LESSONS FROM ARMY SYSTEM DEVELOPMENTS

A Presentation

For

The 4th Annual Acquisition Research Symposium

Research Project Information

- Principal Sponsor: Army Material Command
- Principal Investigators: Bill Lucas (MIT) and Dick Rhoades (UAH)
- Research Period: September 1999 to May 2004 (data analysis and report preparation continued into 2005)
- Funding: ~$200,000
- Research Purpose: Examine the history and processes used in the development of a number of Army systems which made a positive contribution on the battlefield during Desert Storm

  --determine factors which influence success

  --prepare case studies

Systems Studied

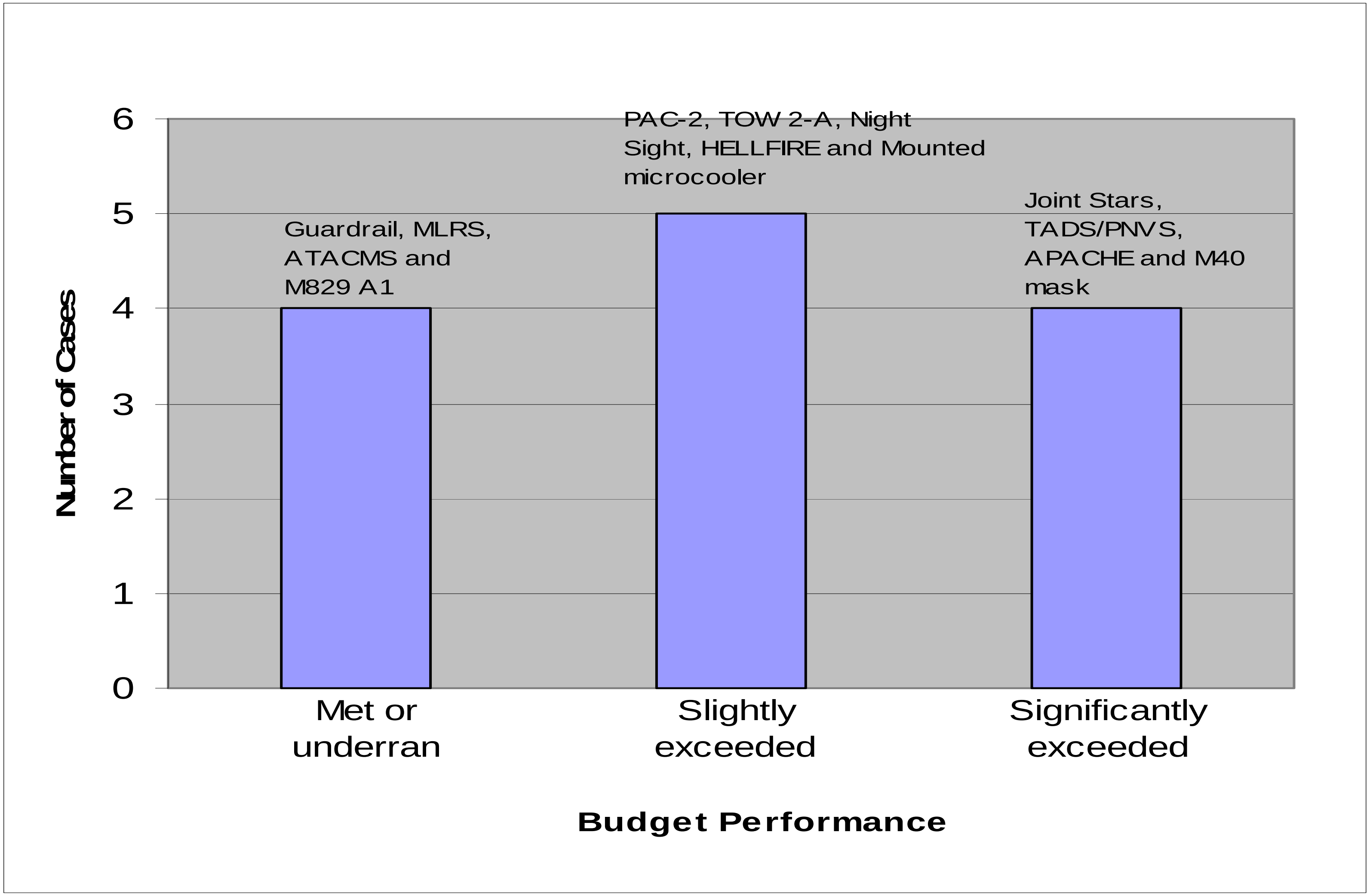
System	Researcher	Commodity category
APACHE attack helicopter	Ference	Aviation
TADS/PNVS (target acquisition and designation/pilot's night vision systems)	Oelrich	Aviation
MLRS rocket system	Sherman	Missiles
ATACMS missile system	Romanczuk	Missiles
M40 chemical protective mask	Ruocco	Soldier support
Dismounted microclimate cooler **Note: Did not enter production**	Ruocco	Soldier support
Mounted microclimate cooler	Ruocco	Soldier support
M829-A1 armor–piercing kinetic energy tank ammunition	Mitchell	Ammunition
FOG-M (fiber optic guided missile) **Note: Did not enter production**	Sherman	Missiles
TOW-2A (Tube-launched missile)	Vessels	Missiles
AN/TAS 4 infrared night sight	Granone	Target acquisition
Joint Stars Ground Station	Sherman	Intelligence
Guardrail common sensor	Sherman	Intelligence
PAC-2 (PATRIOT anti-missile system)	Sherman	Missiles
HELLFIRE missile system	Johansen	Missiles

