

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Tic TOC: Time is money for SCIRT estimates

Story: Estimating

Theme: Finance and Business Systems

A document which describes the SCIRT estimates process and outcomes.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz



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Tic TOC: Time is money for SCIRT estimates

For SCIRT, with a programme of 634 projects to deliver within a five year period and a \$2.2 billion budget, correct project estimates were paramount.



By the numbers: SCIRT's estimating team discusses pricing with the independent estimator.

The sheer scale of the SCIRT programme and the great unknown of unseen damage amid ongoing aftershocks meant calculating accurate cost estimates would be challenging. The deliberate fundamentals and rigorous processes introduced at the outset ensured a successful outcome.

The contractual basis for SCIRT was an alliance agreement (AA) between three owner participants and five non-owner participants. The owner participants were the Christchurch City Council (CCC), the New Zealand Transport Agency (NZTA) and the Canterbury Earthquake Recovery Authority (CERA), later to transition to the Department of the Prime Minister and Cabinet (DPMC). The non-owner participants were national construction companies, City Care, Downer, Fulton Hogan, Fletcher and McConnell Dowell. These companies set up Delivery Teams in separate local offices to deliver SCIRT's work.

The SCIRT commercial model required a Target Out-turn Cost (TOC) to be estimated for the construction work for each project. Delivery Teams were paid the actual cost of the work plus a fee determined as a

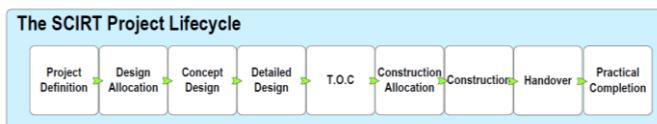
percentage of the TOC. The difference between TOC and Actual Out-turn Cost (AOC) for each project contributed to a pain share/gain share pot that was shared amongst all SCIRT participants at the end of the programme. Delivery Team performance against TOC was also a factor in the scoring system used to determine how much work each Delivery Team was allocated.

Although in principle SCIRT's commercial arrangement seemed simple, in practice, the power of it to drive behaviour was immense. The model drove intense competition between SCIRT's Delivery Teams to be allocated work, yet at the same time drove collaborative behaviour between the same teams. All parties had to perform together to ensure an overall gain rather than pain result at the end of the programme. For further information about SCIRT's commercial Model and how it drove both competition and collaboration, see [All for one, one for all: the SCIRT collaborative - competitive model.](#)

What made SCIRT's estimating process unique when compared with other large-scale civil engineering

programmes, was that SCIRT's \$2.2 billion budget included 634 construction projects, each requiring its own estimate.

As designs were developed and construction details became more certain, project TOCs became more accurate. Although there were some exceptions, on average, TOCs at the concept design stage of the project lifecycle were within 25 per cent of AOC and detailed design TOCs were within 15 per cent of AOC. Once a TOC was set, the assigned Delivery Team's challenge was to deliver under that budget.



Making progress: An illustration of project progression, from definition through to design, estimating, construction and finally handover.

SCIRT's Estimating Management Plan (see attachment) outlined how TOCs were generated to ensure SCIRT delivered on its Alliance Agreement objective of "demonstrating the best long-term value for money". Ensuring value for money included implementing pricing procedures so transparency and probity could be assured.

To deliver best value for money, SCIRT intentionally put in place several interdependent factors to ensure success:

- The estimating team was located within the Integrated Services Team (IST) office, and reported directly to the SCIRT management team to ensure independence from Delivery Teams,
- The estimating team was structured for sustained success,
- A rigorous yet flexible estimating framework and process were created and designed to ensure efficiency, consistency and responsiveness to changes in cost and productivities with time and experience, and
- An independent estimator was employed to verify estimates.

These factors are described in further detail below.

