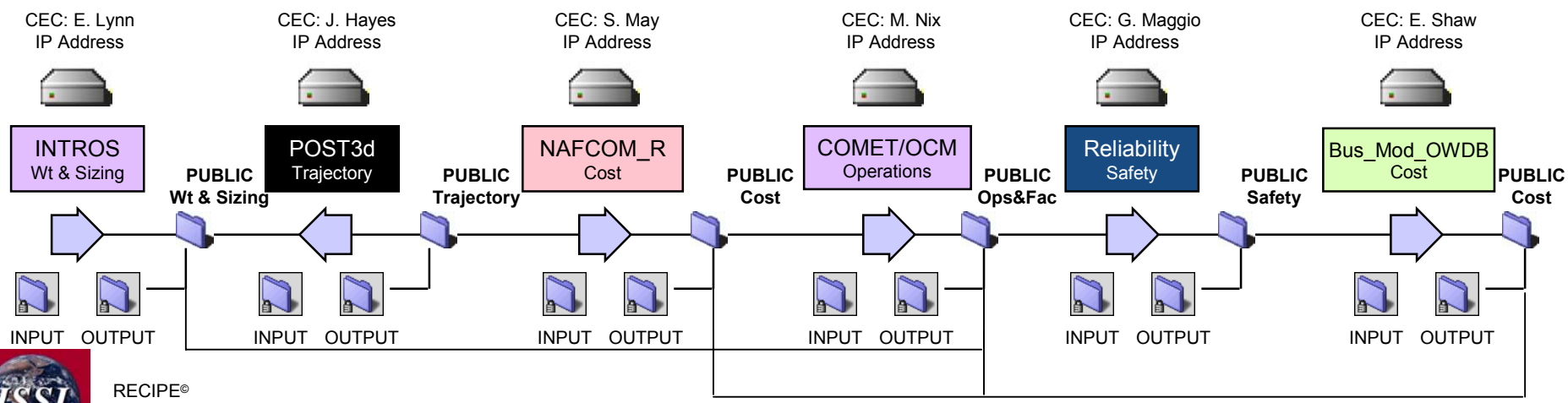
System Overview – Managing Data

- Projects are organized by a three tier hierarchy
  - Project
  - Study
  - Case
- Published data can be stored in a distributed manner or in a central “Mirror” location and archived for permanent storage
- Secure shell can be used for secure transfer of data through firewalls
- The VRC can be used as a permanent restricted storage location which supports ITAR classifications