Research Methodology

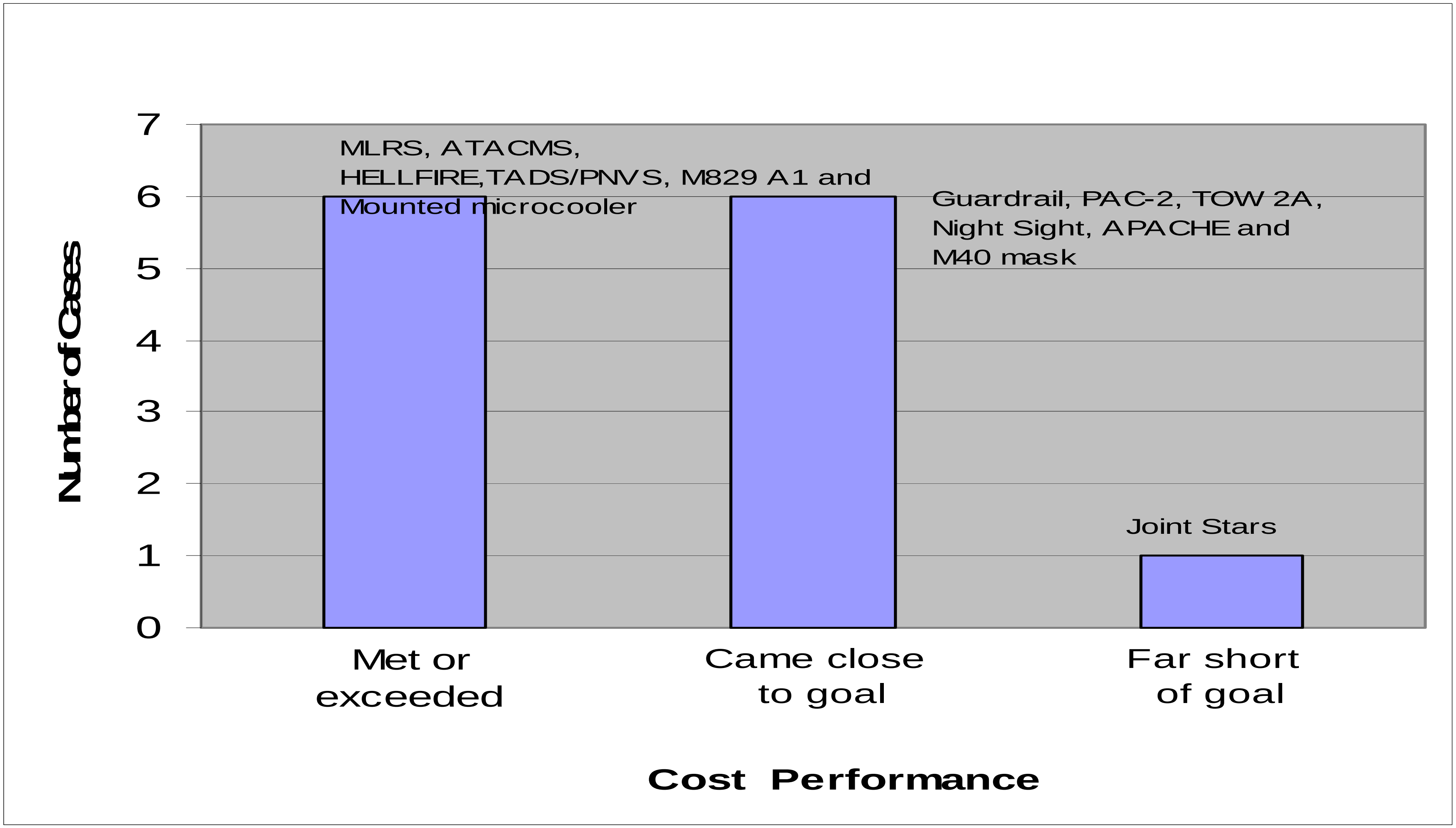
- Army RDEC and PM leadership nominated systems which either did or could have impacted Desert Storm
- Researchers (intended to be “free” Army student labor) selected a system from list of candidates
- “Structured thesis” approach used to gather comparable data on each system studied, but allow researcher to document areas of particular interest in each case study
- Modified version of questionnaire used on LeanTEC was administered to Army and contractor development team members; researcher integrated responses
  ---produced composite “best answer” questionnaire
  ---produced case study on system development

