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On-Time Digital Transformations for COOs and CIOs

Applying hardware-program systems engineering (requirements first, a system drawing before purchase, gated reviews and verification evidence) to business and IT transformation.

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Abstract

Large IT projects overrun. In a database of more than 5,400 IT projects, McKinsey and the University of Oxford found that large projects (initial budgets above $15 million) averaged 45 % over budget and 7 % over schedule, with 56 % less value than predicted [1]. Flyvbjerg and Budzier found that one in six of 1,471 projects had a cost overrun averaging 200 % [2]. Gartner reports that 48 % of digital initiatives meet or exceed their business outcome targets [3].

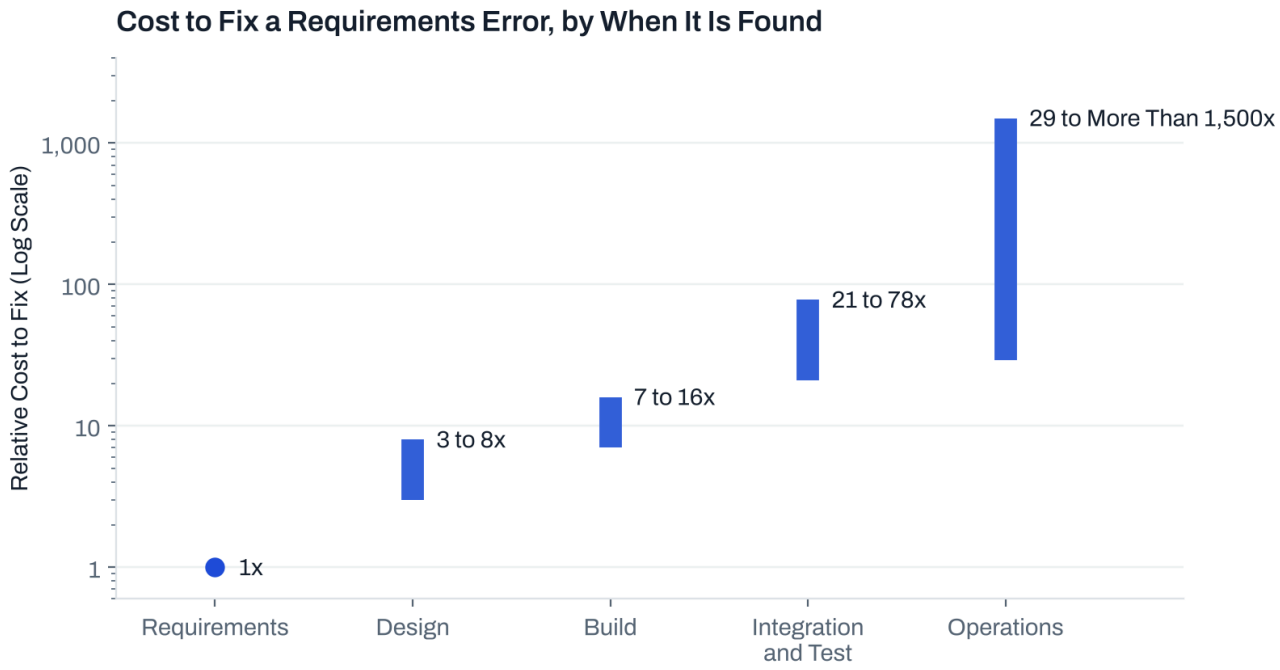
Aerospace programs control the same risk with four practices documented in the NASA Systems Engineering Handbook [5]: testable requirements with bidirectional traceability, an architecture defined before build, life-cycle reviews with entry and success criteria, and verification by test, analysis, inspection or demonstration. We map these to a four-step transformation method (Assess, Design, Build and Migrate, Verify and Hand Off), check it against GAO's nine critical success factors for major IT acquisitions [7], and give a ten-question health check for programs already under way.

