Introduction.

This paper pursues a study devoted to point out geometrical results required by a further structural analysis of physical theories.

In a previous paper [7] we have studied the tangent space of a bundle. Tangent spaces suffice to formulate one - body mechanics, as we are dealing with curves $c : R \to M$, whose differential is a map $dc : R \to T\,M$.
On the other hand, continuum mechanics requires jet spaces, in order to get the derivatives of a field $f : M \to N$ as a map valued on a well structured space $jf : M \to J(M,N)$.

In a way analogous to [7], we show how the affine structure enables us to understand better the nature of jet spaces and of operations on them like Lie and covariant derivatives.

Let M and N be two manifolds. We consider the jet spaces $J^h(M,N)$ and the jet maps $j^h f : M \to J^h(M,N)$ of $f : M \to N$ and the bundles $J^h(M,N)$ on $J^k(M,N)$, with $h > k$. We give an explicit and intrinsic construction of $J'(M,N)$ and $J^2(M,N)$, showing that $J^2(M,N)$ is an affine bundle on $J'(M,N)$. This result can be extendend to higher orders (§ 1).

Let $\eta \equiv (E,p,M)$ be a bundle. We consider the relation between jet of sections JE and jet of maps $J(M,E)$. We give an explicit and intrinsic construction of $J'E$ and J^2E as affine sub bundles of $J'(M,E)$ and $J^2(M,E)$, respectively. This result can be extended to higher orders. We introduce contractions between jet spaces and tangent spaces, which will be used for Lie and covariant derivatives. In the particular case where η is a vector bundle, we show that J^hE is an affine bundle on J^kE, with $h > k$, and we introduce several interesting maps related with tensor product and duality (§2).

Let $\eta = (E,p,M)$ be a bundle. If we endow η with a morphism $B : E \times_M J^k TM \to TE$, affine on hTE and linear on E, we get a Lie operator which unifies the covariant derivatives (k=0), the usual Lie derivatives of tensors (k=1) and of many geometrical objects (§3).

We analyse connections on η in terms of jet bundles and we relate these results with the analogous ones obtained by means of tangent bundles (§4).

In the following, all manifolds and maps are C^{∞}. We leave to the reader the coordinate expression of formulas and the proof of some propositions.