15 systems, 13 produced dictated a focus on relative success factors

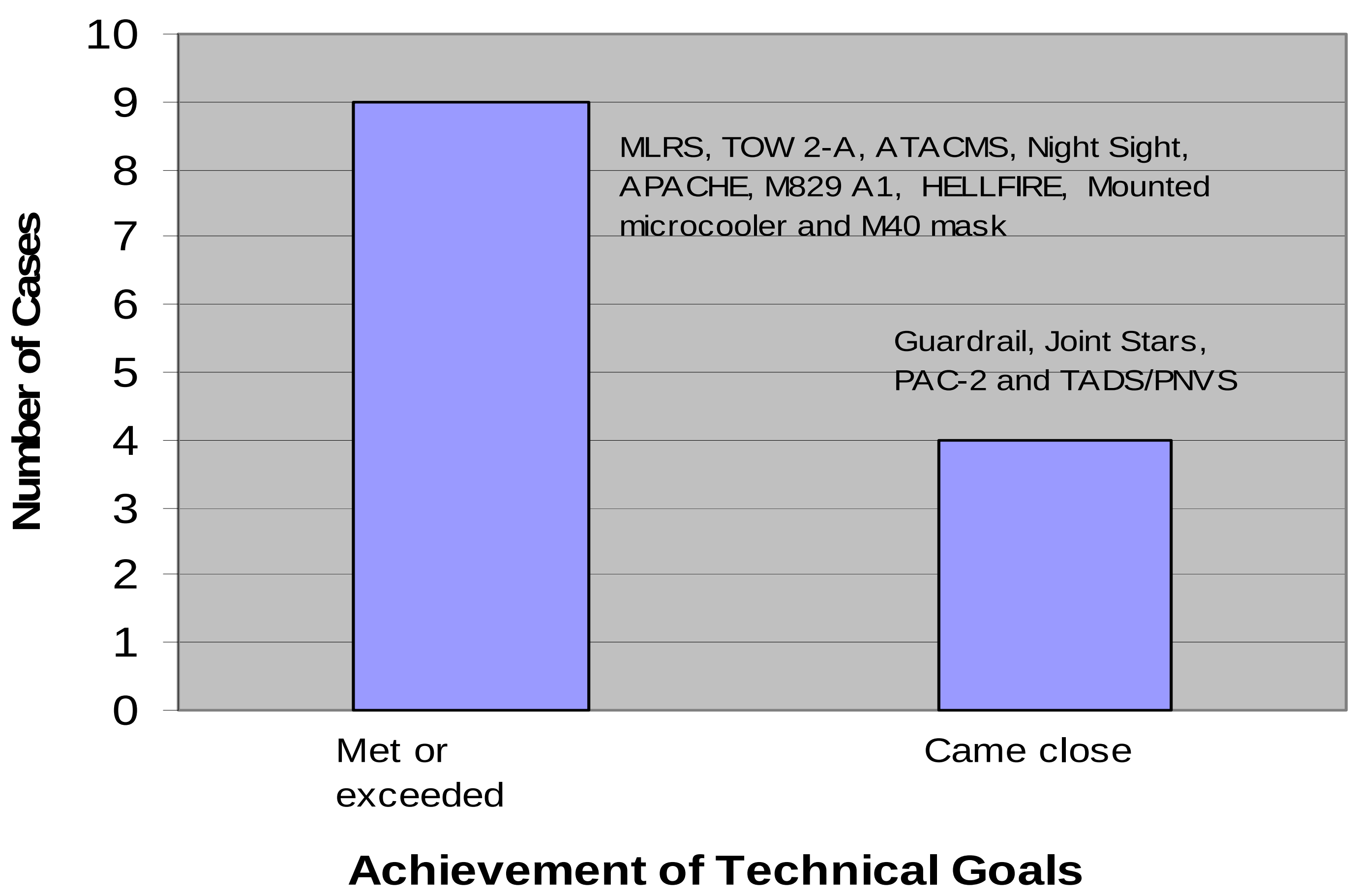