Keywords: digital transformation, program management, systems engineering, stage gates, requirements traceability, GAO

1. Introduction

McKinsey and the Oxford BT Centre for Major Programme Management built a database of more than 5,400 IT projects. Large projects (initial budgets above $15 million) ran on average 45 % over budget and 7 % over time and delivered 56 % less value than predicted; 17 % of IT projects go so badly that they can threaten the company's existence [1]. Flyvbjerg and Budzier examined 1,471 projects (92 % public agencies, 83 % US-based): the average cost overrun was 27 %, but one in six was a "black swan" with an average cost overrun of 200 % and a schedule overrun of almost 70 % [2]. Gartner's 2025 CIO and Technology Executive Survey (n = 3,186) found that 48 % of digital initiatives meet or exceed their business outcome targets [3]. In the federal portfolio, GAO reports that new-system attempts "have too often run far over budget, experienced significant delays, and delivered far fewer improvements than promised" [4].

The economics favor early discipline. The NASA handbook notes that during design only about 15 % of life-cycle cost may be spent while the design commits about 75 % [5, Sec. 2.5]; the handbook presents this as an illustrative Defense Acquisition University curve and notes that numbers vary by project. Stecklein et al. estimated, from spacecraft and aircraft program data and a model of a hypothetical satellite project, the relative cost to correct a requirements error by the phase in which it is found: 3 to 8 times in design, 7 to 16 in build, 21 to 78 in integration and test, and 29 to more than 1,500 in operations, for "a hardware/software system having project characteristics similar to those used in the development of a large, complex spacecraft, a military aircraft, or a small communications satellite" [6]. We use these figures as an analogy, not as an estimate for ERP work.



Source: Stecklein et al., NASA JSC, 2004. Estimated from aerospace program data and a hypothetical project model; shown here as an analogy.

Figure 1. Relative cost to correct a requirements error by phase found [6].

2. Practices Borrowed From Systems Engineering

Practice	NASA Handbook Wording [5]	Use in a Transformation
Verification	"proof of compliance with requirements… as proven [through] performance of a test, analysis, inspection, or demonstration" (Sec. 2.4)	Every requirement names its verification method before build
Validation	"the product accomplishes the intended purpose in the intended environment" (Sec. 2.4)	User testing before formal acceptance; outcome measures against the baseline
Bidirectional traceability	"the ability to trace any given requirement… to its parent… and to its allocated children" (Sec. 6.2)	Requirement to interface to configuration change to test
Life-cycle reviews	Phase boundaries "provide natural points for 'go' or 'no-go' decisions" (Sec. 3.0)	Four gates with entry and success criteria
Late change	"Requirement changes during Phases B and C are more likely to cause significant adverse impacts to the project cost and schedule" (Sec. 6.2.1.2.4)	Freeze and rank requirements at Gate 2; change control after

Table 1. Systems engineering practices and their transformation equivalents.