RECIPE© Example Set-Up



ISAT Example



System Overview – Configuration Management

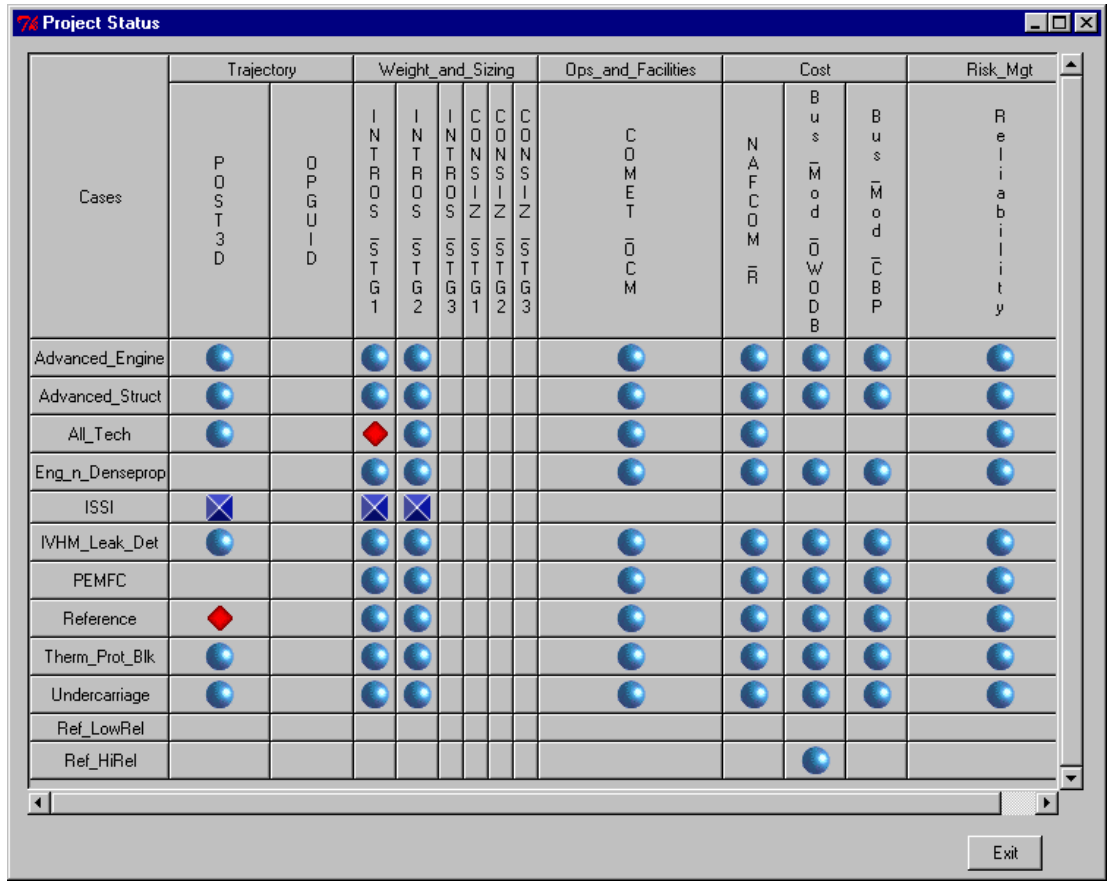
- Hierarchy makes it easy for engineer/manager to find previous work and retrieve/review data
- Final Publish functionality ensures data is not changed after initial work
  - “Freeze” model data so it cannot be changed in the future
  - Data can only be changed by “unpublishing” data after obtaining permission

System Overview – Traceability

- All input files (along with backups) and output files are stored locally
- All input files and published data are stored on “mirror” site via internet
- Logs provide history of actions on each RECIPE© workstation for tracking problems
- RECIPE© will capture
  - Which models have exchanged data for a specific project/study/case
  - What new or different inputs have been entered in a model

System Overview – Management Tools

- Project Status tracks project/study/case
  - Interdiscipline Publish
  - Final Publish
  - Unpublished



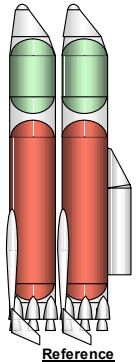
Cases	Trajectory		Weight_and_Sizing						Ops_and_Facilities	Cost			Risk_Mgt
	POST3D	OPGUID	INTROS_STG1	INTROS_STG2	INTROS_STG3	CONSIZ_STG1	CONSIZ_STG2	CONSIZ_STG3	COMET_OCM	NAFCOM_R	Bus_Mod_OWODB	Bus_Mod_CBP	Reliability
Advanced_Engine	●		●	●					●	●	●	●	●
Advanced_Struct	●		●	●					●	●	●	●	●
All_Tech	●		◆	●					●	●			●
Eng_n_Denseprop			●	●					●	●	●	●	●
ISSI	✕		✕	✕									
IVHM_Leak_Det	●		●	●					●	●	●	●	●
PEMFC			●	●					●	●	●	●	●
Reference	◆		●	●					●	●	●	●	●
Therm_Prot_Blk	●		●	●					●	●	●	●	●
Undercarriage	●		●	●					●	●	●	●	●
Ref_LowRel													
Ref_HiRel											●		

System Overview – Management Tools

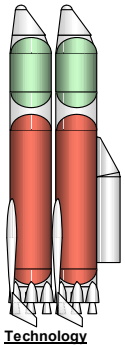
- Access published data
  - Server(s) polled across internet for all published data
  - Project/study/case tree provides method to
    - View published data from any model for any project/study/case
    - Generate "Management Summary"