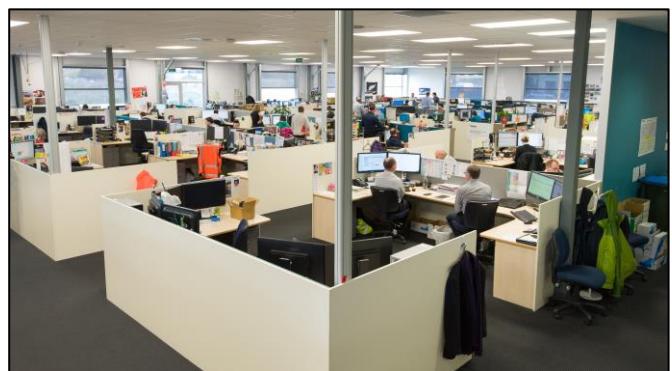
Structured for success

With the scale and complexity of the SCIRT programme, there was an urgent need to find the right people, ready and willing to take on the challenge. "In the early days, SCIRT had to deal with a relentless number of projects, one after another – it just never stopped – and we also had to find the right people because the type of work we undertook was quite variable in terms of skill base," SCIRT estimating manager Roy Butler said.

The estimating team was initially staffed with team members from SCIRT's non-owner participant organisations. To ensure impartiality, estimators did not work on projects allocated to their home organisations. As the team grew (to 12 people at its peak), people came from further afield (external recruits and contractors).

In 2012 a graduate rotation programme started, where recent civil engineering graduates spent six to nine months working within the SCIRT estimating team. This type of rotation worked because it helped keep personnel fresh.

The unrelenting workload meant five years estimating at SCIRT could be tough. With the exception of one or two people, estimators spent 12 to 18 months at IST then moved on to something different, such as working within their SCIRT Delivery Team.



The east wing: SCIRT's Integrated Services Team (IST) powered through multiple projects.

Over the course of the SCIRT programme, there were four estimating managers and more than 20 estimators, with several more working remotely at various times.

The ability to collaborate was key. Design and Early Contractor Involvement (ECI) processes ensured that design and Delivery Teams provided the information required by the estimators to build a comprehensive understanding of the nature of the project and the work required, facilitating the development of accurate estimates.

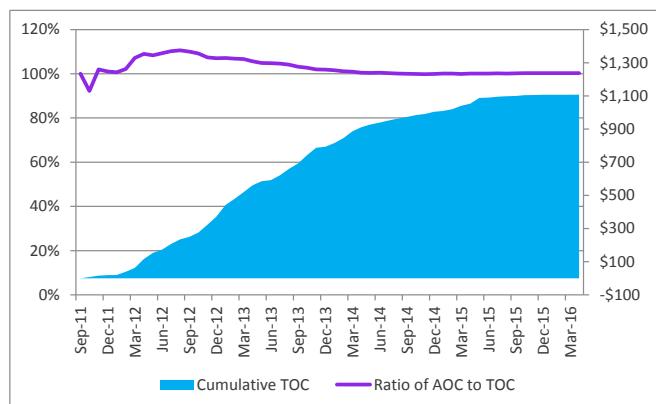
Early Contractor Involvement

Delivery Teams contributed to the formation of project TOCs via an Early Contractor Involvement (ECI) process. This involved attending meetings, risk workshops, and by providing a series of required deliverables to SCIRT's estimating team for consideration when developing the final Construction TOC. For further detail about the ECI process and deliverables, refer to the SCIRT Construction Management Plan.

Fast, accurate and repeatable

With 634 projects to estimate, SCIRT's estimating framework had to be three things: fast, accurate and easily repeatable. To ensure fast through-put, the estimating team set itself a "stretch target" of 30 days to complete each construction TOC.

Although each project had unique aspects, there were similarities that could be applied across asset types (e.g. for wastewater assets: manholes, pipe lengths etc.) which allowed for an easily repeatable approach to initial TOC development. Standard (yet constantly reviewed and adjusted) libraries of costs and rate calculators were incorporated into the team's software package, enabling estimating consistency and fast turnaround times.



Ongoing improvement: The line in the graph above represents TOC compared with AOC, based on when TOCs were created.

The blue area shows the cumulative TOC amount over time. During SCIRT's ramp-up phase, TOCs were found to be too low and Delivery Teams could not deliver projects to TOC.