Outcomes-Development Budget



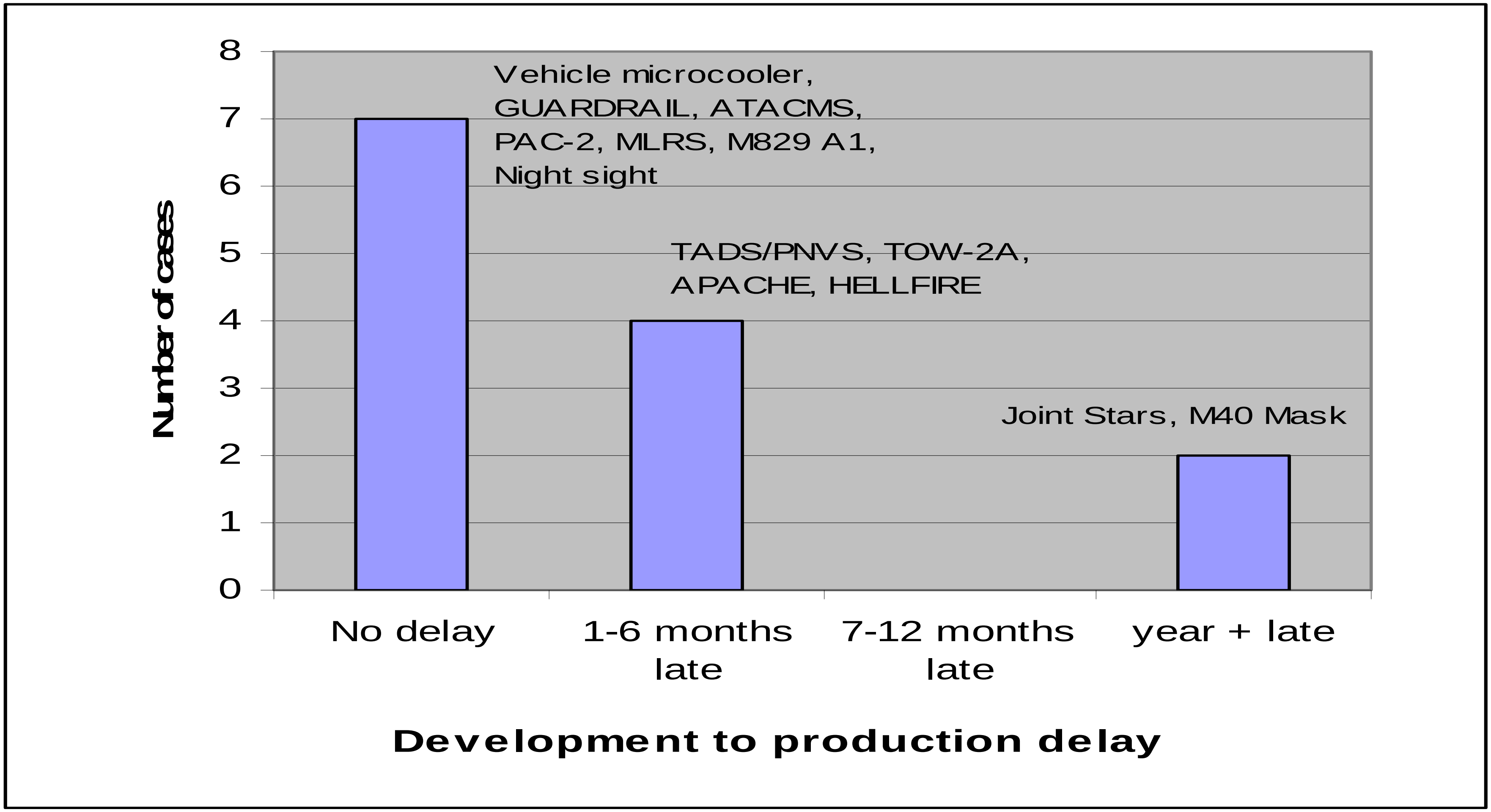