Management Summary

Reference Vehicle : TSTO Bimese- Reference
Technology Vehicle: TSTO Bimese- New Technology



Reference



Technology

Cost

		Reference	Technology	Difference	
Technology Cost, Min	$B	1.0	1.4	40.0	%
Technology Cost, Max	$B	1.0	1.8	80.0	%
DDT&E Costs, Pes.	$M	100	99	-1.2	%
DDT&E Costs, Opt.	$M	100	106	5.7	%
First Unit Costs, Pes.	$M	100	84	-17.1	%
First Unit Costs, Opt.	$M	100	75	-25.0	%
Recurring Ops Cost/Flt, Pes.	$M	100	70	-30.4	%
Recurring Ops Cost/Flt, Opt.	$M	100	69	-30.6	%

Economics

		Reference	Technology	Difference	
Annual Flt Rate, Pes.		10.0	13.8	37.8	%
Annual Flt Rate, Opt.		20.0	24.2	41.8	%
Price/lb to LEO, Pes.	$	100	74	-26.7	%
Price/lb to LEO, Opt.	$	200	150	-25.2	%
NASA LCC Save, Pes.	$B	(10.0)	(7.0)	7.0	%
NASA LCC Save, Opt.	$B	(1.0)	(0.8)	13.3	%
Industry IRR, Pes.		1.0%	1.1%	12.7	%
Industry IRR, Opt.		10.0%	10.9%	9.6	%

Technical

		Reference	Technology	Difference	
Payload Weight	lbm	100	100	0.0	%
Vehicle Dry Weight	lbm	100	81	-19.3	%
Gross Liftoff Weight	lbm	100	83	-17.0	%
Overall Length	ft	100.0	95.1	-5.9	%
Max Wingspan	ft	100.0	95.3	-5.7	%

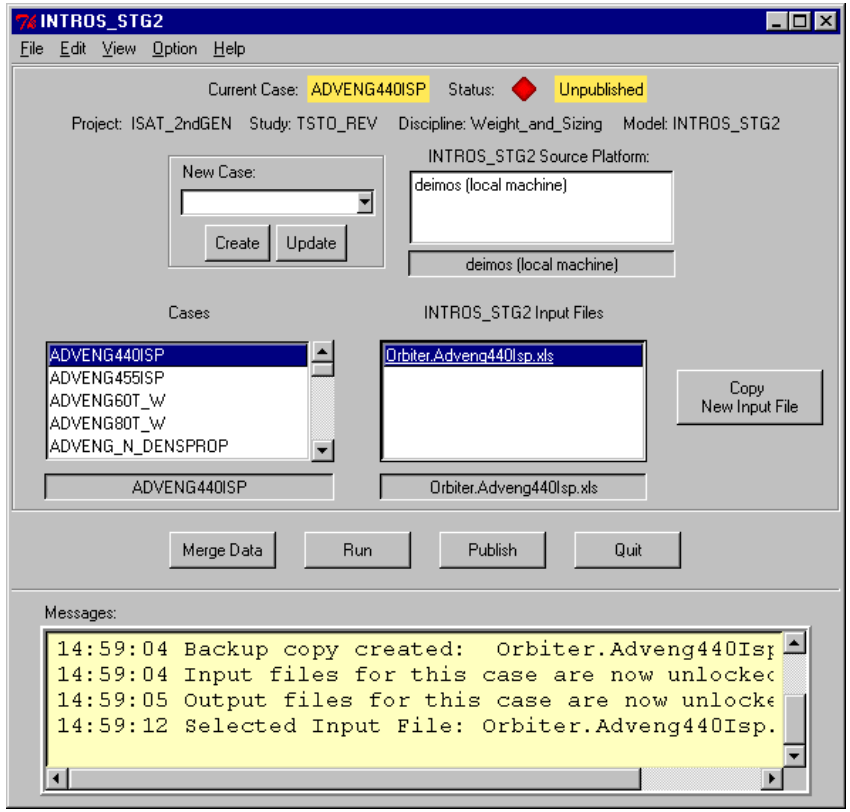
Safety

	Reference	Technology	Difference	
Loss of Vehicle- mean	1:01	1:02	15.22	%
Loss of Vehicle- 25th %tile	1:01	1:02	34.22	%
Loss of Vehicle- 50th %tile	1:01	1:02	28.52	%
Loss of Vehicle- 75th %tile	1:01	1:02	20.20	%