As the programme progressed, Delivery Team procurement and delivery and TOC accuracy improved to the point that over the life of the programme, estimates were within 1 per cent of AOC.

The feedback loop: refining TOC accuracy

Each project was estimated twice, in parallel; once by a SCIRT estimator, and once by SCIRT's independent estimator (IE), Bond Construction Management. The role of the IE is explained in further detail below.

Once a project proceeded to construction, Delivery Teams reported monthly to SCIRT IST. They reported progress against forecast final cost while projects were in construction, and Actual Out-turn Cost (AOC) when projects were completed. This regular, ongoing feedback, combined with feedback from the IE, enabled the estimating team to continually monitor and adjust the accuracy of TOC development. This was further complemented by regular, independent audits of Delivery Teams' AOCs by external company WT Partnership.

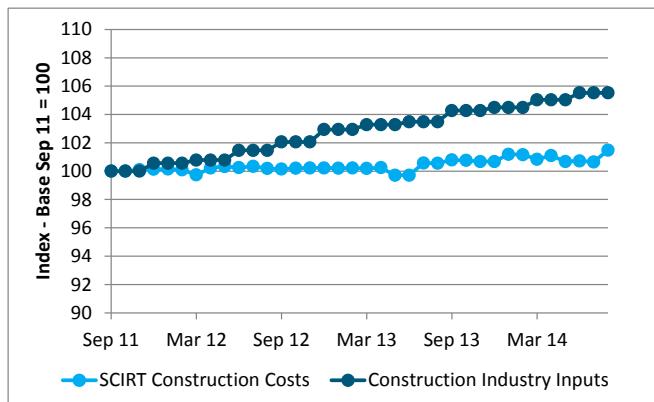
Keeping costs down

Prices and productivity were monitored throughout the programme. A formal review of prices and productivities used in the TOC process was held with the independent estimator at least every six months. The IE kept a database of prices and closely monitored price shifts.

While designers chose the materials, the SCIRT

estimating team researched market prices, working with major suppliers. This didn't preclude Delivery Teams from going elsewhere – they could use their own preferred supply arrangements or carry out the work themselves. While TOCs were based on assumptions of crew and equipment types and sizes, Delivery Teams didn't have to use these. They could also change the "mix of inputs" to reduce overall costs, for example, if labour costs were high for a particular project, the Delivery Team might choose to use more equipment.

Regular pricing audits and reconciliations and ongoing communication with suppliers meant price inflation was kept to a minimum.



Cost control: SCIRT developed an index of key costs, and compared these over time to data provided by Statistics New Zealand for the construction industry.

There was very little movement in these key costs over the life of the programme. SCIRT contained inflation to well below expected, based on national construction indexes. This was mainly achieved by substitution of inputs within projects to avoid cost increases.

Work scope changes

The TOC for each project was estimated according to the scope of the project at the time. The scope could subsequently change if, for example, further site investigations revealed different asset or ground conditions from what the designer had assumed, or if an asset owner wanted to remove or add additional work to the project.

SCIRT established a process for defining and authorising Work Scope Changes (WSCs) which required the estimating team to consider whether an adjustment to the TOC was appropriate. These TOC

adjustments were estimated in the same way as the original TOC using the same rates and prices, where applicable. Refer to the attached Estimating Management Plan for further detail.

Independent Estimator (IE)

Under an alliance contracting model, an independent voice provides confidence that accurate cost estimates are produced. Lyn Provost, Controller and Auditor General, said in her November 2013 report that "The independent estimator's review of SCIRT's target costs for projects to check that they represent fair market pricing is critical to maintaining commercial tension and driving efficiencies".

For this reason, Bond Construction Management, SCIRT's independent estimator (IE), ran a parallel, independent verification process to the SCIRT estimating team. This team was engaged directly by the non-owner participants. There had to be agreement on the TOC (within 2 percent) before it was released to the Delivery Team for construction.

This required both the SCIRT estimating team and the IE to:

- Review the ECI inputs and other information provided to establish and agree a methodology and schedule for the project,
- Obtain specialist subcontractor quotations,
- Carry out site visits, and
- Attend risk workshops.