3. Method

3.1 Steps and Gates

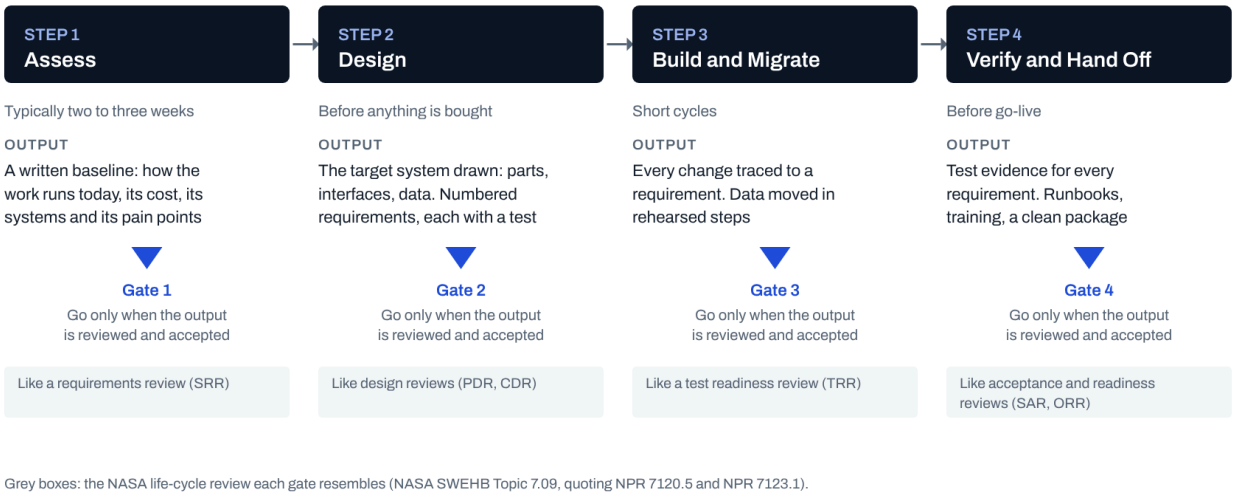


Figure 2. Four steps and gates, with the NASA life-cycle review each gate resembles. Review purposes as stated in NPR 7120.5 and NPR 7123.1 [8].

Gate	Entry	Success Criteria	NASA Analogue [8]
1 Baseline	Process maps, system inventory, volumes, cost by line item	Sponsor and users accept the baseline; improvement targets stated against it	SRR: requirements and concept "will satisfy the mission"
2 Design	Target drawing; numbered requirements with verification methods; buy, build or reuse decisions	Every interface on the drawing has a requirement; requirements ranked; cost and schedule re-estimated	PDR: preliminary design meets requirements "with acceptable risk"; "verification methods have been described". CDR: design maturity supports proceeding to build and test
3 Build Ready to Test	Traced releases; migration rehearsals reconciled to source	Test environment, data and procedures ready; open defects within agreed limits	TRR: test article, facility, personnel and procedures "ready for testing"
4 Hand Off	Test evidence for every requirement; user testing; runbooks; trained operators	All requirements verified or waived by name; operations team accepts	SAR/ORR: end item complete; system and procedures ready for operations

Table 2. Gate criteria.