Example Only

System Overview –Using Tools

- Engineer can always see what project/study/case is being worked
- Files can easily be copied from other project/study/cases
- Engineer works with models in a familiar paradigm
  - Batch Programs with input and output files
    - Programs run local or remote
    - All functions accessible with single click
  - Excel workbooks are launched with a single click (even if multiple workbooks)

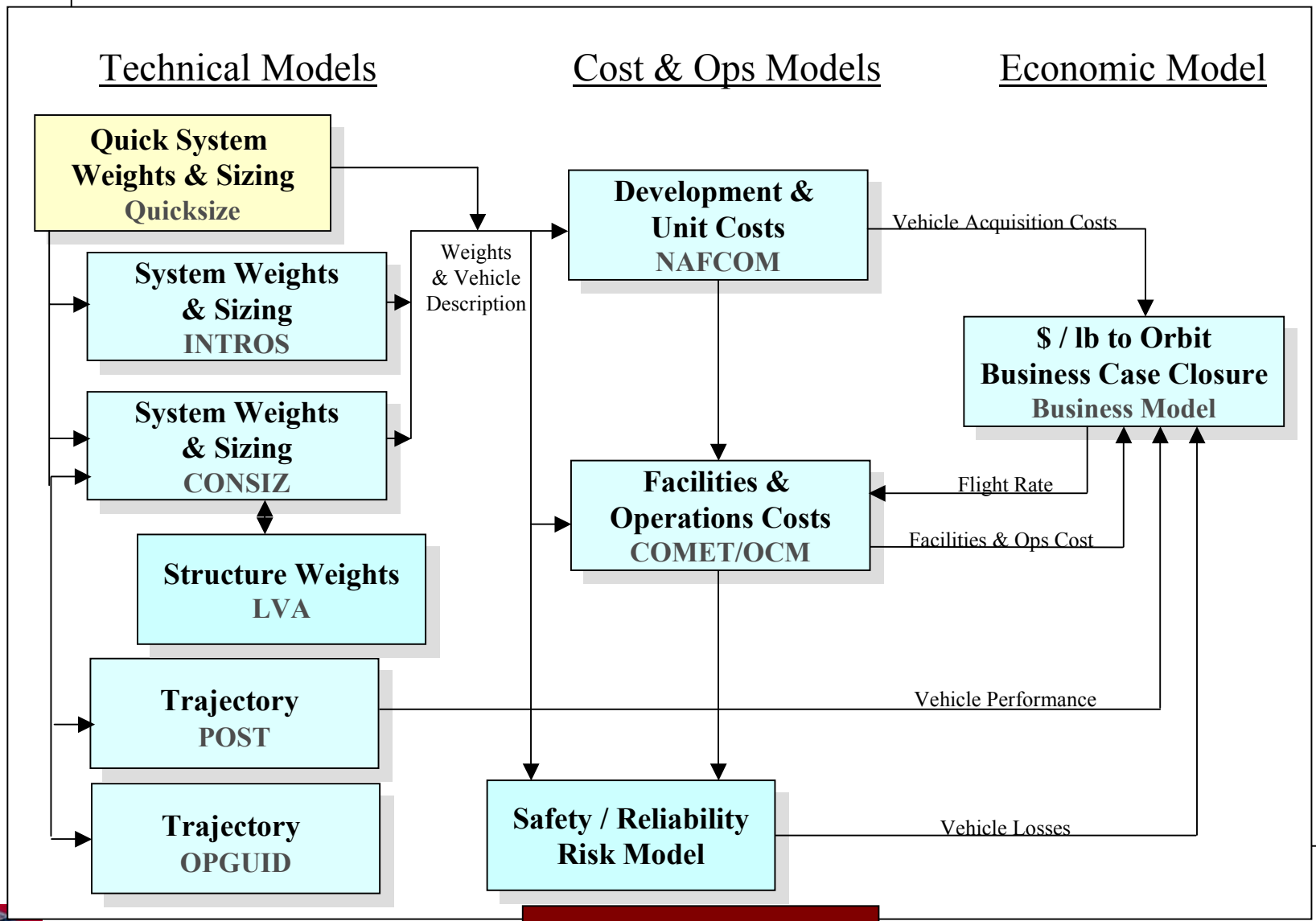


System Overview – Connecting Tools

- Data can be “merged” into the model input file
  - Engineer tells RECIPE© to poll server(s) and identify data from other models which is available for current model to use
  - Engineer tells RECIPE© to insert data into model
  - Can apply
    - Unit conversions
    - Arithmetic conversions
- Data is “Published”
  - Interdiscipline for preliminary publishes while iterating with other models
  - Final when data is available for rest of team
- Several models have been integrated and studies performed

ISAT and RECIPE© : NASA-MSFC CEC & NASA-LaRC CEC

RECIPE©: File Management System and Data Management System



2ndGen ISAT Application

ISSI Assessment System

- Alternate Models in RECIPE©

Geometry / Chemical	Weights & Sizing	Aero / Thermal	Propulsion / Structures	Trajectory	Ops	Cost	Reliability
Pro-E	INTROS	APAS	SCCREAM	POST3d	NROC	NAFCOM _R	SAIC Reliability
CEA	CONSIZ	HYFIM	EPSURBCC	OTIS	Spaceliner 100	Spaceliner 100	RANT/ RAVE
	Quicksize	SINDA	LVA	OPGUID		IEM	
		MINIVER					

System Overview – Future Enhancements

- User Authorization will provide method to permit access to specific project/study/cases and prevent access to others
- Two step plan to simplify process of adding a model
  - "Easy Wrapper" to define RECIPE© model interface, how to run, what data to "Publish", what data and models to "Merge" data
  - "Automatic Wrapper" to aid identification of data and models from which to "Merge"
- Bounds for variables with flagging of variables outside