Outcomes-System unit cost



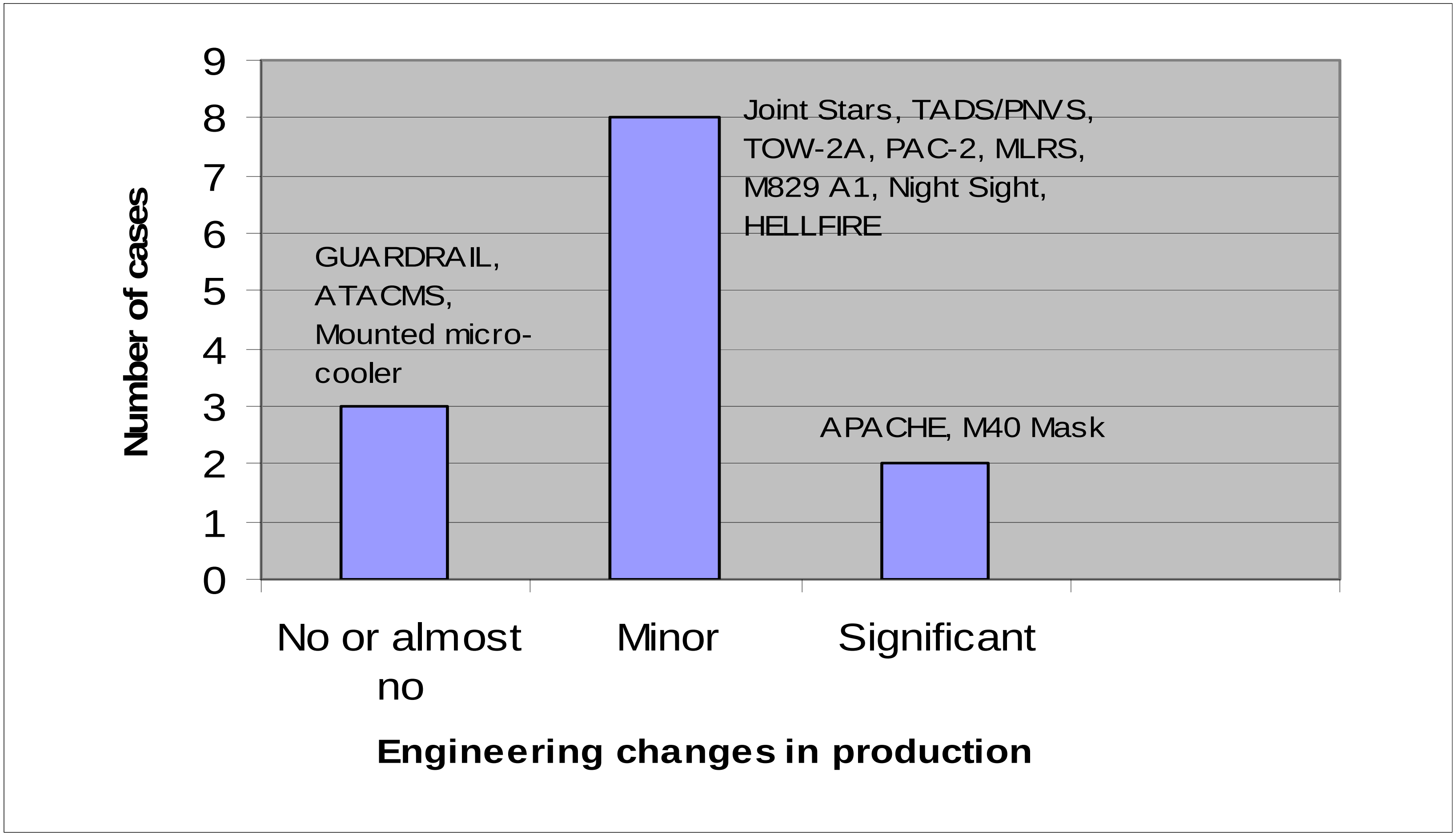
Outcomes-Technical performance