After completing respective estimates, prices were exchanged and major differences identified. These were analysed and the estimator and IE engaged in constructive dialogue to close the gap.

Once agreement was reached, the SCIRT senior management team undertook a review of the TOC and risk register. Once reviewed and approved, the TOC was released to construction allocation (refer to project lifecycle image above).

The independent estimator and the SCIRT estimating manager carried out regular site visits during the programme to observe work activities. This helped to



On the same page: The estimating manager illustrates a point to the estimators.

confirm actual productivity rates achieved with employed resources. These were then compared with assumptions made in the TOC and adjustments made where necessary.

Independent reviews

The overall efficacy of SCIRT's estimating process and the success of its delivery were acknowledged in an independent report by management consulting firm Morrison Low, in conjunction with Australian firm Evans and Peck. The report was commissioned by the Canterbury Earthquake Recovery Authority and released in September 2014. The abstract of this report is attached.

"Morrison Low's independent review of the TOC-setting process and how the alliance allocated projects, claimed costs and generally administered the alliance showed a high degree of compliance with the terms and spirit of the alliance agreement and strong incentives to undertake the works in the most cost-effective manner," it said.

"At the time of reporting, the estimated value of projects allocated to the SCIRT alliance that were either designed, constructed or to be completed was of the order of \$990 million. We believe that the use of such an alliance framework provided the essential coordination of resources to effectively and progressively investigate, design and deliver such an immense workload in the time required. It would not

have been practical to achieve this through traditional contracting methods due to the lead times required for investigations, design and documentation, competitive tendering, award and, importantly, the lack of resources to manage the contracts."

A further audit was undertaken by the Auditor-General in October 2016 which stated "public entities said the audit framework gave them adequate assurance that SCIRT is well managed and delivering value for money".

Lessons learnt

- **Be open with how estimates are created:** SCIRT's atypical organisational structure and commercial model created useful tensions that don't exist in a typical alliance situation. Cost performance influenced how much work (and fee) SCIRT's non-owner participants received and TOCs had to be consistently fair and reasonable to ensure no Delivery Team was unduly disadvantaged. Estimators and estimating managers in similar situations should prepare to be open and transparent with how estimates are derived, with both clients and construction teams.
- **Take a programme-length view:** All parties working within a similar organisational model need to take a programme view of TOC accuracy. Individual TOCs may vary to some degree, but if the estimating process is fair and unbiased, unders and overs will and did, even out.
- **Prepare for changing requirements:** Estimators and estimating managers in similar situations need to be aware that requirements can change (funding arrangements or design requirements), which can cause a significant amount of estimating rework and potential flow-on delays in programme. It would help to have a plan in place detailing how to proceed should these challenges arise.
- **Team rotation:** Most estimators spent two or three stretches of time in SCIRT's estimating team, interspersed with time spent at their home organisations. The work could be demanding and repetitive; planned rotation in and out of the team

helped to keep individuals fresh and engaged.

- **Estimating team and IE site visits:** Regular site visits allowed the team to get a practical, immediate understanding of whether or not their TOCs were accurate.
- **Standardise designers' bills of quantity descriptions:** To ensure alignment with adopted methods of measurement, further ensuring consistency.
- **Establish Early Contractor Involvement deliverables early:** SCIRT did not finalise its list of ECI deliverables until mid-programme. During the early part of the programme, discussions between Delivery Teams and design teams during ECI were not taken into consideration when calculating early TOCs. This resulted in a large number of work scope change submissions. The situation reversed with the addition of deliverables to the ECI process, which allowed Delivery Teams to provide construction methodology related information (deliverables) to the estimating team for consideration when developing construction TOCs.
- **Refine and review procedures:** Further efficiencies would have been realised if SCIRT's estimating database was regularly maintained and updated with item descriptions and codes which aligned with the method of measurement adopted.
- **Adopt a detailed method of measurement basis of payment manual:** One example is CESMM, which is contract neutral and has been developed in conjunction with all readily available estimating software. This would help avoid variability in rates and educate commercial teams within construction organisations to understand what is included and not included in standard rates.