3.2 Requirements and Traceability

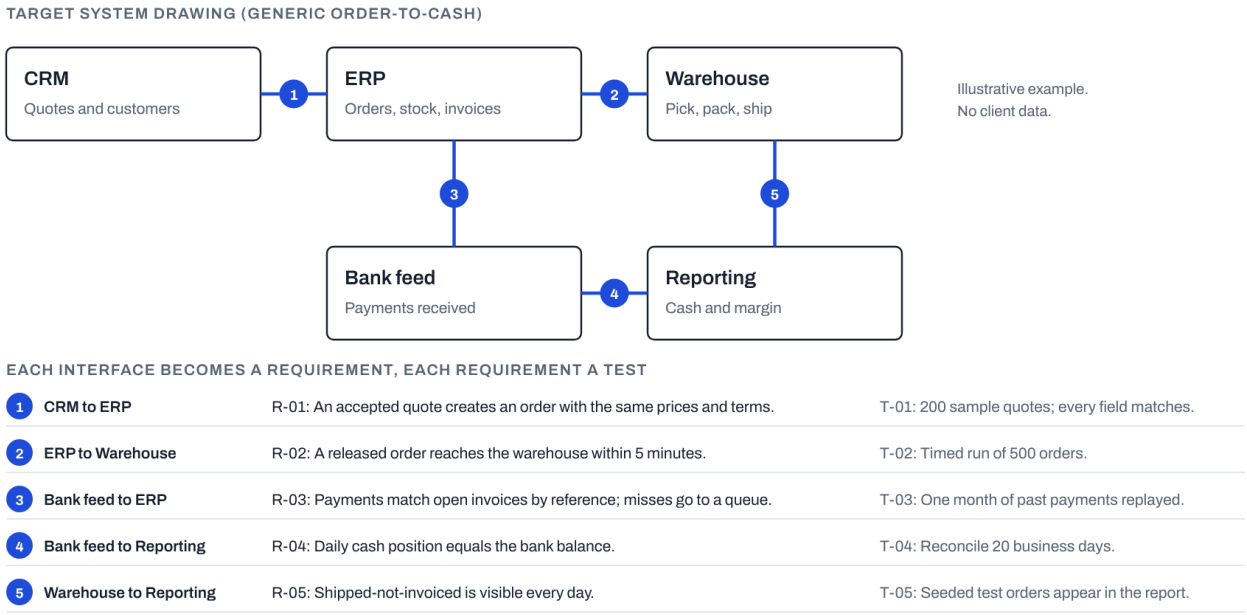


Figure 3. Generic order-to-cash target drawing with interfaces traced to requirements and tests. Illustrative; no client data.

A requirement record carries an identifier, a "shall" statement, a rationale, a source (parent requirement or stakeholder), a priority, a verification method and an owner. The interface list from the drawing is the minimum requirement set: each interface yields at least one requirement on content, timing and failure handling, and each becomes a reconciliation or functional test.

4. Comparison With GAO's Critical Success Factors

GAO studied seven federal IT investments that, according to department officials, best achieved their cost, schedule, scope and performance goals. Officials identified nine factors critical to the success of three or more of them [7]: engaged stakeholders; staff with the necessary knowledge and skills; executive support; end users and stakeholders

involved in developing requirements; end users testing functionality before formal acceptance testing; stable and consistent staff; prioritized requirements; regular communication with the prime contractor; and sufficient funding. In our mapping (Figure 4), the method builds in four factors directly: engaged stakeholders, users helping write requirements, users testing before acceptance, and prioritized requirements. The other five (skills, executive support, staff stability, contractor communication and funding) are organizational conditions; the method checks them at gates but cannot create them.