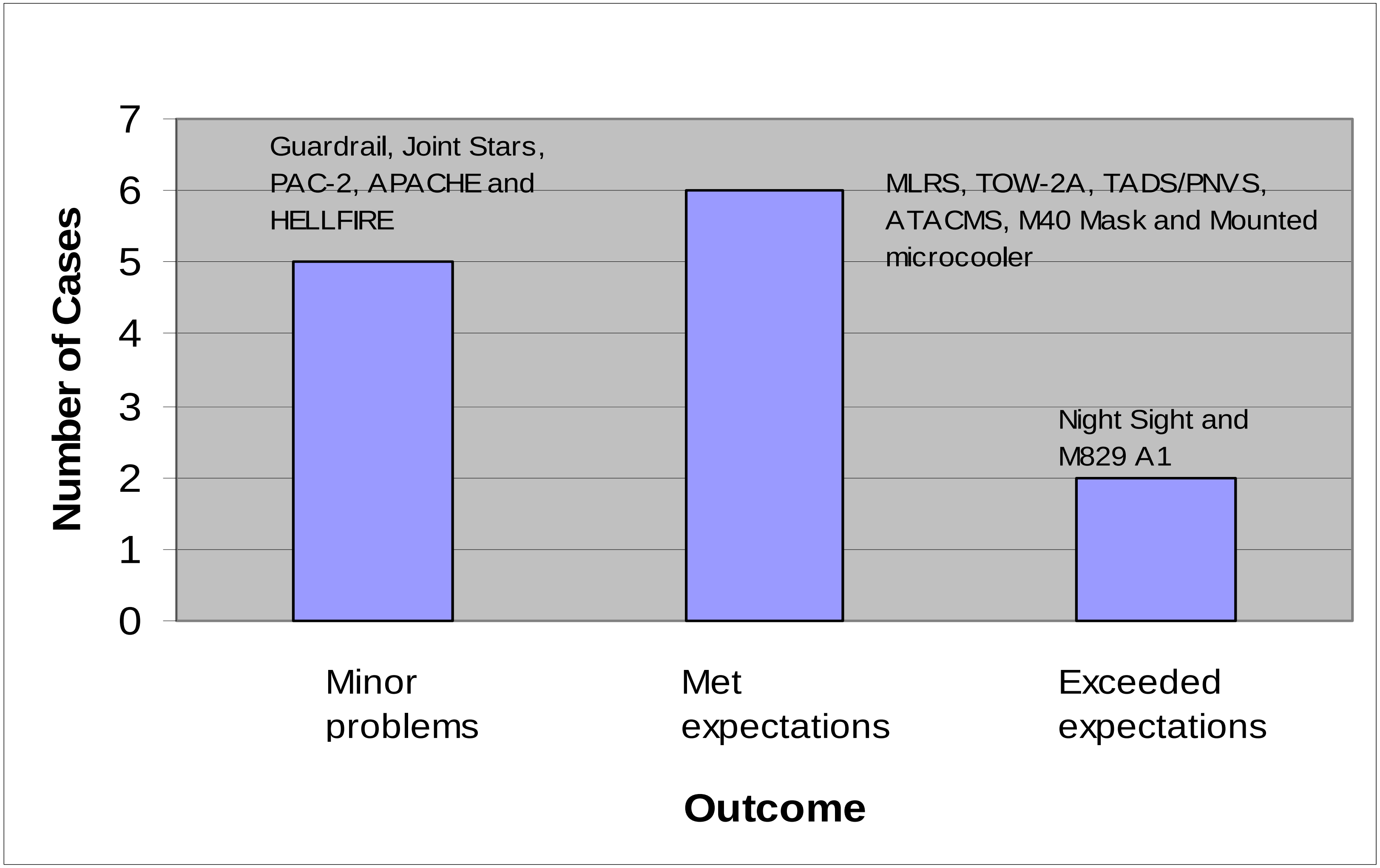
Outcomes-Delay in transitioning to production