- Automatic processing of models with optimization capability
- Interface with PDM's including MSFC's IMAN

System Summary

- Makes life easier for the manager
  - Provide security of mind about data
    - Easy to retrieve
    - Not changing (without consent)
    - Archived
    - ITAR restricted (if stored in VRC)
  - Provide method of tracking and recovering from problems
  - Provide progress tracking of projects
  - Provide method to view data transferred between models
  - Provide automated comparison report of important data which is portable to other presentations

System Summary

- Make life easier for the engineer
  - Simplify process of exchanging data with other engineers
    - Receive data
    - Send data
  - Simplify process of working with data
    - Easy to find current data
    - Easy to find old data
  - Simplify process of working with engineering tools
    - Allow engineer to work in familiar paradigm without usual overhead
      - Edit input and output files with a single click
      - Generate desired plots of a program run with a single click
    - Make programs easy to use
      - Reduce manual work
        - » Typing
        - » Data manipulation
      - Launch programs with a single click
        - » Run local
        - » Run remote

System Summary

- What are the top five reasons to use RECIPE©?
  - 1) Engineers get to work with their models in a familiar atmosphere and can easily receive data from other models as soon as it is ready!
  - 2) Engineers and managers can trace problems and know that finished data is secure from tampering and easily retrieved!
  - 3) Engineers and managers can easily view results and easily export those results to other presentations!
  - 4) Engineers can easily retrieve important data from other models and insert that data into their models!
  - 5) ISSI will provide support and do everything possible to satisfy you, the customer!

Contacting ISSI

- Interested parties can contact us at

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