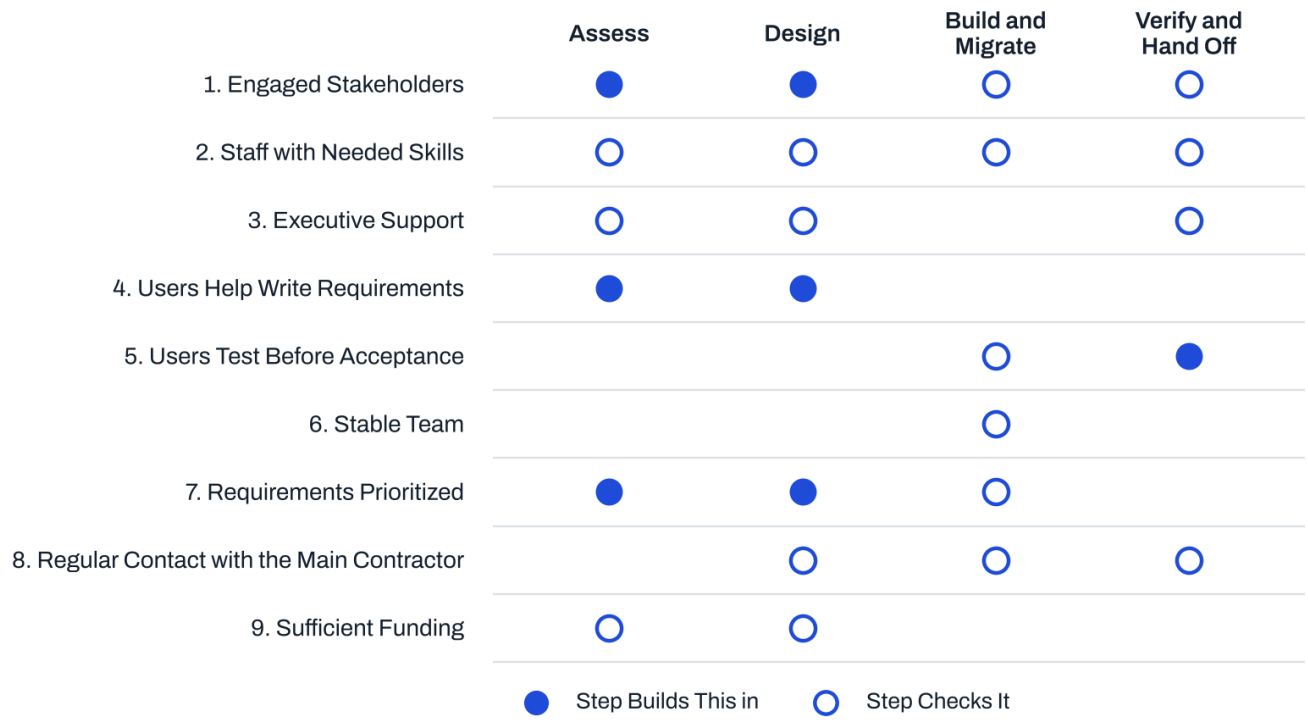


Figure 4. GAO's nine success factors against the four steps [7].

5. Program Health Check

#	Question	Step
1	Is there a written baseline of today's process and its cost?	Assess
2	Is there one drawing of the target system showing every interface?	Design
3	Is every requirement numbered, with a verification method?	Design
4	Did users help write the requirements?	Assess, Design
5	Are requirements ranked?	Design
6	Can every change in the current release be traced to a requirement?	Build
7	Has the data migration been rehearsed and reconciled to source?	Build
8	Do users test before formal acceptance?	Verify
9	Does each phase end in a review that can stop the program?	All
10	Are runbooks and a trained operations team in place before go-live?	Verify

Table 3. Health check for a running program. The first "no" marks the priority fix.

6. Implications for Programs

The four practices add modest effort early and protect the late phases, where the cost of correction is highest. In our view the target-system drawing is the most frequently skipped and most valuable artifact, because it turns integration risk into a list of requirements and tests. For a program already under way, the health check gives a fast, evidence-based place to start.

References

1. M. Bloch, S. Blumberg, J. Laartz, "Delivering large-scale IT projects on time, on budget, and on value," McKinsey & Company, Oct. 1, 2012. https://www.mckinsey.com/capabilities/tech-and-ai/our-insights/delivering-large-scale-it-projects-on-time-on-budget-and-on-value
2. B. Flyvbjerg, A. Budzier, "Why Your IT Project May Be Riskier Than You Think," Harvard Business Review 89(9), 23-25, Sept. 2011; author copy arXiv:1304.0265.
3. Gartner, press release, Oct. 22, 2024: "Gartner Survey Reveals That Only 48% of Digital Initiatives Meet or Exceed Their Business Outcome Targets" (2025 CIO and Technology Executive Survey, n = 3,186); a similar figure is reported in Gartner's 2026 CIO Agenda. https://www.gartner.com/en/newsroom/press-releases/2024-10-22-gartner-survey-reveals-that-only-48-percent-of-digital-initiatives-meet-or-exceed-their-business-outcome-targets
4. U.S. GAO, High-Risk Series: Heightened Attention Could Save Billions More and Improve Government Efficiency and Effectiveness, GAO-25-107743, Feb. 25, 2025. https://www.gao.gov/products/gao-25-107743
5. NASA, NASA Systems Engineering Handbook, NASA/SP-2016-6105 Rev 2, 2016. https://www.nasa.gov/reference/systems-engineering-handbook/
6. J. M. Stecklein, J. Dabney, B. Dick, B. Haskins, R. Lovell, G. Moroney, "Error Cost Escalation Through the Project Life Cycle," NASA JSC, JSC-CN-8435, INCOSE International Symposium, 2004. https://ntrs.nasa.gov/citations/20100036670
7. U.S. GAO, Information Technology: Critical Factors Underlying Successful Major Acquisitions, GAO-12-7, Oct. 21, 2011 (publicly released Nov. 21, 2011). https://www.gao.gov/products/gao-12-7
8. NASA Software Engineering Handbook, Topic 7.09, "Entrance and Exit Criteria" (quoting NPR 7120.5 and NPR 7123.1). https://swehb.nasa.gov/x/SQH7 (accessed Nov. 2026)

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