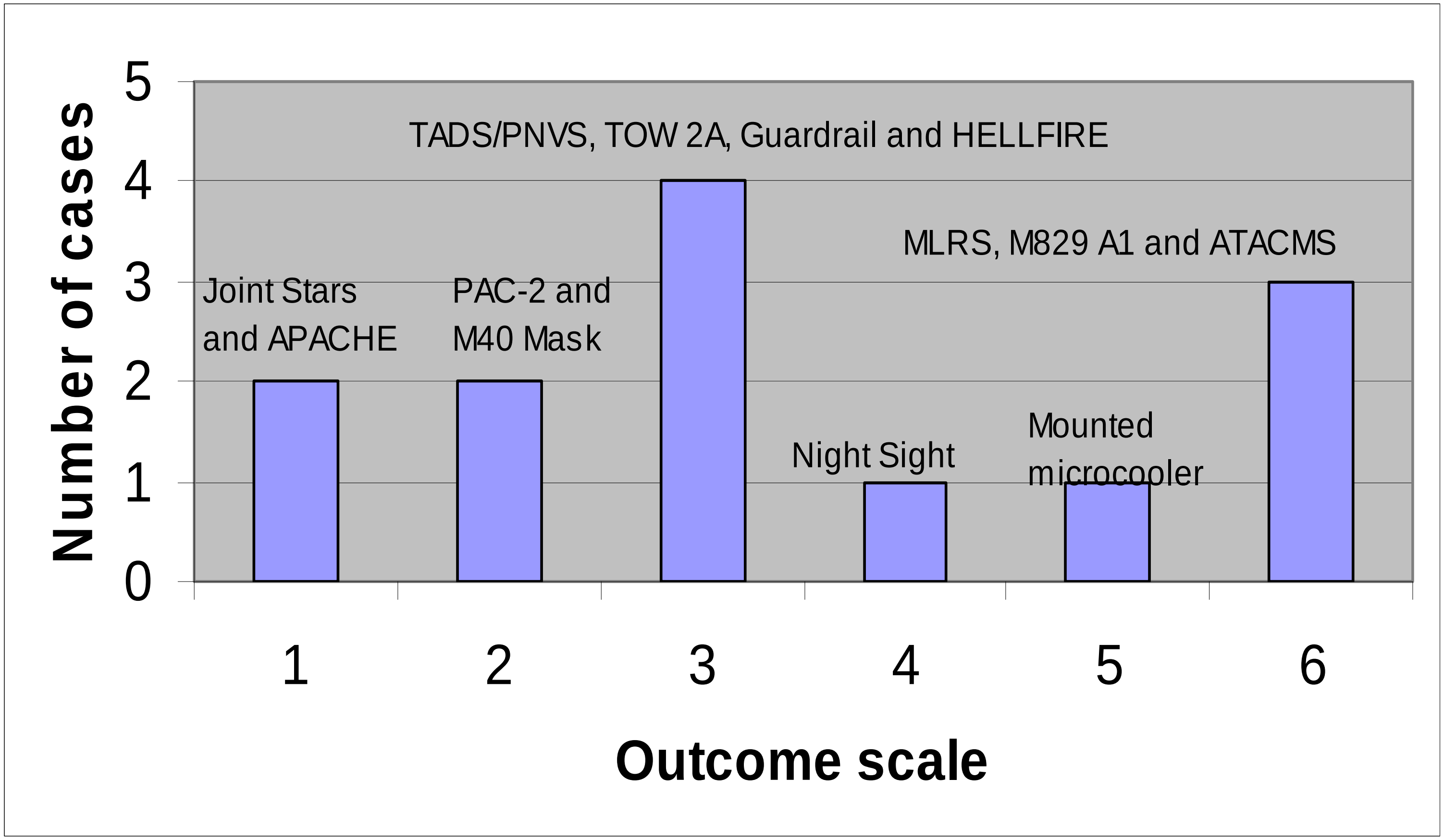
Outcomes-Changes in production



Outcomes-Operational Performance



Outcomes-Integrated Scale



Scale: Sum of number of preferred outcomes using six outcome metrics

Summary Case Information

System/case	Development duration (months)	PM's most difficult problem	Key outcomes achieved (0-6)
APACHE attack helicopter	108	Control of production costs; influenced by integration plant location choices	1
TADS/PNVS (target acquisition and designation/pilot's night vision systems)	~36	Cost growth in development	3
MLRS rocket system	33	Establishing and managing four nation cooperative development program	6
ATACMS missile system	37	Key vendor went out of business	6
M40 chemical protective mask	~48	Immaturity of critical technologies	2
Dismounted microclimate cooler **Note: Did not enter full development**	Not applicable	Lack of stable user requirements due to immaturity of technology	Not applicable
Mounted microclimate cooler	~24	Key vendor failed to support integration schedule	5

Summary Case Information (cont.)

