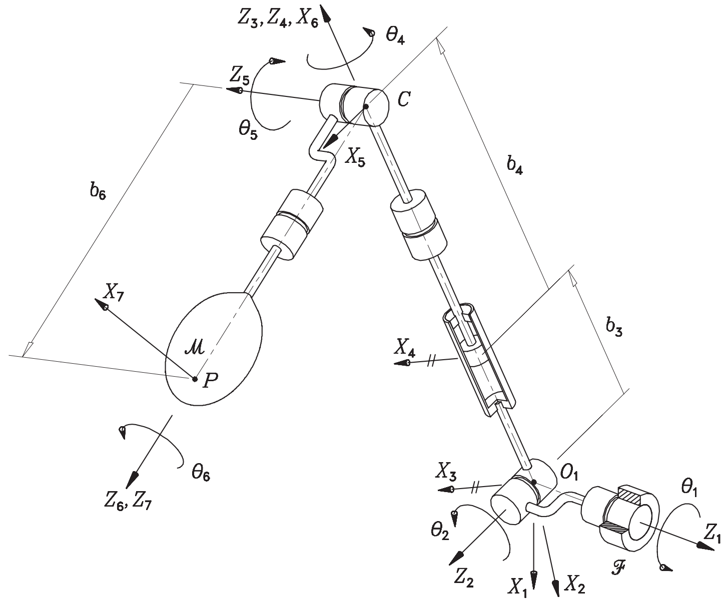


Figure 2.6: The kinematic chain of a flight-simulator limb

and

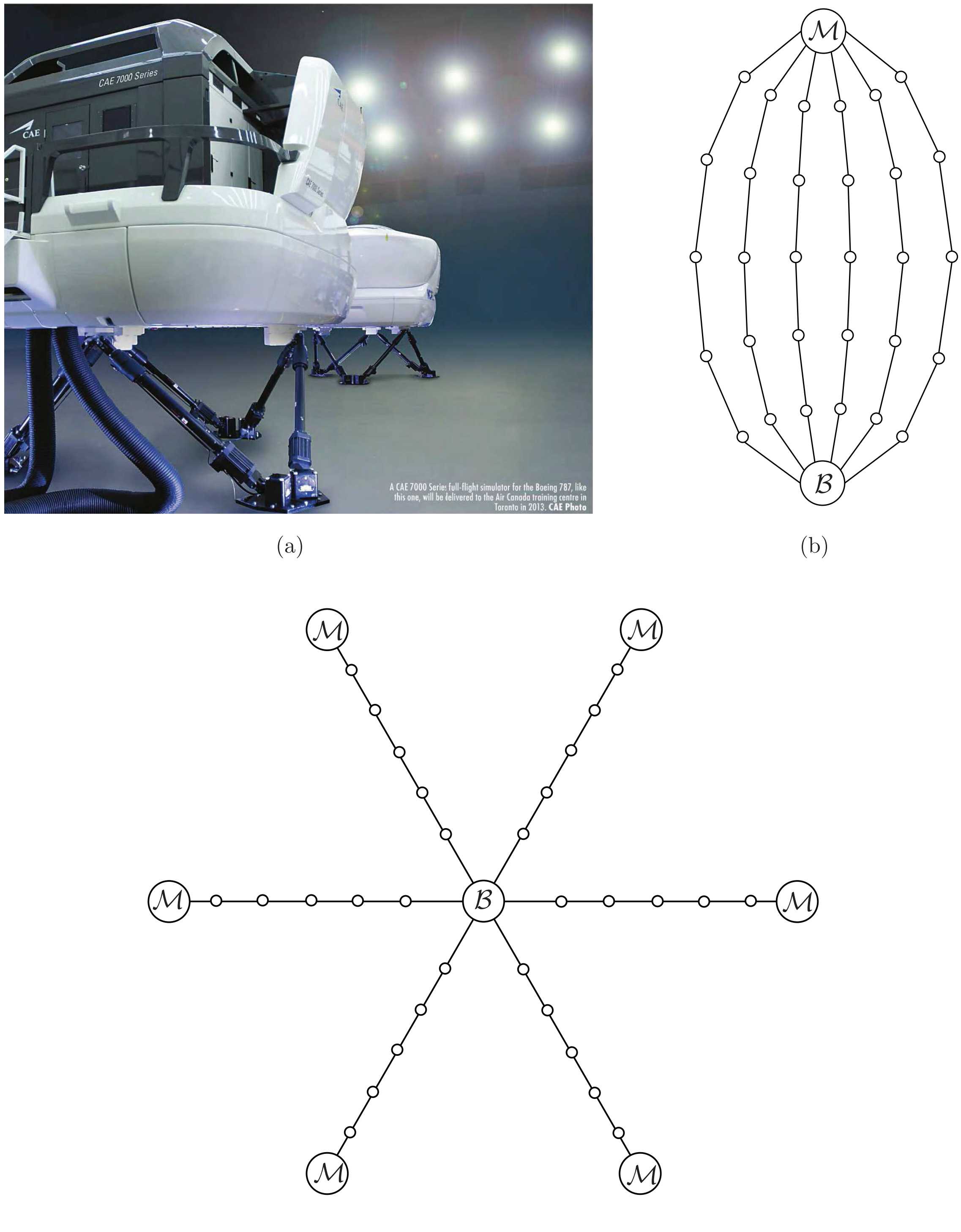
P4 for every $a \in \mathcal{G}$, there exists an element a^{-1}, called the *inverse of a under* $\star$ such that $a \star a^{-1} = a^{-1} \star a = \iota$.

Two types of groups are found, discrete and continuous. The former have a discrete set of elements, the later a continuum. An example of a discrete group is the *symmetry group* of a regular polygon, defined as the set of rotations about the centre of the polygon that leaves the figure unchanged. Continuous groups, or Lie groups, named after the Norwegian mathematician Sophus Lie (1842–1899), are of interest to this section.

If the elements of a set $\mathcal{D}$ are the displacements undergone by a rigid body, then we can define a binary operation $\odot$—read "o-dot"—of displacements as the *composition* of displacements: As the body undergoes first a displacement d_a and then a displacement d_b, taking the body, successively, from pose $\mathcal{B}_0$ to pose $\mathcal{B}_a$, and then to pose $\mathcal{B}_b$, it is intuitively apparent that the composition of the two displacements, $d_a \odot d_b$, is in turn a rigid-body displacement.

More concretely, a rigid-body displacement, illustrated in Fig. 2.8, is defined by a translation $\mathbf{b}$ of a landmark point, say O in the figure, and a rotation $\mathbf{Q}$ about the same point. Point P in the displaced posture is assumed to be the displaced counterpart of a point P_0—not shown in the figure—of position vector $\boldsymbol{\pi}_0$ in the reference posture. Under these conditions, the position vector $\mathbf{p}$ of P in the reference frame $\mathcal{A}$ can be expressed as

$$\mathbf{p} = \mathbf{b} + \underbrace{\boldsymbol{\pi}}_{\mathbf{Q}\boldsymbol{\pi}_0} = \mathbf{b} + \mathbf{Q}\boldsymbol{\pi}_0 \tag{2.4}$$



(a) (b)

(c)

Figure 2.7: A flight simulator: (a) its photograph; and (b) & (c) two alternatives of its graph representation (Permission to reproduce from CAE Electronics Ltd. is pending)

which gives the displaced position of P as a sum of vectors, the second being, in turn, the product of a matrix by a vector. A terser representation can be obtained, involving only