System/case	Development Duration (months)	PM's most difficult problem	Key outcomes achieved (0-6)
M829-A1 armor–piercing kinetic energy tank ammunition	~36	Achieving needed innovation in system design	6
FOG-M (fiber optic guided missile) **Note: Did not complete development**	Not applicable;	Lack of sustained user support	Not applicable
TOW-2A (Tube-launched missile)	48	Stability of threat armor requirements	3
AN/TAS 4 infrared night sight	~24	Selection of unqualified vendor and split management responsibility	4
Joint Stars Ground Station	105	Cost and schedule growth/delivering complex software	1
Guardrail common sensor	~24	Complexity of integration of mission equipment	3
PAC-2 (PATRIOT anti-missile system)	~52	Early fielding to meet SCUD missile threat	2
HELLFIRE missile system	~84	Adversarial relationship between key vendor and prime	3

Significant Relationships

Factor	Relationships Found/Comments
1. Project team characteristics and practices:	
--leadership	Team leader's perceived ability to obtain resources, his/her breadth of experience and ability to resolve technical issues all are positively related to reduced engineering changes during production and completing development within budget.
--staffing	Low turnover in key project team members relates positively to completing development within budget, to meeting system unit cost targets and to achieving system performance objectives.
2. Role of government S&T organizations	Army labs/centers were typically actively involved in both pre-development and development phases; actively involved in both successes and failures; and actively involved in both short and long developments.
3. Testing and simulation approach	Validating component and system maturity at the right time in the program relates positively to completing development within budget, to meeting system unit cost targets and to successful performance in the field. The quality of the testing and simulation conducted relates positively to reduced engineering changes during production and to meeting system unit cost targets.

Significant Relationships (continued)

<u>Factor</u>	<u>Relationships Found/Comments</u>
4. Importance of stability:	
--funding	Funding uncertainty was related to increased turnover in key project team members and the need to deal with changes in testing plans and other project structure issues.
--system requirements	Changes in system requirements, particularly during the middle of development, relate to an increase in late engineering changes and negatively to project success in meeting its goals for systems costs.
--key user (TRADOC) personnel	Changes in key TRADOC personnel during development relates to less successful performance in the field.
5. Timely communication of problems	Nearly all cases described timely communication of problems from contractor to government PM and from government PM to Army leadership.
6. Importance of technology maturity (TRLs)	Maturity of critical technologies used in systems studied, as measured by TRLs, was similar to that found in previous LeanTec study of small electronics projects. No positive correlation found between higher TRLs at the start of development and most outcome variables.

Destabilizing Influences

Variable	Timing Implications
1. Reductions in project funding	Potential for change in administration every 48 months; typical turn-over in key military leaders occurs every 24-36 months. Potential change in key Congress positions every 24 months; likelihood increases with development duration
2. Uncertainty in project funding	Potential for change in administration every 48 months; typical turn-over in key military leaders occurs every 24-36 months. . Potential change in key Congress positions every 24 months; likelihood increases with development duration.
3. Change in system requirements	Changes in the threat environment occur unpredictably, but become more likely with longer development durations. Changes in doctrine and system requirements follow a similar pattern.
4. Change in key user representatives	Typical turn-over in such key military positions occurs every ~36 months
5. Change in key project team members	Typical turn-over in military acquisition positions occurs every ~36 months. Longer development durations present more opportunities for career moves on the part of key civilian team members

Central Conclusion

Shorter development cycle times favorably correlate with key project outcome variables, largely by minimizing the exposure of the project to destabilizing influences

Length of Project Development and Project Performance

(Average number of successful outcomes)

	Over 3 years	Three years or less	Sig. at
Length of development	2.00	4.71	.002